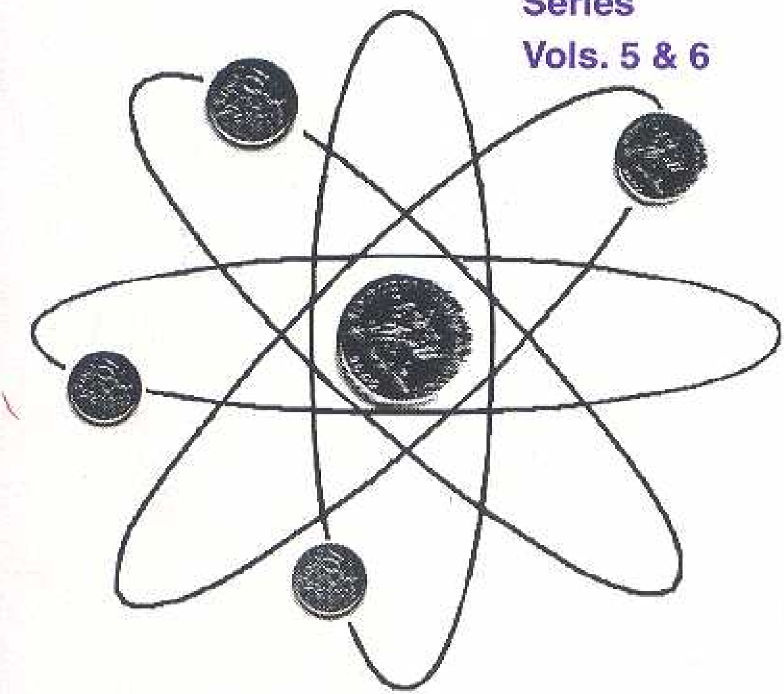
Empirical Studies in Caribbean Economy

Technical Papers Series
Vols. 5 & 6



Edited by
Alain Maurin & Patrick Watson

Caribbean Centre for Monetary Studies

Empirical Studies in Caribbean Economy

This is the fourth publication in The Technical Papers Series of the Caribbean Centre for Monetary Studies. This edition, Volumes 5 and 6 takes a retrospective look at the empirical modelling work that has come out of the Annual Monetary Studies Conference

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Caribbean Centre for Monetary Studies

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Empirical Studies in Caribbean Economy

Edited by

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and
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FOREWORD

Caribbean scholarship has traditionally maintained a theoretical perspective with regard to the way in which our economies work. Consequently, the literature on the region's development is filled with critical theoretical analysis of the workings of Caribbean economies. Yet while this work is not without richness in its interpretation as well as its ideological and policy perspectives, the field of empirical work remains an area that has never been fully developed. So much so that a recent commentary on Caribbean scholarship stated that, at a time when the region faces daunting problems as it approaches the next millennium, the lack of Caribbean conceptualisation and empirical substantiation make Caribbean scholars' arguments merely ideological and undercut their professional commitment to Caribbean development.

This *Technical Papers Series* by the Caribbean Centre for Monetary studies (CCMS) is an encouraging step to redirect Caribbean scholarship towards empirical work. The Series is the product of the annual CCMS Monetary Studies Conference introduced in 1989 to explore the potential of econometric and other quantitative models to meaningfully contribute to economic analysis. The exchange of ideas engendered by these formal "modelling sessions" has proven fruitful and beneficial to all concerned. Discussions have addressed a wide range of existing modelling approaches such as *inter alia* structural econometric modelling, Auto Regressive Integrated Moving Averages (ARIMA) modelling and Vector Auto Regression (VAR) modelling.

However, it would seem that this enthusiasm to apply econometric models in the analysis of Caribbean economies is not shared by policy makers, even though proper policy analysis cannot be creditably conducted without sound empirical and econometric work. In many countries official reports are often underpinned by substantive econometric studies. Yet the same does not occur in the Caribbean despite the impressive amounts of work done by central bankers, academics and other analysts of the region's economic panorama.

Perhaps, more crucially, this means that econometric analysis is being overlooked at a time when new demands are emerging in the discipline of monetary economics with direct implications for public policy. The market-driven process has effectively changed the space in which monetary economics is practised. At the same time the shifting paradigms within the theoretical understandings of the economic phenomena of the process itself has resulted in the new demands being made on the subject. International capital flows, larger monetary unions and different currency arrangements are examples of the phenomena that are redefining economic parameters. Even the field of empirical analysis faces its own challenges brought on by the increasingly volatile and uncertain global environment.

This fourth publication of the Technical Papers Series of the Caribbean Centre for Monetary Studies, bringing together the best papers arising from the Centre's modelling sessions, is but a step towards addressing not only the empirical gap in Caribbean literature, but also the new challenges that have emerged. The book adds value to the world of scholarship as it presents the considerable efforts of many researchers to better understand the Caribbean macroeconomy. Moreover, by addressing a range of different problems using a variety of techniques, the book seeks to interest a wide readership: from the student to the professional economist at the highest levels of the public and private sectors. Like the three publications that have gone before it, this book promises much to all students and practitioners of Caribbean policy analysis and practice.

Winston Dookeran
Governor
Central Bank of Trinidad and Tobago

Introduction

Patrick Watson
and
Alain Maurin

The articles making up this compilation are revised version of papers first presented at the 29th, 30th and 31st Monetary Studies Conferences held, respectively, in Barbados (1997), The Bahamas (1998) and Suriname (1999). These annual conferences, now organised under the auspices of the Caribbean Centre for Monetary Studies, are the successors to the Regional Programme of Monetary Studies. Most of the articles making up this book originate in the special Modelling Sessions of the conference but some originated from the general sessions. Indeed, it is a noticeable trend that more and more of the presentations outside of the modelling sessions give pride of place to econometric and other quantitative methods which is testimony to the fact that state-of-the art econometric techniques are not just the domain of the privileged few. It is the hope and expectation of the authors of this compilation that, very soon, there will be no need for the special modelling session since it will be difficult to establish which papers do or do not belong to this session as opposed to the mainstream conference sessions.

This collection is the fourth in a series. The papers selected here continue the tradition of papers that appear in previous publications like Nicholls *et al* (1996), Worrell and Craigwell (1997) and Kim et Agbeyegbe (1998).

The Monetary Studies Conference has been in existence for more than 30 years now and it seem as good a time as any to take stock of the empirical modelling work that has come out of the sessions. This is the subject of Chapter 1 which is treated by Watson and Smith. In the earlier years of the conference, and certainly before the introduction of the Modelling Session in 1989, most of the work done was classic "textbook" econometrics, accompanied by the classic errors and shortcomings as well. The application of econometric methods appeared more as a formal requirement of scientific work than a genuine tool to aid in economic analysis. Indeed, a lot of the reported results were generally ignored by the various writers when the time came to draw weighty conclusions and make policy recommendations. Often, too, the perceived necessity to ignore the results was attributed to poor data sets.

But the rise of the science of econometrics is a direct result of inadequate data sets. After all, was it not Hendry (1980) who wrote that:

> ...Economic data are notoriously unreliable...and in an important sense econometrics is little more than an attempted solution to our acute shortage of decent data...

The many applied econometric contributions of the 1980s in fact largely ignored some of the serious work going on in the North Atlantic on areas like General-to-Specific modelling, VAR modelling and the related concept of causality and, eventually, unit roots and cointegration. There was still emphasis on the debate between the relevance of Ordinary Least Squares (OLS) as opposed to Two Stage Least Squares, about correcting for autocorrelation and other such standard fare. As it is to be expected, too, the application of even the standard methods was subject to much abuse (see Watson (1987).

There is no doubt about the impetus that the introduction of modelling session gave to the applied econometric work appearing. Perhaps, too, the impetus benefited from the return to the native land of some of our young scholars. They brought with them intellectual zeal combined with knowledge of the modern methods which they had used and even helped to advance during their years of graduate study in well-known metropolitan centres like London and Manchester. The period of "catch-up" had begun and the scholarly contributions reflected this. The concepts of causality and especially those of unit roots and cointegration took pride of place both in and out of the formal modelling sessions.

The remaining chapters in this book are testimony to the creative application of modern methodology to pressing economic problems. In Chapter 2, Craigwell and Warner deal with the ever present and ever thorny problem of unemployment. The aim of this paper is to determine some of the causes of unemployment in Barbados over the years 1980 to 1996 and a very novel econometric method is applied to a 6 equation Autoregressive Distributed Lag (ARDL) model of the Barbadian labour market. It comes out of the work being done at Cambridge, led by the eminent econometrician M.H. Pesaran and emphasizing the modelling of long run structural relationships. The main theoretical reference is Pesaran (1997) and others include Pesaran and Shin (1999) and Garratt *et al* (1999). OLS yields consistent estimators of both the long run and short run parameters of the model employed. Some manipulation is required to obtain the required quarterly data set which may have some influence on the results obtained. The findings indicate that wages paid by the employer is one of the major determinants of unemployment, and therefore, a reduction in social security taxes may be considered. Other factors affecting unemployment were the high levels of hiring and firing costs, indicating that labour market legislation should be re-examined.

Maurin and Montauban take us in Chapter 3 into the realm of state space modelling. Since the seminal work of Kalman (1960), economists have been grappling with the potential of state space modelling for estimation and forecasting. Harvey (1991) is one of the great pioneers in the application of the Kalman filter to economic data. But for many years, economists did not rush precipitously toward the state space approach. Perhaps it was because the methodology appeared difficult.

It was the seminal work of Aoki (1987) that resuscitated interest in these models towards the end of the decade of the 80s. Maurin and Montauban use the Aoki approach to state-space modelling and compare it with different variants of VAR modelling. Using Trinidad and Tobago data, they find that the state space version is a useful alternative to its VAR counterparts.

In Chapter 4, Borda, Manioc and Montauban look at the persistence of shocks in the Barbadian economy. This is undoubtedly the first work of its kind in the Caribbean economic literature. The concept of persistence has become a major preoccupation of scholars worldwide and its interest to Caribbean scholars was inevitable, especially the persistence of monetary shocks, given the active role played by the Central Banks in the Caribbean region. The aim of this paper is to measure the persistence of shocks on sectoral and aggregate output in Barbados and the eventual links that might exist between them. Measures of persistence of sectoral and macroeconomic shocks are discussed and then applied to the Barbadian economy within the framework of a constrained VAR model.

Tourism is one of the main revenue earners in the Caribbean and tourism maturity is consequently a matter of great concern. In Chapter 5 Whitehall and Greenidge for the first time apply econometric methods to the phenomenon of tourism maturity (which means increasing difficulty in attracting tourists despite marketing efforts). The authors argue that existing models of tourism demand (which focus on income and price factors) are of limited utility as they need to be modified for tourism maturity phenomena and related externalities. This paper presents a single equation constrained optimisation Lagrangian model of tourism demand which encompasses both the externality and the income/price factors. Alternative models were tested on data for Barbados, one of the more mature Caribbean destinations. It was found that the standard models are not very applicable to this destination but an improved explanation may be obtained by the addition of tourism interaction externalities such as the tourism density ratio and the relative tourism density ratio. While this result is not unexpected, the value of this effort is in modelling and testing the impact of tourism externalities in a rigorous econometric framework. The significance of the results is the provision of a basis for modelling tourism maturity and confirming the implication of life cycle studies that maturity of a destination alters the demand for the tourism product, irrespective of price/income factors.

In Chapter 6, Kendall looks at the relationship between interest rates and savings in the Guyanese economy and the eventual link to growth in that economy. The Guyanese economy has only recently been liberalised after years of financial repression, making it a good laboratory for the testing of the well-known McKinnon-Shaw hypothesis. The paper reviews interest rate policy in Guyana during the period 1965 to 1995 and an interesting model is set up, estimated and used as the basis of the tests and policy conclusions, in order to examine the validity of the McKinnon-Shaw hypothesis. The model supports the hypothesis that financial repression did lower the level of savings and real income growth during the period.

In Chapter 7, Lattie pursues the measurement of a monetary conditions index (MIC) for Jamaica, an example that will almost certainly be followed in the other territories of the Caribbean region. The paper argues that MICs are applicable to the Jamaican economy especially since deregulation and liberalization of the financial sector in 1991. The results obtained suggest that the index is most useful when the exchange market exhibits stable conditions and could be a constructive tool in the simultaneous management of the foreign currency and domestic money markets. The results also suggest that extending the current framework to include the MCI as an auxiliary operating target would be useful since it retains its simple property of ease of calculation and displays close association with domestic inflation.

Finally in Chapter 8, Watson and Teelucksingh develop a medium-size structural econometric model of the Trinidad and

Tobago economy. The authors argue that their paper is an exercise in econometric modelling as much as it is an attempt to derive appropriate policy measures and to forecast key macroeconomic variables of small open economies like that of Trinidad and Tobago. They find that the proposed econometric model provides a good fit of the data. They use it to make some general conclusions about the relative usefulness of monetary and fiscal policy and make recommendations about using the model for forecasting.

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CHAPTER 1

THE CONTRIBUTION OF THE MONETARY STUDIES PROGRAMME TO CARIBBEAN ECONOMETRIC MODELLING

Patrick Kent Watson
and
Nicole Smith

The Contribution of the Monetary Studies Programme to Caribbean Econometric Modelling

Patrick Kent Watson
and
Nicole Smith

ABSTRACT

This paper reviews the contribution of the annual monetary studies conferences of the CCMS to econometric practice in the Caribbean region. It examines a series of papers presented at these conferences in the light of existing econometric theory and practice and the role that the econometric results play in arriving at serious theoretical and policy conclusions. Some shortcomings are uncovered but the general trend has been a positive one.

Keywords. Econometric methods, econometric practice.

INTRODUCTION

Many Caribbean economists are agnostic when it comes to econometrics. Privately they condemn it; publicly they ignore it. The many papers containing applied econometric work that have come out of the RPMS/CCMS conferences may appear to belie this assertion but this is only on the surface. By far the majority of papers presented at the RPMS do not have an econometric component. Furthermore, the so-called modelling session that came into existence in 1989 first appeared as an appendage to the conference and was even held after the closing ceremony. Up to the present time it is seen as a departure from the main proceedings and many of the major participants have voiced concerns about the validity of the exercise.

The paper examines a sample of the contributions of papers with an econometric content presented at the Monetary Studies Conferences. We attempt to evaluate

- the soundness of the econometric practice at the time
- the conclusions drawn and suggested policy prescriptions
- the contribution to the understanding of the Caribbean economic reality
- the contributions to Caribbean econometric practice

We deal with these areas of interest under the following headings:

1. Money, Banking and Related Matters
2. Savings
3. Macroeconometric modelling
4. Exchange rate determination, the foreign exchange reserves and related matters.
5. The Stock Market, Capital Markets and Volatility
6. Inflation rate and Interest rate determination
7. The Balance of Payments.

MONEY, BANKING AND RELATED MATTERS

One would expect that a conference devoted to monetary studies and funded by the Central Banks of the Commonwealth Caribbean would give pride of place to this subject matter. There has been a significant number of research articles arising out of the RPMS/CCMS devoted to this area. Some of the areas of concern dealt with are the following:

- commercial bank portfolio behaviour
- the determination of the money supply
- the estimation of the money demand function
- the role of interest rates as an instrument of monetary policy
- the monetary transmission mechanism
- the demand for commercial bank deposits and loans

In many cases the econometric study was not central and the results, even by the authors' own admission, were not helpful. There was a general reluctance to let the econometric results prevail over *a priori* theoretical considerations.

A very good example of commercial bank portfolio behaviour is Bourne (1977). This is a fairly sophisticated paper from a mathematical point of view. Utility functions are used to derive estimable equations. The results are presented in a five-equation model with cross-equation restrictions. A seemingly unrelated regression model is obtained and an appropriate estimation method applied using quarterly data for the period 1962 to 1971. The results are generally useful and several conclusions are drawn. The most significant finding of the study is that deposit liabilities are the main single determinant of short-period changes in the portfolio of the banks. It is established that the rate (nominal) of interest is not a significant variable in the determination of portfolio allocation and that the 1967 devaluation of the pound resulted in a shift of resources away from foreign denominated securities.

Ramsaran (1980) was interested in establishing the determinants of the money stock and the implications for monetary policy, in particular the control of the monetary stock. In a style typical of other papers he presented at conferences, he fits a series of regression models using, in this case, the two general forms below:

$$H = f(CAB)$$
$$H = f(BOP)$$

H is high-powered or base money, CAB, the current account balance and BOP, the Balance of Payments. The author makes no reference to the fact that CAB is a component of BOP and BOP in turn is a component of M_2 (money supply broadly defined). So, in the first instance, there is no real difference in the explanatory variable. Secondly, if the analysis had been taken one step further, and M_2 used instead of CAB or BOP, this would have resulted in an estimation of the so-called money multiplier (which, in our view, can be better measured directly as M_2/H). Ordinary Least Squares (OLS) is used to fit the models.

D. Worrell (1983) looked at growth in banking activity and tried to account for changing patterns in demand for banking deposits by the public. The paper also addressed the assets side of the balance sheet and looked at the demand for loans as well. The identification problem was evident as a number of the coefficients of the demand functions had positive signs, which may suggest that the function estimated was actually a supply function (or some hybrid). This paper could have benefited from an incorporation of the disequilibrium methods introduced by Fair and Jaffe (1972) which allow the economic investigator to differentiate between demand and supply series. The use of nominal rather than real income values was another shortcoming of the paper.

St. Cyr (1978) questioned whether the money supply was responsible for the inflationary process in Trinidad and Tobago. He fitted the following function:

$$p = f\left(\frac{M_d}{M_s}\right)$$

where p is the price level. It is not quite clear how the author distinguished between money demand and money supply since he assumed the existence of money market equilibrium in the paper.

Ramsaran and Maraj (1985) attempted to fit a series of demand for money functions for the period 1970-1974 for Trinidad and Tobago. Once again the estimated coefficients suggested that identification was a problem (was it money demand or supply?). The authors also seemed to believe that elasticities could be derived only from a double logarithmic model. There were also significant data problems identified, such as whether permanent, real, or nominal income should be used in the estimation. Ramsaran and Maraj considered all these possibilities and concluded that the interest rate was not a determinant of the demand for money in Caribbean economies. Bourne (1977) had already come to this conclusion. The authors also suggested that the $\bar{R}^2$ statistic tended to be lower for real rather than for nominal values. This statement is not entirely a valid one as in some of the cases the dependent variable differed; comparisons based on $\bar{R}^2$ are then not valid. Ramsaran (1991) followed this exercise on the demand for money with a paper that estimated an income velocity of money function. The author selected an equation that described the velocity of circulation of money as a function of income and the rate of inflation. He described in depth the perceived significance of the level of income to the income velocity of circulation in Barbados, Guyana, Jamaica and Trinidad and Tobago. The precise nature of the influence of the rate of interest variable on the velocity of circulation was inconclusive. The authors, however, attempted to grapple with a useful problem.

In the Ramsaran papers, the authors fitted a myriad of functions in an attempt to derive the significant explanatory variables in the equations. This practice ran counter to the LSE methodology of "general to specific" modelling, which was already growing in popularity since the appearance of Davidson et al. (1978), and is reminiscent of data mining (see Lovell 1985).

Watson (1996) moved away from the traditional methods in an attempt to model the money transmission mechanism in the Trinidad and Tobago economy. His paper applied the Vector Autoregression (VAR) methodology to quarterly data to derive a link between the monetary and real sectors. The empirical evidence was used to conclude that both money and credit matter in the transmission process but that money played a more important role. This paper represented a first attempt to apply VAR analysis to monetary studies in the Caribbean's RPMS Conferences.

Savings and Investment

Banks and banking instruments are the first choice of Caribbean savers. The importance of savings to the Caribbean society cannot be overemphasized. Accumulated savings is the prime mover of economic activity. To some extent, the issues addressed in this category were already raised in the previous section.

Ekanyake and St. Cyr (1991) attempted to establish a savings function for Trinidad and Tobago. They first looked at savings as obtained from two household budgetary surveys and then national savings obtained from the national income accounts for the period 1955 to 1987. They fitted the following function:

$$S = f(Y, r)$$

where S is the national savings level, Y is national income, and r the rate of interest. The key concern was the question of the validity of the McKinnon/Shaw hypothesis (i.e. whether or not the interest rate variable was a significant determinant of savings) compared to, say, the Keynesian hypothesis. The authors expressed little confidence in the results of the estimation exercise. They estimated a marginal propensity to save of 36% over one period covered by the data and then of 22% in a later period. It is hardly likely that these results would differ so significantly over this time period and, at any rate, both appear unduly high for Trinidad & Tobago.

Ekanyake and St. Cyr also looked at national income data for the entire period 1955-1987, then for the sub periods 1955-1973 and 1985-1987. A causality test was introduced to determine whether interest rate caused savings or vice versa. The results of the causality test showed that interest rates caused savings, yet the interest rate variable was not significant in the regression exercise. Estimates of the marginal propensity to save, once again, differed significantly over the duration of the study. They also fitted a simultaneous model based on the model introduced by Leff and Sato (1975) with no particularly startling results.

Ramsaran (1981) also attempted to develop a savings function with an objective similar to that of St. Cyr and Ekanyake and fitted the following savings function for the Trinidad and Tobago economy:

$$S = f(Y)$$

He established that the (nominal) interest rate was insignificant, excluded it from the regression and concluded that policy measures to increase the level of savings should not involve the interest rate. The use of nominal interest rates in this exercise, however, could have masked the trend in the real interest rates.

Watson and Ramlogan (1990) looked at a savings function for Trinidad and Tobago and attempted to discern the direction of causality between real interest rates and the level of savings. They verified that real interest rates are significant, more so in the long run than in the short run, and they also Granger-cause the national savings level. The authors adopted an Error Correction Mechanism (ECM) as introduced by Engle and Granger (1987). They employed the Engle and Granger two step procedure to estimate the ECMs. The Engle-Granger cointegration test was also incorporated in the analysis. That the interest rate is an important determinant of savings, especially over the long run, sharply contradicts the results of previous studies like those of Bourne and Ramsaran. This may be a direct consequence of the use of the Engle-Granger methodology which was not available for use in earlier studies. Foreign savings were also found to be very important and, indeed, was a more important determinant of national savings than interest rate in the short run.

Watson (1993) employed panel data techniques to look at savings functions in the OECS region. He was concerned with the econometric validity of using these methods in general and showed them to be valid only if some important underlying assumptions were pre-tested. The author observed that savings functions throughout the OECS were disparate and concluded that those functions should be fitted separately for each country and not pooled. Watson also concluded that foreign savings were dominant in some cases and not in others. Also, the McKinnon-Shaw hypothesis was rejected in some, but not all, cases.

Ramlogan and St. Cyr (1991) attempted to derive the determinants of private investment. They fitted the following function:

$$I_P = f\left(GDP,\ I_g,\ W_r,\ C_p,\ S_f\right)$$

where I_p represents private investment, GDP gross domestic product, I_g public investment, W_r the real wage rate, C_p domestic consumption, and S_f foreign savings. There were two immediate problems with this regression. First, the authors used nominal values in their calculations instead of constant price values: there was no attempt to deflate the variables used. Secondly, they derived private investment as a residual, obtained by deducting government expenditure from total investment.

They concluded that the crowding-out effect was evident for the Trinidad and Tobago economy. Further they rejected the McKinnon/Shaw hypothesis and observed that the level of foreign savings was a significant determinant of private investment in Trinidad and Tobago. Crowding-out was verified even more forcefully for Jamaica but rejected for Barbados.

Watson (1992) estimated a private investment function for Guyana using constant prices but used the retail price index as a deflator. This, of course, is a very unreliable indicator of the level of investment prices. Watson rejected the crowding-out theory for Guyana and concluded that public investment was a major determinant of private investment in Guyana. The McKinnon/Shaw hypothesis was verified in that the real interest rate was significant. The author incorporated the Engle-Granger two-step procedure to establish cointegrability among the variables over the period 1970 to 1990. The ECMs were successfully established.

Macroeconometric Models

It was perhaps inevitable, given the thrust of econometric modelling all over the world, that this aspect of applied econometric work would receive considerable attention in the Caribbean. Some of the macroeconometric models presented at the CCMS/RPMS conferences are under the guise of monetary models and done within a monetary framework, like that of Keith Worrell (1979). This is an example where the author specifies, estimates, and tests a macroeconometric model based on the work of Linder (1967).

The author estimated an eleven equation model (five identities) of the Jamaican economy. He utilized the two-stage least squares (2SLS) estimation method and compared them to others referred to as OLS. There was a serious attempt to validate the model using standard statistical criteria and other tests such as the Bassman overidentification test and the Theil forecast errors test. This work represented a reasonably careful application of existing econometric methodology at the time the author was writing. The ESP programme was used to calculate coefficient estimates. The money supply equations were fundamental to the system. They were, however, estimated in the differenced form which could be indicative of some misspecification. It is small wonder then that these results were "most disappointing." The author attributed the failure of his model to the presence of multicollinearity, which is not always clearly discernible. Worrell was not satisfied with the model and was not prepared to discredit *a priori* expectations which the results seemed to challenge.

Worrell and Holder (1979) presented another example of an econometric model which was also a monetary model in the sense that it focused on the instruments of monetary policy. It was clearly a first stage in the development of an overall model that linked the real to the monetary sector. The model was highly aggregated and was estimated over the period 1946-1978 using the two-stage least squares (2SLS) estimation method. It contained 10 equations, 5 of which were behavioural. There was some attempt at evaluation, such as the use of the R^2 statistic, the student *t*-statistics and the Durbin-Watson (DW) statistic, in the presence of 2SLS estimation. This practice was criticized by Watson (1987). Further, in one specification, high R^2 values coexisted with low DW statistics which may be suggestive of spurious correlation.

Interestingly enough, it was established that the demand for loans was positively related to the interest rate. This is a perverse result and might imply that the authors estimated a supply function instead of a demand function. At the time the paper was written, the literature on disequilibrium models was new, but the classical identification problem was already established. The simulated values were used to evaluate this model, but these results were poor. Once again, this did not deter the authors from recommending the use of the model based on its *a priori* construct.

Joefield-Napier (1979) constructed a quarterly model of the Trinidad and Tobago economy with objectives somewhat similar to the Worrell/Holder model. He attempted to answer the question, "Does money matter?" (Worrell 1979 and Watson 1994 also raised this issue). The author fitted his model with data spanning the period 1970 to 1978. OLS was the estimation method. In addition, the author estimated an aggregate export function. Trinidad & Tobago exports are dominated by the export of oil and therefore, in our view, exports should be exogenous. Both the money demand and money supply variables were incorporated into the analysis. It was not clear why the author did this since he had previously established that these two variables were in equilibrium and the published values identical.

Other macroeconometric modelling papers of note include Williams (1985). This author looked at a portfolio balance model. The demand for money was incorporated through a partial adjustment process and the supply of money was assumed to be exogenous. The three stage least squares (3SLS) procedure, with correction for serial correlation, was used to estimate the model. The model used quarterly data for the period 1966-1983. The poor results were blamed on "data problems." Around this time, Samuel (1986) presented a critique of these models and called for the incorporation of disequilibrium systems and rational expectations functions using Lucas' critique at the estimation stage.

Henry *et al* (1989) and Watson and Teelucksingh (1995) represent attempts to estimate fairly large macroeconometric models in the Caribbean. In the paper by Henry *et al*, the stated objective is "to map out the course of the Trinidad and Tobago economy in the next five years." The paper attempted to predict the movements of the major macroeconomic variables, in particular GDP, the government budget balance, the balance of payments and the unemployment rate. The model was estimated using annual data over the time period 1966-1986. The 2SLS method was applied to blocs in a model that the authors claimed to be bloc recursive (the justification for this claim is not evident from the paper).

The model employed 34 equations with 18 exogenous variables. It was evaluated using ex-post forecasting for the period 1987 to 1988 and ex-ante forecasting over the period 1989 to 1993. On both grounds the results were not convincing: Simulations did not track properly and forecasts had very large errors. Watson (1994) discussed some of the shortcomings of this CBMOD1 model developed by the Central Bank of Trinidad and Tobago. CBMOD1, however, represented a comprehensive attempt to deal with macroeconometric policy formulation for the forecast period spanning 1989 to 1993. It was a classical approach to modelling and for that period, it was the largest macro-econometric model of a Caribbean economy.

The Watson and Teelucksingh (1995) paper is a cointegration approach to estimating a multiple equation system in which a variant of the LSE "general to specific" modelling methodology is employed. This paper presented a relatively large model with a prolific use of identities as compared to the paper by Henry et al. The paper drew policy conclusions about the relative strengths and weaknesses of fiscal and monetary policy.

The Exchange Rate, Foreign Exchange Reserves and Related Matters

The foreign exchange rate is one of the most significant variables in very small open economies like those of the Caribbean region. The exchange rate has both economic and social implications and can greatly affect the well-being of Caribbean nationals. The collapse of the Bretton Woods system in 1973 resulted in a reversion to a flexible system of exchange rate determination for the metropolitan countries. The experience of the Caribbean with a floating exchange rate regime can be traced to the liberalisation of markets in Guyana, Jamaica and Trinidad and Tobago. Jamaica has the greatest experience with the use of alternative management techniques in fixed and floating systems. The exchange rate has appeared as an explanatory variable in several of the econometric models derived in previous studies. The exchange rate as a dependent variable became more pronounced in the period after the liberalisation of Caribbean rates of exchange in the 1990s. This section focuses on the following areas:

- the determination of the exchange rate;
- the validity of the notion of purchasing power parity to the Caribbean economy;
- the impact of a devaluation on the balance of payments;
- the existence and nature of exchange rate volatility and its implications to the real sector.

Ramcharran (1983) developed a small model to analyze the impact of devaluation on the demand for imports and exports in Jamaica. An aggregate import function was fitted, followed by separate fits for imports of consumer durables, consumer non-durables, raw material and capital goods. The explanatory variables in the demand for imports function were real income, the price index of the export commodity and the exchange rate. Log linear demand functions were employed.

Exports were treated in a similar fashion: an aggregate function, then separate functions for bauxite, sugar and alumina were estimated. The explanatory variables selected for the demand for exports function were real income, the exchange rate, the price index of the import commodity, and gross foreign reserves.

The annual data spanned the period 1969 to1978 which the author acknowledged as "too short for time series analysis," yet he proceeded with the estimation and results. The results denoted low R^2 statistics, insignificant coefficient values and a DW statistic that indicated the presence of serial correlation. Yet the author concluded, on the basis of such questionable results, that a devaluation would significantly affect the levels of imports and exports in the Jamaican economy.

Gajadhar (1990) used annual data covering the period 1962-1988 and OLS to estimate an exchange rate function. The independent variables used were domestic inflation, international inflation, the balance of payments and a time trend (the latter was used to capture the effects of the progressive deterioration of the public debt position). The "independence" of (at least) the balance of payments variable may be debatable since it may be argued that the balance of payments is itself a function of the rate of exchange. The use of cointegration or even causality analysis, already fashionable by this date, might have shed some light on this question. The results showed a high R^2, no clear evidence of serial correlation and coefficients which were significant. The author nevertheless attempted to correct for possible serial correlation using the Hildreth-Lu procedure at a time when this practice was under severe attack by the general-to-specific school and when there was really no real need to do so.

Ghartey (1994) used the framework of the monetary approach to fit a model of the exchange rate and attempted to test the purchasing power parity theory for Trinidad and Tobago, Jamaica and Barbados. He fitted the rate of change of the exchange rate as a function of the difference in the change of domestic and foreign price levels. The monetary approach to the exchange rate equation purports that the exchange rate is determined by the difference in the domestic and foreign money supply variables. The author tested for seasonal integration and cointegration and used seasonally differenced quarterly data for the period 1960:01 to 1992:04.

The results indicated that there were no seasonal unit roots for the countries in the study while The Dickey-Fuller (DF) tests showed all the series to be I(1). It is no great surprise that seasonality should count for very little in the variables probably because "quarters" in the context of the English speaking Caribbean may not have the same meaning as it does in a 4-season country like the USA. Seasonal influences are likely to be reflected more in monthly data but when aggregated into quarterly data the effects might be "smoothed" out. The causality tests indicated that the change in the money supply variable Granger-caused the change in the exchange rate in Jamaica only. The study consisted primarily of reports of the findings of the estimation exercise. There was little discussion on the policy conclusions of these results.

The Rate of Inflation and The Interest Rate

The price level and the rate of interest are the equilibrating variables in the goods and money markets respectively. Inflation is defined as an appreciable and sustained increase in the level of prices. During the 1980s chronic balance of payments deficits and frequent realignment of the exchange rate were significant factors influencing the increase in the rate of inflation for the Caribbean countries. In the previous sections, we have shown that the RPMS/CCMS authors have all but excluded the nominal interest rate as a significant variable in the determination of the demand for money and the level of national savings. In this section, the authors were primarily interested in the determinants of the level of inflation and the real interest rate.

Using a single equation system, Thomas (1992) derived an inflation function for Jamaica that was solely dependent on the impact of the exchange rate. That is to say, he attempted to model the inflationary response to the magnitude and duration of exchange rate shocks. The openness and smallness of the Jamaican economy implied price-taking behaviour, hence the exchange rate was a significant explanatory variable. The author acknowledged that a more complete analysis would involve an assessment of the role of external shocks and domestic monetary shifts in stimulating inflation, through the adaptation of a simultaneous equation model. This paper is very much policy oriented. Thomas chose Jamaica because of its repeated attempts to use the exchange rate as an instrument during the 1980s. A monthly distributed-lags system was used to capture the dynamic features of the process of the inflationary response to exchange rate changes. The classic Koyck transformation method was employed to fit a monthly model of the response of the consumer price index to changes in the exchange rate.

The incorporation of the distributed lag system implies a monotonic decreasing effect as one moves into the past in relation to an exchange rate shock. The Koyck transformation was used to obtain a model containing a lagged value of the endogenous variable. Thomas claims, with no justification, that this transformation also results in elimination of serial correlation. In fact, it is well known that the disturbance term of the original distributed lag model is assumed to be white noise and, indeed, with the presence of sufficient lags, is very likely to be. The disturbance of the transformed model, on the other hand, was serially correlated as an MA(1) process. OLS results were then biased AND inconsistent (and not consistent as Thomas claimed). This model was fitted for two time periods, January 1978 to December 1980 and January 1984 to December 1989, since the exchange rate was fixed for these periods. The paper concluded by noting that the effects of the exchange rate on inflation were temporary, with the implication that policy can affect nominal and not real exchange rate values.

Joefield-Napier (1975) was concerned with the real causes of the inflationary spiral in the Jamaican economy. He investigated several theories that relate the inflationary process to changes in domestic money supply, the cost of production, and structural imbalances. The author claimed that inflation in Jamaica goes beyond the classical cost-push, demand-pull scheme, and inflationary explanations must be expanded to incorporate the role of the rate of interest and government monetary and fiscal policies.

Joefield-Napier begins by providing a lengthy theoretical discourse on the possible causes of inflation in the Jamaican economy. Annual data for the periods 1959 to 1972 are used in the study. The author derives estimates of the expected rate of inflation from the rural and urban consumer price indices. He fits a model in which the demand for real money balances is a function of the expected rate of change of prices per month. Thus it appears that the author is concerned with the issue of causality between the real demand for money and the expected rate of inflation.

There is minimal use of econometric methods in this paper. The results of the estimation of the foregoing exercise are very poor with low R^2 and *t* statistics that imply a non-rejection of the null hypothesis. Joefield-Napier points to the presence of serial correlation but makes no attempt to deal with it. The author then fits alternative models of the demand for real money balances using different definitions of the money stock and concludes that there is a high income elasticity of demand for real money balances. There is no discussion of the identification problem and the equivalence of money demand and money supply is implicit in the analysis. The author justifies his *a priori* expectation largely through the analysis of the trends of macroeconomic variables rather than through the incorporation of econometric methodology.

In another paper, Joefield-Napier (1977) attempts to discern the linkages between foreign interest rates in the North Atlantic countries and domestic interest rates in the Caribbean economies. He incorporates the works of Thomas (1965) and McClean (1975) who viewed the linkage as arising out of the policy of Head Offices in the metropolitan countries, and structural and institutional factors, respectively. The equation fitted showed the three-month treasury bill rate for the UK as a function of the three-month treasury bill rate of the US, Canada, and the Caribbean (Guyana, Jamaica and Trinidad and Tobago), a rate differential and a dummy variable representing the oil shock.

Serial correlation is detected in the equation studied so the author then estimates the equation in the first differences which he hopes would lead to the partial elimination of the problem of serial correlation. This was a fairly standard practice at that time but we now know that it results in a misspecified model if, as is likely, the variables are I(1) and cointegrated. He also attempts to estimate the rate of harmonization between the Caribbean interest rates and those of the North Atlantic. A simple correlation matrix is constructed but the results are not definitive. This paper fails to draw concrete conclusions about the association between Caribbean and international interest rates, but it does provide some useful suggestions for the investigation of a more disaggregated model of financial flows between the two regions.

Bourne and Persaud (1975) attempt to discern the effects of selected financial variables on the inflationary process in Trinidad and Tobago during the period 1967-1974. A hybrid of the demand-pull and the cost-push theories of inflation was chosen as the selected methodology. The authors developed a recursive structural model based on a system of thirteen equations. The endogenous variables were the rate of change of prices, the total supply of goods and services, the final demand accounting relation, the balance equation for final goods and services, the consumption function, the investment function, government expenditure, money demand, the wage rate and import prices. The money supply process was assumed exogenous. This simultaneous system of equations was solved to obtain the reduced form. Quarterly data for the period 1967:01 to 1974:04 were used in the estimation exercise. The assumption of static prices implied that there were no lagged endogenous variables in the equation. The authors determined the lag length of the explanatory variables by incorporating a rudimentary stepwise regression to the log-linearized price equation. They excluded those variables that added less than 0.6 to the value of the adjusted coefficient of determination. The authors then fitted a range of reduced form equations that incorporated various combinations of the selected explanatory variables. Finally the authors reported on the significance of the selected coefficients. They concluded that government financing and the exchange rate were the most significant determinants of the inflationary process, while domestic credit had minimal influence.

Syfox (1991) provided a quantitative analysis of inflation in post-independence Guyana. The selected inflation rate equation was a function of the rate of growth of the money stock, the rate of growth of nominal interest rates and the rate of growth of real incomes. The author relied on the theoretical underpinnings of the Monetarist, Keynesian, and structural view of the inflation process to determine the model to which Guyana best conforms.

This study is one of the earliest cases of the application of the general-to-specific methodology in the Caribbean and, in the spirit of Hendry's (1980) "test, test and test," Syfox conducts a battery of tests to justify the validity of the model. First, he tested for the presence of heteroskedasticity and rejected this hypothesis. Second, he tested the data for the presence of ARCH processes as outlined by Engle (1982) and concluded that this type of heteroskedasticity did not affect the model. The models were tested for first, second and third order autocorrelation and the author concluded that there was no serial dependence in the error terms. The author then justified the absence of multicollinearity by demonstrating that there was little change in the parameter estimates based on minute changes in the sample size. He further employed the Ramsey Reset test for misspecification and the Chow test for structural breaks. Syfox concluded that foreign inflation, the exchange rate and import price elasticities seemed to be the most significant cause of domestic inflation in Guyana.

Robinson (1996) uses a Vector Autoregressive ECM model to explain the monetary transmission process and to forecast the inflation rate in Jamaica. He fitted a monthly model of the inflation process for the period 1980:01 to 1995:12. The long run static model provided very good results with a high R^2 statistic and significant explanatory variables. The short run ECMs also resulted in a fairly good fit. The author was, however, cautious in suggesting the causality of the relationships based on the apparently high correlations. The paper provided an in-depth discussion of the origin, advantages and disadvantages of adopting a VAR specification methodology over conventional models. Robinson concluded that expansionary monetary policy has an expansionary effect on prices, while contractionary policy has a lag effect of at least two months. Exchange rate stabilization was suggested as the most effective way of reducing price instability.

Samuel *et al.* (1994) attempted to investigate the extent to which price convergence has been achieved in the CARICOM region. They employed cointegration methodology to assess the perceived stability of the long-run relationships among similar variables in the region. A quarterly VAR using data for the period 1957:01 to 1993:04 was used to test whether the inflation rates in Barbados, Dominica, Jamaica and Trinidad and Tobago had, in fact, converged to the 'core' US inflation rate. The data set consisted of the consumer price index (CPI) for the CARICOM countries and the producer price index (PPI) for the United Sates. The order of integration of the variables was determined at the seasonal frequencies, after which the authors tested for the presence of a cointegrating vector among the variables at the appropriate frequency. With the exception of Dominica, seasonal dummy variables were not significantly different from zero. The Johanssen test revealed some convergence among the US, Barbados and Dominica rates but not among the US, Jamaica and Trinidad and Tobago rates. The authors attributed this divergence from their *a priori* expectations to the presence of exchange rate volatility in these two countries. Further, they believed that a monetary union could be achieved within a floating exchange rate regime as long as the floating exchange rates are stable. Hence, despite the empirical results, the authors were generally unwilling to alter their *a priori* expectations. Instead, they cited the characteristics of the data set as the prime reason for the disparity of their results from what they anticipated.

The Stock Market and Volatility Persistence

Some of the more "frontier type" econometric methods are to be found in studies devoted to stock market volatility and volatility persistence. The modelling of stock market behaviour in the Caribbean is closely related to the examination of volatility in stock returns. There is some overlap within this topic area into the examination of volatility in exchange rate returns.

Bourne (1985) presents a highly descriptive paper on the economic aspects of the Trinidad and Tobago stock market. He examines the coefficients of variation, weekly percentage changes and standard deviations of stock prices as indicators of volatility. Pooled data on seven manufacturing firms and three banks over the period 1971 to 1982 are used and equations for the bid price are estimated. The results show that the yield and price earnings ratio are significant in the determination of bid prices of manufacturing firms, while the dividends ratio and the post tax profits ratio best explain the bid price in commercial banks. Bourne further addresses the issue of stock market efficiency through the evaluation of a log-linear random walk model of stock prices. The results show that there is serial dependence in six of the sixteen stocks examined. The market is, therefore, inefficient as there is no independence in successive changes in stock market prices. Finally, the author attempts to determine the extent of influence of inflation on stock prices and returns through the application of a simple linear regression model. All the hypotheses put forward by the author are examined using the traditional approach of the application of OLS to a linear model and the verification of the significance of explanatory variables from observation of the standard t and F tests. At the time when this paper was written, literature that addressed the issue of volatility in a non-linear environment was already available. This paper could have, therefore, benefited from an incorporation of an ARCH type process to examine the issue of non-linearity or volatility persistence in the error term.

Leon (1991) presented what is probably the first Caribbean study of volatility within a Generalised Autoregressive Conditional Heteroskedastic (GARCH) framework. His paper demonstrated that the observed autocorrelation of stock price returns in Jamaica could be modelled as a GARCH process. The monthly data for this exercise extended over the period 1969:07 to 1988:12. Leon first established the existence of unit roots in the data through the application of the Dickey-Fuller tests and observations of the autocorrelation and partial autocorrelation functions. He then fitted the data to a GARCH-in-mean process. The results indicated that 54% of the shocks persist after one year. This, he believed, could lead to expenditure switching by risk-averse economic agents as stock returns are negatively related to volatility. The author suggests that a stable macroeconomic climate is required to stimulate the growth of equity markets in developing countries.

Kim and Langrin (1996) examined volatility spillovers of stock returns in the United States to stock returns in Jamaica and Trinidad and Tobago using a GARCH specification. The authors believed that newly liberalized economies were subject to increased volatility due to the direct purchases of domestic securities by foreign investors. That is to say, the liberalization of the foreign exchange markets and the relaxation of capital controls allow the easy repatriation of profits and the conversion of domestic currency to the US dollar. The data used in the analysis consisted of a weighted index of daily stock market returns for the period November 1987 to December 1995. The results suggested that a GARCH (2,2) process provided the best fit for the Jamaican data, while a GARCH (1,1) provided the best fit for Trinidad and Tobago and the United States data. Volatility spillovers are not immediately observable and as such an indicator vector or instrument must be generated to act as a proxy. The authors employed a technique used by Hamao *et al.* (1990) and Kim and Rogers (1995).

The results indicated that although volatility spillovers were important in explaining volatility in stock returns in both markets, volatility spillovers from the US during the pre liberalization time period was more significant for Jamaica than Trinidad and Tobago. They suggested that market inefficiency and barriers to entry might be the major reasons why spillover was less prevalent in Trinidad and Tobago.

Hamilton (1996) explored the issue of increased stock market volatility in Jamaica in the post liberalization era. She employed the GARCH methodology to determine the extent and causes of stock market volatility in Jamaica for the period October 1988 to October 1994. As with the previous authors, Hamilton used the maximum likelihood estimation technique offered by the Regression Analysis of Time Series (RATS) programme to obtain solutions to a GARCH type specification.

Nicholls *et al.* (1996) investigate the issue of volatility in selected Caribbean exchange rates in the post-liberalized period. The paper begins by addressing the issue of non-linearity in the data generating process. The BDS statistic is employed to verify this hypothesis. This paper represents a first attempt by Caribbean authors to diverge from the assumption of linearity in exchange rates and to test for the existence of non-linearity through the investigation of alternative correlation dimensions. The authors attribute the non-linearity to the existence of volatility persistence in the error terms. The data are then fitted to a GARCH (1,1) process. The results indicate that, for Jamaica and Guyana, exchange rate volatility is evident in the post-liberalized era. The evidence of volatility in the Trinidad and Tobago data, however, is far less pronounced.

THE BALANCE OF PAYMENTS

Cox and Zephirin (1979) develop a model that links prices and credit to the balance of payments for Barbados. They investigate the relationships under the broad headings of the elasticities, absorption and monetary approaches and the fiscal approach to the balance of payments. In the analysis of the elasticities approach, the authors are interested in the effect of a devaluation on the balance of trade. In analyzing the absorption approach, they are interested in whether balance of payments disequilibria are due to disequilibria between domestic absorption relative to domestic output. In the examination of the monetary approach, they define the monetary base identity as the sum of commercial bank deposits and currency in circulation, which in turn is equivalent to the sum of net foreign assets, net credit to the government, commercial bank credit and other assets and liabilities.

In the fiscal approach, the authors are concerned with the extent of the influence of fiscal deficits on current account imbalances.

Annual data for the period 1966 to 1977 are used in the regression analysis. The authors note the small sample size as a primary cause of unfavorable regression results and were therefore reluctant to rely solely on the regression results. They incorporate the use of 'chart analysis' in the discussions. Cox and Zephirin make no definitive conclusions about the balance of payments and the factors that influence its components. Instead, they point to the fact that several theories of the balance of payments appear relevant to Barbados. Policy makers must, therefore, be cognizant of this characteristic in developing techniques for this variable.

Syfox (1992) presented a model of the balance of payments of Guyana in an attempt to assess its performance after the implementation of structural adjustment mechanisms such as the Economic Recovery Programme. He fitted the balance of payments for Guyana as a function of the foreign inflation rate, depreciation, real income, the interest rate and domestic credit, using annual data over the period 1963 to 1988. The results of the exercise are mixed. The signs of the coefficients of domestic credit and real income are contrary to *a priori* expectations. World inflation and depreciation are significant. Overall, the author presents a useful discussion of the relevance of the diagnostic checks to his analysis. There is some confusion about the meaning of the constant term. The author incorrectly suggests that if all other variables remained constant, then the dependent variable would increase to the extent of the constant term. This is true only if zero values of the independent variables are within the experience of the model, which is hardly likely to be the case.

St. Cyr (1978) establishes a relationship between wages, prices and the balance of payments for Trinidad and Tobago for the period 1956-1976. He begins by outlining the various interrelationships that exist among macroeconomic variables such as the balance of payments, the money supply, aggregate demand, imports, domestic and international prices. He presents a simultaneous model consisting of six equations, two of which are identities. The author cites unavailability of disaggregated data as a major shortcoming of his analysis. The results of the initial estimation are relatively favourable. Further, St. Cyr derives the reduced form of the structural equations and analytically determines the short-run multipliers. The author concludes that significant levels of domestic inflation would generate balance of payments disequilibrium for the Trinidad and Tobago economy.

Modeste (1992) uses a distributed lag model to test for the influence the exchange rate on the balance of payments of Guyana. The author relies on the monetary approach to the balance of payments as his theoretical framework. He derives a single reduced form equation for the international reserves flow as the solution of a simultaneous model that consists of four equations: the percentage change in the demand for money, the rate of change of prices, the percentage change in the money stock and money market equilibrium. The model is fitted by OLS using annual data for the period 1964-1990. The author concludes that both the foreign price level and the exchange rate were significant variables for the balance of payments in the Guyanese economy.

CONCLUSION

The Monetary Studies programme has been a very useful outlet for econometric work in the Caribbean. A lot of the work presented there eventually appeared in journals like Social and Economic Studies and as chapters in books. But there is a still much ground to cover. Conclusions have been often tentative, almost apologetic, and in many instances policy recommendations have ignored the results obtained. Data problems have been frequently advanced for the lack of confidence in the models.

There is no doubt that great care should be employed in using the results obtained. Yet we cannot help but believe that authors should be a bit bolder in their interpretations and policy prescriptions. If not, it would always appear that econometric methods are employed to give some perceived respectability to the work, as if it were some necessary evil that should otherwise be avoided.

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CHAPTER

2

UNEMPLOYMENT IN BARBADOS: 1980-1996

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ABSTRACT

The aim of this paper is to determine some of the causes of unemployment in Barbados over the years 1980 to 1996. To this end, features of the labour market are discussed and an econometric model formulated using the Autoregressive Distributed Lag methodology. The findings indicate that wages paid by the employer is one of the major determinants of unemployment, and therefore, a reduction in social security taxes may be considered. Other factors affecting unemployment were the high levels of hiring and firing costs, indicating that labour market legislation should be re-examined.

Keywords: Unemployment, Autoregressive Distributed Lag, Labour Market Legislation.

The sorest ill that heaven hath
Sent on this lower world in wrath
Unemployment (to call it by its name)
Waged war on economics,
Sparing no country from the plague.
They died not all, but all were sick.
No jobs were left;
So hope and therefore joy were
dead...

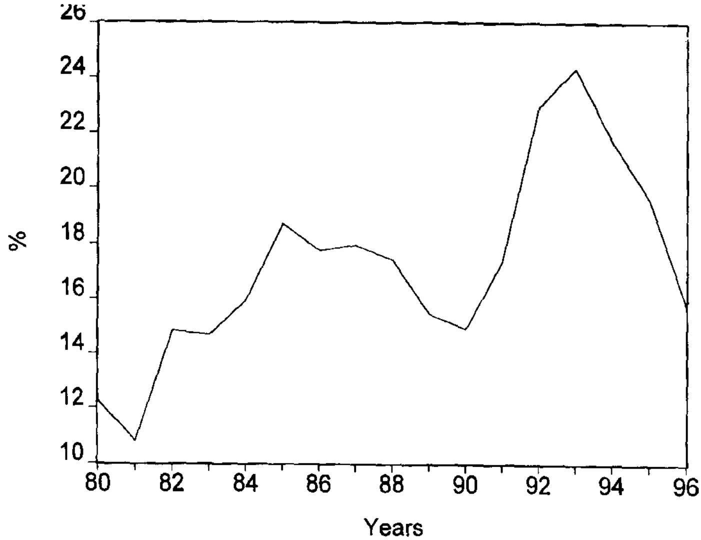
Sneesens and Dreze (1986)

1. Introduction

Throughout the years, one of the main policy objectives of Barbadian governments has been to reduce the level of unemployment.[1] This has always been a concern because of its magnitude and possible economic, social and political effects on the macroeconomy. Between 1980 and 1990, the average unemployment rate was 15.5%, but with the structural adjustment programme in 1991, the rate rose from 14.9% in 1990 to 24.3% in 1993. It then trended downwards to reach 15.8% in 1996 as Figure 2.1 illustrates.

1 Brathwaite (1988) notes that concern about unemployment dates back to the 'Report on Poor Relief' of 1875

FIGURE 2.1: THE AVERAGE ANNUAL UNEMPLOYMENT RATE



But even with this decline, the Barbadian unemployment rate still lies above those of some other Caribbean and industrialized countries as Table 2.1 shows.

Table 2.1: Unemployment Rates in Selected Countries (1996)

COUNTRIES	RATE
Antigua and Barbuda	9.0
Australia	8.6
Bahamas	10.8
Barbados	15.8
Belize	13.8*
Brazil	5.8**
Canada	9.8
Dominican Republic	16.7
France	12.7
Germany	11.5
Grenada	17.0
Hong Kong	2.8
Italy	12.1
Jamaica	16.1
Japan	3.4
Mexico	3.7
Singapore	3.0
St. Kitts and Nevis	4.5
St. Lucia	16.7
Trinidad and Tobago	16.3
U.K.	7.6
U.S.A.	5.4

Source: Central Bank of Barbados

Note : * - To April 1996

** - To March 1996

What explains this rather high level of unemployment? How is this related to the broader economic changes that occurred in the economy over the same period? Although these are important questions to policy makers, few Barbadian researchers have attempted to address these issues.[2] The aim of this paper, therefore, is to determine some of the causes of unemployment in Barbados over the period 1980-1996, in the hope of providing a better understanding of this problem.

To undertake this task, first some features of the labour market in Barbados are discussed. These features, along with a review of the empirical literature of labour markets in Caribbean countries, lead to a specification of a labour market model that consists of labour demand, labour supply and real wage equations. These equations are estimated and the results are reported. The policy implications of these results are discussed and, finally, some conclusions are drawn.

2. Some Features of the Labour Market

The following discussion of the trends and composition of the labour force, employment and unemployment in Barbados is hampered by serious data problems. For instance, different estimates of these labour aggregates appear from time to time over the period 1946 to 1980. Compare the figures in ABT Associates (1998), Brathwaite (1988) and Mascoll (1985). Only from 1980 are consistent data on the composition of these aggregates (by age,

2 This sparse literature is briefly reviewed in the Appendix.

education, sex, etc.) available. However, some of the data stops at 1993 and moreover, the inherent data problems still exist for most of these aggregates. See, for example, the discussion by Anayadike-Danes (1994) on the unemployment rate.

2.1 Participation Rates and the Composition of the Labour Force

The overall participation rate rose from 64.7% in 1981 to 66.3% in 1993 and then to 67.6% in 1996. There were significant changes in the participation rates for women and men as Table2.2 and Figure 2.2 show.

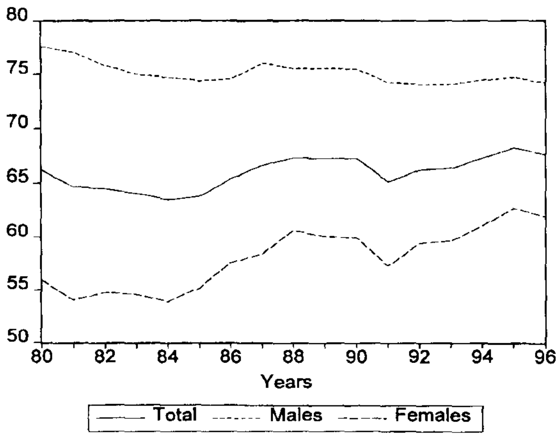
Table 2.2: Participation Rates by Sex and Age (%)

	Males		Females		Total	
Age	1981	1993	1981	1993	1981	1993
15-19	51.8	20.6	33.9	36.4	43.4	41.3
20-24	92.7	61.3	80.3	80.4	86.4	86.0
25-29	95.9	72.3	80.2	87.7	87.7	91.5
30-34	94.9	78.3	80.8	88.0	88.0	91.6
35-44	94.1	82.2	73.4	85.5	83.8	90.0
45-64	89.7	69.9	50.0	57.7	70.0	67.2
65 & Over	27.4	8.7	6.9	5.6	15.0	6.9
Total	77.2	74.1	54.0	59.8	64.7	66.3

Source: Barbados Statistical Service.

Rates for women increased, especially for those between 35 and 44 years of age, rising from 73.4% in 1981 to 85.5% by 1993.[3] Rates for men, on the other hand, fell in all categories, but significantly so for those under 25 years old.

FIGURE 2.2: PARTICIPATION RATES



The rise in the female participation rate reflects the fact that, increasingly, households are being led solely by females, but even in the cases where women are not required to earn a living to support their families, the society has evolved to a level where it is now considered a social norm for female school leavers to seek work. Coppin (1995) also argued that the rise in the female labour force can be attributed to

- improved educational and training opportunities for females, thus boosting their human capital;

3 Note that data on the participation rates by age cohort are not available for the 1994 to 1996 period.

- the expansion of selected areas in the economy (for example, information services, banking and finance);
- the establishment of day care services and
- net outward migration.

The decline in participation rates for young men can be explained by teenagers staying longer at school, and more of them continuing with further education. Evidence of this is found in the econometric study of Deutsch (1994) who found, using data from the 1993 Continuous Household Sample Survey, that years of completed school and being head of the household are significant factors influencing both male and female participation rates. This evidence is consistent with those in other countries (see, for example, Demekas and Kontolemis, 1996).

As a result of these developments, one can say that the profile of the labour force has become:

(i) More female oriented - women were 49% of the labour force in 1996, and 48% in 1993, compared with 46% in 1980.

(ii) Somewhat older, as the majority of women entering the labour force are between 35 and 44 years old - workers over 30 made up 64% of the labour force in 1993 as opposed to 54% in 1980.

(iii) Better educated - according to Downes (1998), a substantial proportion of the labour force has at least secondary school education due to a compulsory school attendance requirement.

2.2 Employment

Employment rose from 100,200 in 1981 to 114,400 in 1996 as seen in Table 2.3.

Table 2.3: Employment by Sector ('000 persons)

Sector (Gender)	1981	1983	1996
Agriculture	9.4	5.8	6.0
Men	5.6	3.5	3.7
Women	3.8	2.3	2.3
Manufacturing	1.4	10.6	9.7
Men	6.4	5.2	4.3
Women	7.7	5.4	5.4
Construction & Quarrying	6.3	7.3	9.9
Men	6.1	6.8	9.4
Women	0.2	0.5	0.5
Commerce & Tourism	23.4	24.8	28.2
Men	12.6	11.8	13.0
Women	10.8	13.0	15.2
Transport, Communication & Utilities	6.0	6.0	6.2
Men	4.7	4.6	4.4
Women	1.3	1.4	1.8
Finance & Business Services	3.9	5.8	8.3
Men	1.7	2.5	2.3
Women	2.2	3.3	6.0
Government & Other Services	37.1	40.1	46.1
Men	20.3	19.4	23.2
Women	16.8	21.7	22.9
Total	100.2	100.4	114.4

Source: Barbados Statistical Service.

Government together with other services has been the largest employer, followed by commerce and tourism, and then manufacturing. Their respective shares in 1981 were 37.1%, 10.8% and 14% compared with 40.3%, 24.7% and 8.5% in 1996.

There has been a noticeable shift away from agriculture and manufacturing towards the service-oriented industries. For example, agricultural employment fell by 3,400 or 36.2% between 1981 and 1996, and manufacturing employment by 4,400 or 33.3% over the same period. In contrast, employment grew in the financial services sector (128%), construction and quarrying (57.1%), government and other services (24.3%) and commerce and tourism (20.5%).

The information from Table 2.3 indicates that both men and women were the losers from the decline in agriculture and manufacturing. In agriculture, more men lost their jobs over the period 1980-1996; the decrease for men and women was 1,900 and 1,500, respectively. For manufacturing, more women lost their jobs: 2,300 women compared to 2,100 men. Overall, the share of women in total employment increased from 44.2% in 1980 to 46.3% in 1993 and to 47.1% in 1996. However, the share of men fell from 55.8% in 1980 to 53.8% in 1993 to 52.9% in 1996 suggesting that the increase in employment reflected more jobs for women.

An interesting question to ask is whether the new jobs in the service sector went to workers released from agriculture and manufacturing or to new entrants? Data to answer this question properly are unavailable but looking at the data on the composition of employment by degree of educational achievement in Table 2.4 could give some indication.

Table 2.4: Employed Labour Force by Highest Level of Educational Attainment ('000 persons)

Level of Education	1981	1993
Primary	48.2	26.9
Secondary	47.1	61.2
University	4.4	11.6
Vocational	0.4	0.6
Other/None	0.1	0.1

Source: Barbados Statistical Service.

The data suggest that the composition of employment has changed in favour of educated workers, particularly secondary and university graduates whose numbers increased in 1981 from 47,000 and 4,400 respectively, to 61,200 and 11,600 in 1993. On the other hand, primary school graduates (less educated) fell by 23,300 to 26,900 over the period. As it is likely that workers leaving agriculture and manufacturing were probably less educated than those entering the labour force, the tentative conclusion is that few of the workers who lost agricultural and manufacturing jobs were successful in finding jobs in the service sectors, the rest either became unemployed or dropped out of the labour market.

It is generally believed that a large majority of workers in the agricultural sector are self-employed and/or unpaid family workers. But, from Table 2.5, it would appear that the fall in agricultural employment did not reflect a decline in the self-employed, unpaid family worker and apprentice categories. Contrary to expectations, employment in these categories increased. However, the decrease in the private employees category probably reflects the fall-off in manufacturing workers.

Table 2.5: Employment Status ('000 persons)

Employment Status	1981	1993
Self Employed	11.1	14.0
Employed	-	0.9
Self Employed	-	13.1
Government Employee	23.7	23.5
Private Employee	64.3	62.3
Unpaid Family Worker and Apprentice	1.1	0.5
Total	100.2	100.4

Source: Barbados Statistical Service
Note: - not available

2.3 Size and Composition of Unemployment

The number of unemployed persons in Barbados more than doubled between 1980 and 1993 (from 14,500 to 32,300) but fell to 21,500 by 1996. Who are the unemployed? Despite the substantial gains in employment made by women, the increase in female participation rate during the 1980s and 1990s meant that most of the unemployed continued to be women as shown in Table 2.6.

Table 2.6: Rate of Unemployment by Sex

Year	Male	Female	Total
1981	7.4	15.0	10.8
1993	21.3	27.6	24.3
1996	12.3	19.4	15.8

Source: Barbados Statistical Service

The age profile of the total unemployment pool appears to have changed dramatically: in 1981, 60% of the unemployed were less than 25 years old compared to 37% in 1996, indicating that youth unemployment has declined significantly as shown in Table 2.7.

Table 2.7: Youth Unemployment ('000 persons)

Year	Under 25	Over 25	Total
1981	7.4	4.8	12.2
1993	12.1	21.2	32.3
1996	8.0	13.5	21.5

Source: Barbados Statistical Service.

Table 2.8 below shows that, relative to other Caribbean countries, the share of youth unemployment in overall unemployment appears quite similar.

Table 2.8: Youth Unemployment in 1995 in Selected Caribbean Countries ('000 persons)

	Bahamas	Barbados	Belize	Jamaica	Trinidad and Tobago
Unemployed Youth	6.5	10.5	3.9	104.8	35.2
Total Unemployed	15.9	26.9	8.9	186.7	89.4
Share	0.41	0.39	0.44	0.56	0.39

Source: ILO, Digest of Caribbean Labor Statistics, Trinidad & Tobago, 1996

In both the male and female groups, Table 2. 9 and Figure 2.3 below indicate that the share of 15-19 year old unemployed persons declined as young people tended to stay longer at school. But the largest increase in unemployment for both men and women occurred in the 25-44 years age bracket. It is likely that these are the people who were originally employed in agriculture and manufacturing as private employees and, with the decline in these sectors, lost their jobs and were unable to find new employment.

FIGURE 2.3: AGE PROFILES OF THE UNEMPLOYED

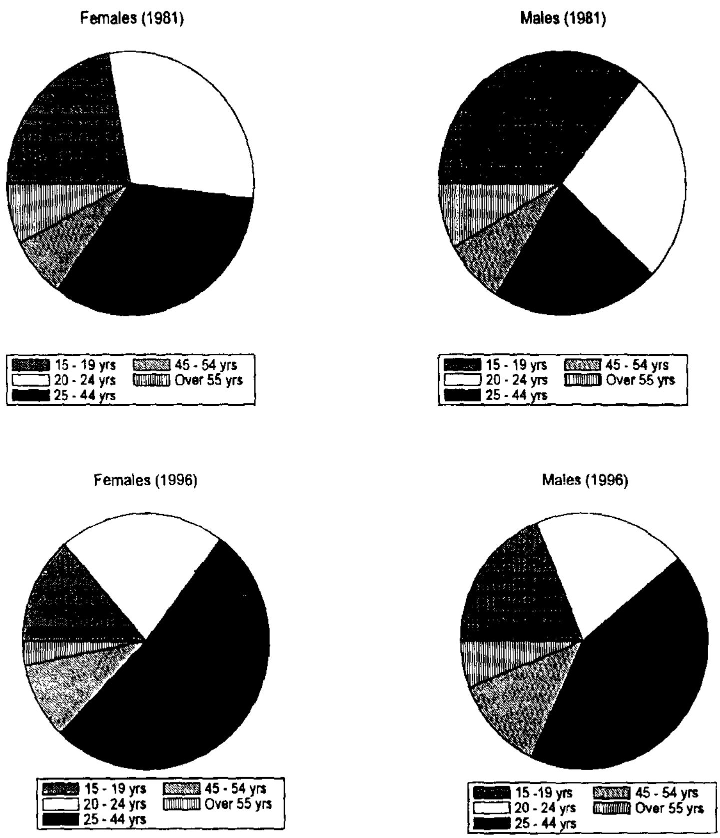


TABLE 2.9: UNEMPLOYED LABOR FORCE BY AGE AND SEX
('000 persons)

	15-19 Years		20-24 Years		25-44 Years		45-54 Years		55 Years+Over		All Ages	
Year	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1981	1.8	1.9	1.3	2.4	1.1	2.7	-	-	0.4	0.6	4.6	7.6
1993	2.7	2.7	3.4	3.3	6.4	9.3	1.2	1.9	0.8	0.6	14.5	17.8
1996	1.6	1.8	1.8	2.8	3.6	6.7	1.0	1.3	0.5	0.4	8.5	13.0

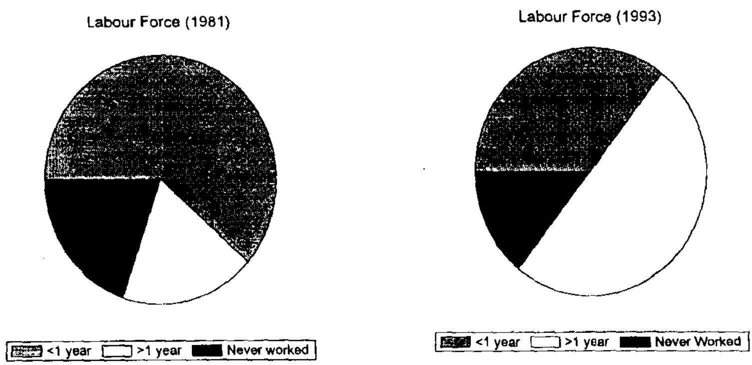
Source: Barbados Statistical Service

It would be useful to study the educational profile of the unemployed since many commentators have stated that a large number of unemployed people are highly qualified. Data from official sources to prove this hypothesis are not available but Downes (1998) in a recent survey of the labour market indicates that "over 70% of the unemployed have at least secondary level education ... [and]... there is very little unemployment among those with university and technical/vocational education" (p. 3).

2.4. Duration of Unemployment

The overall rise in unemployment in Barbados in the 1980s and the early 1990s has been associated with an increase in long-term unemployment (defined as those unemployed for over a year). Figure 2.4 shows that the percentage of unemployed workers who have been out of work for less than a year declined from 62% in 1981 to 36% in 1993, while, simultaneously, the percentage of those who have been unemployed for more than one year rose from 18.9% in 1981 to 50.2% in 1993.

Figure 2.4: Duration of the Unemployed Labour Force



Both men and women were affected, but women more so as Table 2.10 clearly shows.

TABLE 2.10
DURATION OF UNEMPLOYED LABOUR FORCE BY SEX
('000 persons)

Duration	1981	1993
Less than 1 Year	7.5	11.5
Men	3.3	6.7
Women	4.2	4.8
Over 1 Year	2.3	16.2
Men	0.6	6.4
Women	1.7	9.8
Never Worked	2.4	4.6
Men	0.7	1.6
Women	1.7	3.0
Not Stated	-	-
Total	12.2	32.3

Source: Barbados Statistical Service.

Furthermore, the incidence of long-term unemployment (the share of long-term unemployment out of total unemployment) was considerably higher for women than for men as may be seen in Table 2.11.

Table 2.11
Incidence of Long-Term Unemployment by Gender (%)

Year	1981	1993
Men	4.9	20.1
Women	14.0	30.9

Source: Barbados Statistical Service.

This confirms the finding that in countries where unemployment rates are higher for women than for men, the incidence rate for women also tends to be significantly high.

Again it would have been useful to look at the duration of unemployment by age but the data to allow this are not available.

2.5 Unemployment, Wages, Prices and Productivity

Table 2.12 below shows that the worsening of Barbados' overall growth performance during the last 15 years or so is reflected in productivity growth, which fell from 5.9% in the 1980s to 1.8% in the 1990s. Wage and price inflation declined over the period while there was a large increase in unemployment. The decline in inflation partly reflects the prices and income protocol between the social partners. The protocols allowed for an 8% wage cut in public servants' salaries followed by a wage freeze and controls on prices. These and other issues are discussed fully in Craigwell and Stumpp(1998).

TABLE 2.12: AVERAGE GROWTH IN UNEMPLOYMENT, WAGES, PRICES AND PRODUCTIVITY

	1980-1989	1990-1996	1980-1996
Wage Inflation	6.4	2.9	3.9
Price Inflation	5.9	3.1	4.7
Real Wage Inflation	0.5	-1.9	-0.6
Productivity Growth	5.9	1.8	4.1
Unemployment	15.8	21.0	17.9
Real GDP Growth	1.7	0	1.0

Source: Central Bank of Barbados

3. THE EMPIRICAL MODEL

From the above discussion, it is postulated that the increase in unemployment in Barbados over the period 1980-1996 reflects changes in the demand and supply functions of labour. Hence, the empirical model of the labour market considered here involves an aggregate labour demand equation, an aggregate labour supply equation and a wage setting equation. As it turns out, this type of structure is conventional (see, for example, the references in Layard, Nickell and Jackman (1991), Henry and Snower (1996) and Karanassou and Snower (1998) and is consistent with the review of the empirical literature in the Caribbean (see Appendix 2.1).

It is possible that a large number of explanatory variables could enter either the labour demand, labour supply or wage setting equation. However, if this approach is followed, problems with degrees of freedom would arise. A more parsimonious set of variables is required. Data inadequacies (for example, with import prices) allowed for a simpler model to be derived. Another procedure used to resolve the problem of a large number of variables was to seek a model that had strong theoretical foundations. Given these conditions, the model tested is as follows:

$$\ln LF_t = f(\ln LF_{t-i}, \ln W_{t-i}, UR_{t-i}, \ln WAP_t) \qquad (1)$$

$$\ln W_t = g(UR_{t-i}, \ln W_{t-i}, \ln PROD_{t-i}, \ln WMIN_t) \qquad (2)$$

$$\ln E_t = h(WEMP_{t-i}, \ln E_{t-i}, \ln Y_t) \qquad (3)$$

$$WEMP = W + TSS$$

$$UR = 1 - (E/LF)$$

$$\ln PROD = \ln(Y_t/E)$$

where LF_t is the labour force, W_t is the real wage, UR_t is the unemployment rate, $PROD_t$ is labour productivity, Y_t is the level of output, E_t is employment, $WEMP_t$ is the wage paid by the employer, which is the real wage plus the tax rate on social security (TSS_t). WAP_t is the working age population, and $WMIN_t$ is the minimum wage. Each equation uses a set of lags on both endogenous and exogenous variables to facilitate analysis of the adjustment processes and dynamics within the labour market.

Equation (1) is a labour supply equation and follows a specification similar to that used in developed countries (see, for example, the studies in Henry and Snower 1996). The equation is modelled as a function of the unemployment rate and a positive relationship with the real wage, labour supply, and the working age population. The working age population *(WAP)* is assumed to be exogenous. The rationale behind this formulation is that potential employees will determine whether or not to enter the labour market based on the probability of employment, the wages they can get if employed, and other social and demographic influences exogenous to the model, like the *WAP*.

Equation (2) is a wage setting equation which is assumed to be jointly determined by the bargaining process between the unions and employers (see, for instance, Layard, Nickell and Jackman, 1991 and Downes and McClean, 1982). This process is posited to be affected by the unemployment rate, the productivity of labour, the minimum wage, and past real wages. The minimum wage *(WMIN)* is postulated to be exogenously determined.

Equation (3) is the labour demand (or employment) equation and follows the right-to-manage literature (see Booth 1995). Therefore, it suggests that once wages have been determined by the bargaining process, employers are at liberty to set employment at a level that will maximise profits. Hence, employment depends on the wages paid by employers, and on employment lagged, as well as output*(Y)*. Output is assumed to be exogenously determined. This may be a strong assumption but estimating the model with system equation techniques may reduce the possible bias that arises from making this assumption. An alternative remedy is to formulate and estimate a production function. This is not done here because of inadequate data on quarterly capital stock.

4. Econometric Methodology, Data and Results

4.1 Methodology

Since the emergence of the unit-root/cointegration literature, the common practice in empirical economics has been to test for the existence of long-run relations using cointegration techniques (given that the application of unit root tests has identified the underlying variables as integrated of order 1 [I(1)]), and subsequently estimate the short-run dynamics and adjustment mechanism towards equilibrium through an error correction model.

Despite the popularity of the above methodology, the estimation of the labour market presented here is based on the autoregressive distributed lag (ARDL) modelling approach to cointegration analysis, proposed by Pesaran and Shin (1997). The reasons for adopting the ARDL modelling approach are four-fold: first, since the ARDL approach is applicable irrespective of whether the regressors are I(0) or I(1), the pretesting problems that surround the cointegration analysis do not arise; second, the estimated coefficients can be given a straight-forward economic interpretation, for example, the coefficients of the lagged employment terms in the labour demand equation may be interpreted as the employment adjustment effect; third, this approach performs better in small samples than the fully modified OLS approach of Phillips and Hansen (1990); and fourth, it is possible to incorporate both *apriori* information readily on signs of individual parameters and to allow differing lag lengths to be estimated for individual variables.

The ARDL approach involves running the following general regression:

$$y_t = \alpha_o + \alpha_1 t + \sum_{i=1}^{p} \varphi_i y_{t-i} + \beta' x_{t+} \sum_{i=1}^{q-1} \beta_i *' \Delta x_{t-1} + v_t$$

$$\Delta x_t = P_1 \Delta x_{t-1} + P_2 \Delta x_{t-2} + \ldots\ldots\ldots + P_s \Delta x_{t-s} + \varepsilon_t$$

where x_t is the k-dimensional I(1) variables that are not cointegrated among themselves, v_t and Δx_i are serially uncorrelated disturbances with zero means and constant variance-covariances, and P_i are $k \times k$ coefficient matrices such that the vector autoregressive process x_t is stable. It is also assumed that the roots of $(1 - \Sigma \varphi_i Z^I = 0)$ all fall outside the unit circle and there exists a stable unique long run relationship between x_t and y_t. Given this structure, Pesaran and Shin (1997) have shown that the OLS estimators of the short run parameters are $T^{1/2}$ consistent with the asymptotically singular covariance matrix, and the ARDL based estimators of the long run coefficients are super consistent, and valid inferences can be made using standard normal asymptotic theory.

4.2 Data

The observations used in this study were collected on a quarterly basis from 1980 to 1996. Data were for the most part directly obtainable from the *Annual Statistical Digest* and the *Economic and Financial Statistics* published by the Central Bank ofBarbados. For output data, for which official quarterly information was not available for most of the period, the series developed by Lewis (1997) was used. In addition, the wages series was spliced, with 1980 being employed as the base year.

Since the series was only available on an annual basis, it was divided by four and smoothed using the Holt-Winters technique to give an estimate of quarterly wages. Due to a lack of data, the total adult population was utilised as a proxy for the working-age population for the period under review. The minimum wage for adults, that is, those over 18 years, was employed in the study. In a manner similar to that of Franks (1996) the wages paid by the employer were proxied by the sum of the real wage and social security taxes.

4.3 Results

The variables were first tested for unit roots using the Augmented Dickey-Fuller (ADF) test. This statistic indicated that the variables were all non-stationary in their levels, and furthermore, that they could all be treated as I(1) variables.[4] Next, an autoregressive distributed lag model of the labour market was estimated using the ARDL methodology discussed above. Recall that Pesaran and Shin (1997) showed that once the appropriate lag structure is chosen, OLS estimators of the short run and long run[5] parameters are consistent. Therefore, the optimal lag structure must be determined. To do this, a search procedure was conducted over eight lags using the Schwarz Bayesian and Akaike Information Criteria, but only those lags that were significant were retained in the final specifications. Due to the possible simultaneous bias of treating output as an exogenous variable (see Section 3),

4 Results are available upon request.

5 In this approach, the long run coefficients are computed by dividing the short run parameters (in levels), by the sum of the coefficients of the lagged dependent variable.

these final specifications were re-estimated using Three Stage Least Squares (3SLS). However, as it turned out, the 3SLS estimates were similar to the OLS results, hence the OLS findings were maintained for examination. It should be noted that these equations (see Tables 2.13, 2.14 and 2.15) passed all the standard tests for misspecification, structural stability, normality, heteroscedasticity, and autocorrelation.

Labour Force Equation

The results obtained from estimation of the labour force equation are displayed in Table 2.13. These results show that both the unemployment rate and the real wage in the same period are negatively correlated with the labour force, while the total adult population is found to have a positive effect.

TABLE 2.13: RESULTS OF THE LABOUR FORCE EQUATION

Variable	Coefficient	Std. Error	t-Statistic
lnLF(-2)	0.497	0.111	4.461
lnUR	-0.001	0.0005	2.033
DlnUR	0.061	0.023	2.615
DlnUR(-4)	0.041	0.024	1.706
DlnUR(-6)	-0.049	0.027	-1.819
DlnUR(-7)	-0.078	0.027	-2.860
DlnUR(-8)	-0.055	0.025	-2.226
lnW	-0.057	0.020	-2.842
DlnW	0.227	0.109	2.069
DlnW(-1)	-0.217	0.096	-2.265
DlnW(-3)	0.245	0.098	2.502
DlnW(-6)	-0.186	0.083	-2.242
DlnW(-7)	-0.169	0.078	-2.192
lnWAP	0.433	0.214	2.019
@TREND(1980:1)	0.003	0.001	3.542
C	4.599	2.214	2.077

R-squared	0.956
Adjusted R-squared	0.941
S.E. of regression	0.017
Sum squared resid	0.011
Ramsey Reset Test (P-value)	0.847
White Heteroscedasticity Test (P-value)	0.272
Chow Test (P value)	0.042
Breusch Godfrey Autocorrelation (P-value)	0.599
Normality (P-value)	0.480

Implied long-run equation:

$\ln LF = -0.002*\ln UR - 0.113*\ln W + 0.862*\ln WAP + 0.006*trend + 9.142$

Furthermore, the findings reveal that even though the coefficient of the lagged dependent variable is relatively high, the fact that only one lagged dependent variable is significant indicates that labour force growth does not exhibit any great persistence. This may suggest that entering and exiting the workforce does not involve large adjustment costs. The fact that unemployment enters the equation in lagged form suggests that there is some time before workers become discouraged from seeking employment. Measures to keep the long term unemployed involved in the labour market are therefore of great importance. The negative correlation between the real wage and the labour force comes as somewhat of a surprise as one would have expected the attraction of higher real wages to lead to an increase in participation in the labour force. Franks (1996) suggests that such an outcome is not inconsistent with rational utility maximization as higher wages among primary wage earners may lead secondary household members to participate less through an income effect. Finally, examination of the relationship between the population and the labour force has provided some support for the hypothesis that increases in the population have, over the years, been one of the main factors contributing to growth in the labour force.

Wage Equation

Estimation of the wage equation showed that while both the minimum wage and the unemployment rate were inversely related to the real wage in the same period, a positive relationship was discovered between productivity and the real wage as Table 2.14 shows.

TABLE 2.14: RESULTS OF THE WAGE BARGAINING EQUATION

Variable	Coefficient	Std. Error	t-Statistic
lnW(-1)	0.581	0.087	6.699
lnW(-4)	0.265	0.114	2.319
lnW(-5)	-0.229	0.119	-1.927
lnW(-8)	0.329	0.082	4.008
lnUR	-0.045	0.012	-3.589
DlnUR(-1)	0.026	0.015	1.693
DlnUR(-5)	-0.027	0.015	-1.786
lnPROD	0.020	0.011	1.853
DlnPROD(-8)	0.056	0.026	2.157
lnWmin	-0.009	0.005	-1.854
@TREND(1980:1)	-0.001	0.001	-2.652
C	0.325	0.130	2.499

R-squared	0.994
Adjusted R-squared	0.993
S.E. of regression	0.011
Sum squared resid	0.006
Ramsey Reset Test (P-value)	0.734
White Heteroscedasticity Test (P-value)	0.227
Chow Test (P value)	0.036
Breusch Godfrey Autocorrelation (P-value)	0.163
Normality	0.327

Implied long-run relationship:

lnW = -0.161*lnWmin - 0.786*lnUR +0.357*lnPROD
+0.013*trend+0.579

Examination of this equation also reveals that real wages exhibit a high level of persistence as indicated by the magnitude of the summed coefficients of the lagged dependent variables (0.95). This may be due in part to the staggered wage setting that currently exists in Barbados, which will tend to make current wages dependent on their past values. Another finding from this analysis is that the minimum wage enters the equation with a negative sign. This is not surprising since, in general, minimum wage legislation is not binding in Barbados as wage rates negotiated by the labour unions tend to dictate the wage levels in the economy (Downes (1998)). The negative relationship between unemployment and the real wage may be explained by the hypothesis that higher unemployment will reduce workers' demands for wage increases by simultaneously raising fears of unemployment among the 'insiders' and increasing the competition for jobs from "outsiders."

Labour Demand Equation

Analysis of the labour demand or employment equation in Table 2.15 shows the existence of a negative correlation between employment and real product wages while real GDP is positively related to employment.

TABLE 2.15: RESULTS OF THE LABOUR DEMAND EQUATION

Variable	Coefficient	Std. Error	t-Statistic
lnE(-1)	0.623	0.149	4.164
lnE(-2)	0.339	0.182	1.860
lnE(-3)	-0.192	0.101	-1.909
lnE(-4)	0.256	0.136	1.883
lnE(-6)	-0.244	0.132	-1.839
DlnWEMP(-2)	0.049	0.021	2.323
DlnWEMP(-4)	-0.071	0.029	-2.460
DlnWEMP(-5)	-0.278	0.139	-1.999
DlnWEMP(-6)	-0.151	0.084	-1.809
DlnWEMP(-8)	0.039	0.017	2.268
lnY	0.307	0.106	2.897
@TREND(1980:1)	0.001	0.001	1.879
C	0.985	0.372	2.648

R-squared	0.885
Adjusted R-squared	0.849
SumSquared Resid	0.028
S.E. of regression	0.027
Ramsey Reset Test (P-value)	0.449
White Heteroscedasticity Test (P-value)	0.904
Chow Test (P value)	0.025
Breusch Godfrey Autocorrelation (P-value)	0.593
Normality	0.549

Implied Long-run relationship:
lnE = -0.619*lnWEMP + 0.034*trend + 4.530

The negative relationship between the real product wage and employment was expected as increasing labour costs will often force employers to reduce the number of workers employed. The effect of output on the level of employment was also found to support the theory, as in an effort to satisfy increasing demand for output, employers will often increase staff. The results also suggest that there is significant persistence in employment, as the sum of the lagged values of employment in the distributed lag model is relatively high at 0.80. This strong correlation between employment and its past values may be related to considerable hiring and firing costs.

5. Policy Implications

The above results have implications for unemployment policies in Barbados. Firstly, since wages paid by the employer is a significant determinant of unemployment, one implication is that a reduction in the social security taxes, which affects the employee wage, should increase the demand and provide greater incentives for the unemployed to seek work. Indeed, according to Downes (1998, p.4), establishments report that although the administrative work associated with the National Insurance Scheme (NIS) is not very burdensome, the employer's contribution to the NIS is too high. From 1994, the employer's contribution to the NIS has been as high as 9.25% of the maximum insurable earnings of workers. In addition, employers contribute a further 0.59% in the form of a training levy.

Secondly, the finding that it takes the unemployed some time before they are discouraged from seeking employment suggests that training should be provided to ensure that these persons remain actively involved in the labour market. Training allows for upgrading the quality, skills and supply of the labour force. According to Downes (1998, p.4), private sector companies provide training for their staff especially in the areas of company orientation, technical training, safety and work behaviour. Most employees are trained on the job. Employers have found that training programmes must not only emphasize technical and cognitive skills but also attitudinal skills. From the Government's point of view, several training programmes are available. For instance, the Technical and Vocational Education and Training Programme, the Skills Training Programme and the Apprenticeship Programme. See Craigwell and Stumpp (1998) for further discussion of these training programmes.

Thirdly, the strong correlation between employment and its past values (labour demand persistence) usually indicates a rigid level of labour market legislation, particularly high firing costs, which raise the costs of adjusting a firm's level of employment. The obligation to make a severance payment when dismissing individual workers is the most common firing cost. To qualify for severance pay in Barbados, the individual must have been working for two years. The rate of benefit is 12.5 days per year for the first nine years. However, an individual who is laid off after one year of work is entitled to one month's pay. If he or she is laid off after 10 years, then that individual is entitled to 5.8 months.

Of course, all of these measures (training, social security tax reduction etc.) should be combined with job creation strategies in order to be fully effective. With the policy of economic diversification, a lot of emphasis for job creation is being placed on the services sector, especially in the tourism, offshore and government sub-sectors. Several pieces of legislation, schemes and institutions have targeted the development and expansion of these sectors with some success. See Brathwaite (1988), Craigwell and Stumpp (1998) and Warner (1998) for further discussion.

6. Conclusion

The aggregate equations estimated here represent only a basic model of the Barbadian labour market. Indeed, as data become available, additional variables unique to small open economies should be included in further specifications of the model. Nevertheless, there is enough evidence to suggest that some tentative conclusions could be drawn about the Barbadian labour market. One such conclusion is that the wages paid by the employer significantly affect the level of unemployment. The implication here is that a reduction in social security taxes could increase the demand and therefore provide greater incentive for the unemployed to seek work.

While the result that it takes the unemployed some time before they become discouraged from seeking employment is a positive sign, measures should still be taken to ensure that these persons remain actively involved in the labour market. This suggests that increasing emphasis should be placed on apprenticeship programmes and the retraining of unemployed persons, particularly in the 15-24 age group. This paper also reports that there may be a need to reduce the costs attached to hiring persons. These costs seemed to create persistence in the employment adjustment process. These measures must, however, be coupled with job creation strategies in order to be fully effective. Although available information indicates that policy makers have reaped some success with these strategies, there is still some room for improvement, particularly within the agriculture and manufacturing sectors. The number of jobs these sectors provide could be increased if financial incentives along with programmes designed to sensitise the public to the importance of manufacturing and agriculture are implemented.

In conclusion, quantitative research on employment determination in the Caribbean shows that changes in output is a key variable. To a lesser extent, the lagged employment variable also plays a role in explaining employment in the region. The impact of the real wage variable on employment is somewhat mixed.

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Appendix 2.1: Literature Review of Empirical Labour Market Studies of the Caribbean

Author(s)	Equations	Variables	Estimation Technique	Data Range and Frequency	Results
Downes and McClean (1982) Barbados	Wage	Export prices *(PX_t)*, output *(Y_t)*, employment *(N_t)*, *($PROD_t$)*, the aggregate retail price level *(P_t)*, prices, *(PM_t)*, interest rates *(R_t)*, a vestor of tax rates *(T_t)*	OLS Cochrane Orcott	Annual Data from 1960-1977	All the explanatory variables were significant and carried the expected signs. However, there was some evidence of serial correlation. The Cochrane Orcott iterative procedure did not yield estimates that were significant different from OLS.

Appendix 2.1: Literature Review of Empirical Labour Market Studies of the Caribbean - Cont'd

Author(s)	Equations	Variables	Estimation Technique	Data Range and Frequency	Results
Boamah (1984) Barbados	Labour Demand	Slack conditions (S_t), prices (P_t), money wages (W_t), output (Q_t) and employment lagged once (E_{t-1})	OLS	Annual data from 1959-1980	Q_t and E_{t-1} positively affected employment while S_t had a negative impact. W_t and P_t were insignificant.
	Wages	Price expectations (Pe_t), the prime lending rate (Rd_t), productivity lagged $(Q_t/E_t)_{-1}$, real weekly earnings (EN_t/RPI_t), and the unemployment rate (U_t)			Both Pe_t and (EN_t/RPI_t) had a positive impact on wages. U_t, $(Q_t/E_t)_{-1}$, (EN_t/RPI_t) were statistically insignificant.

Appendix 2.1: Literature Review of Empirical Labour Market Studies of the Caribbean - Cont'd

Author(s)	Equations	Variables	Estimation Technique	Data Range and Frequency	Results
Boamah, Holder, Mascoll, Worrell (1984) Barbados	Labour Demand	Real GDP *(Y_t)*, real wages *(W_t)*, employment lagged once *(E_{t-1})*	OLS	Annual Data from 1958-1983	Both Y_t and E_{t-1} were positive, and significantly related to the demand for labour. W_t proved to be insignificant.
	Wages	Marginal productivity of labour *(MPL_t)*, expected deflator *(Pe_t)* and wages lagged once *(W_{t-1}) * $(1+Pe_t)$*			Pe_t was the only variable found to be significant. Possible existence of multicollinearity.

Appendix 2.1: Literature Review of Empirical Labour Market Studies of the Caribbean - Cont'd

Author(s)	Equations	Variables	Estimation Technique	Data Range and Frequency	Results
	Labour Supply (L^s)	Wages (W_t) in the current period, and wages lagged once (W_{t-1}).	Two-stage Least Squares (TSLS)	Annual data from 1962-1980	Both variables were statistically significant, but the current real wage variable carried an incorrect negative sign. Evidence of multicollinearity.
Mascoll (1985) Barbados	Labour Demand (L^d)	W_t, real income (Y_t), marginal revenue product (B_t).			All explanatory variables with the exception of B_t were significant and carried the correct sign. Evidence of serial correlation.
	Wages (W_t)	W_{t-1}, L^d, L^s			All variables are statistically significant. W_{t-1} and L^d positively affected the real wage while L^s was found to have an adverse affect. Co-efficients are usually large.

Appendix 2.1: Literature Review of Empirical Labour Market Studies of the Caribbean - Cont'd

Author(s)	Equations	Variables	Estimation Technique	Data Range and Frequency	Results
Leon and Mascoll (1986) Barbados	Desired Demand for Labour	Expected output (OE_t), the real wage (W_t), labour Productivity (P_t)	OLS	Annual data from 1962-1980	W_t, P_t and Oe_{t-1} were negatively related to employment while employment in the previous period positively impacted on the desired demand for labour.
Downes (1987) Barbados	Labour Demand	Real wages (W_t), import prices index of intermediate goods (Pm_t), GDP at factor cost (Q_t), employment levy (EL_t), import price of capital goods (Pk_t), exports (X_t), total domestic credit (Dc_t), total government expenditure (Ge_t), gross fixed capitl formation (K_t), employment lagged once (E_{t-1}), time variable $(TECH_t)$	OLS TSLS IV ECM	Annual from 1960-1984	The results obtained from OLS and TSLS estimation were similar, that is, Q_t and E_{t-1} positively affected current employment while W_t was inversely related to employment. Using the four techniques, W_t, Q_t and E_{t-1}, were significant and carried the same signs as the OLS estimation. However, this result varied according to the choice of instrumental variable used. With the ECM, the long run change in employment was positively affected by the change in Q_t, the previous level of output Q_{t-1}, and EL_t. The change in W_t and E_{t-1} were found to exert a negative influence on employment.

Appendix 2.1: Literature Review of Empirical Labour Market Studies of the Caribbean - Cont'd

Author(s)	Equations	Variables	Estimation Technique	Data Range and Frequency	Results
Nicholls and Bourne(1989) Barbados	Employment	Total Gross Domestic Product $(BGDP_t)$	TSLS	Annual data from 1968-1987	$(BGDP_t)$ is positive and significant. Evidence of autocorrelation
Manhertz (1971) Jamaica	Private Sector Labour Demand	GNP and Trend	OLS	Annual data from 1959-1966	Both GNP_t and the trend are significant and positive. Evidence of serial correlation.
Brewster (1972) Trinidad and Tobago	Change in the demand for labour	Consumption expenditure (C_t), wages (W_t), domestic output (O_t), capital formation (K_t), labour productivity (P_t), export wage gap (E_t), import coefficient (I_t), revenue coefficient (R_t), profit tax coefficient (P_t), exports $((X_t)$	OLS	Annual data from 1951-1968	C_t and O_t exerted a positive influence on employment while W_t and P_t were negatively related to employment. Problem with simultaneous equation bias, multicollinearity and serial correlation.

Appendix 2.1: Literature Review of Empirical Labour Market Studies of the Caribbean - Concluded

Author(s)	Equations	Variables	Estimation Technique	Data Range and Frequency	Results
Henry, Hilaire and Nicholls (1989) Trinidad and Tobago	Labour Demand	Non-Oil GDP ($NGDP_t$), and oil exports ($XOIL_t$)	TSLS	Annual Data from 1966-1986	$NGDP_t$ is positive and significant while $XOIL_t$ was insignificant
	Wages	The expected price level (PRE_t) and the unemployment rate (UNR_t)			Both variables were positive and significant
Nicholls and Bourne (1989) Trinidad and Tobago	Employment	Total Gross Domestic Product ($TGDP_t$)	TSLS	Annual Data from 1968-1987	($TGDP_t$) is positive and significant. There is some evidence of autocorrelation

CHAPTER 3

SHORT-TERM MODELLING AND FORECASTING WITH VECTOR AUTOREGRESSION AND STATE SPACE MODELS: APPLICATIONS TO TRINIDAD AND TOBAGO

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SHORT-TERM MODELLING AND FORECASTING WITH VECTOR AUTOREGRESSION AND STATE SPACE MODELS: APPLICATIONS TO TRINIDAD AND TOBAGO

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ABSTRACT

Renewed interest in state-space modelling followed the seminal work of Aoki (1987a). In this paper, the Aoki approach to state-space modelling is used and compared with different variants of VAR modelling. Using Trinidad & Tobago data, we find that the state space version is a useful alternative to its VAR counterparts.

Keywords: State space models, VAR models, short-term forecasting, impulse response analysis.

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INTRODUCTION

Until quite recently, economic modelling in the Caribbean revolved around traditional econometric models. See Craigwell et al. (1996) for a survey. A large amount of this work is based on annual data due largely to the almost total absence of an adequate data base of higher frequency data. But if the decision-maker finds such models useful for medium-term forecasting and analysis, he also needs tools to guide his action in the short term.

To deal with this dilemma, more and more studies presented in the recent literature are dedicated to the application of time series models. Indeed, it is now widely accepted that time-series methods offer useful alternatives when structural econometric models are unavailable or too difficult, if not impossible, to construct. It is possible to use time series models to analyse the economic structure of a country and to study the relationships between key variables in the economy. Furthermore, many studies argue that time series techniques give results which are comparable, or even superior to, results obtained from the traditional macroeconometric models. See McNees (1986), Makridakis (1986), Wallis (1989) and Aoki (1990) for a few examples.

Time series studies in the Caribbean involve largely the use of VAR models. Some authors have also used ARIMA and GARCH but to date precious little use has been made of the state space approach. Yet Aoki (1987b) has argued that the state-space approach is more general than the VAR approach and provides models with better properties. Following this lead, Maurin (1998) describes this approach and uses it for forecasting various Caribbean time series.

It is clear that the various time series methods are all interesting alternatives for the economist but it is also true that there is as yet no clear cut answer as to which one is best. It must also be acknowledged that empirical studies comparing the various alternatives are lacking. This paper is an attempt to fill this gap. We compare the VAR and state space methods on the basis of their strength in forecasting and economic analysis.

The rest of the paper is structured as follows. We begin by presenting briefly the various VAR and state-space models appearing in the literature. Then we apply a selection of them to Trinidad & Tobago data in an effort to determine the best model. Finally, we use the best models to study the dynamic interactions between the variables by means of impulse response functions.

SECTION I
THE VECTOR AUTOREGRESSION APPROACH

The use of VAR models was first recommended by Sims (1980) as an efficient alternative to verify causal relationships between economic variables and to forecast their future values. This approach has its foundation in the work of Wold (1938) and Box and Jenkins (1976). Given Y_t the vector of variables, the classical VAR model explains each variable by its own p past values and the p past values of all other variables by the relation

$$Y_t = d_0 + \sum_{k=1}^{p} \Phi_k Y_{t-k} + \varepsilon_t \qquad (1)$$

where the Φ_k are $n \times n$ matrices, d_0 a deterministic component which may include a constant and seasonal dummies and ε_t is a zero-mean vector of white noise processes with positive definite contemporaneous covariance matrix Σ and zero covariance matrices at all other lags.

Ordinary Least Squares (OLS) may be used to estimate the $n \times (np+1)$ parameters in (1). It is well known that the OLS estimators in this context are equivalent to the maximum likelihood estimators, are consistent and asymptotically efficient. See Lütkepohl (1993). For practical reasons, VAR estimation requires the use of lengthy time series. For selection of the optimal lag structure, the value of p is chosen to minimise different information criteria (Akaike, Schwarz or Hannan and Quinn).

Several problems arise in the use of the standard VAR formulation proposed by Sims (1980), in particular those caused by over-parametrisation. Litterman (1981) suggested the use of a Bayesian procedure to deal with these. The application of the Bayesian principle implies that an *a priori* probability distribution has to be chosen. Usually, the hypothesis of normality for the coefficients is adopted since, in most cases, the underlying economic theory has little influence on the distribution of errors. Litterman assumes that, with the exception of the coefficient corresponding to the lag of one period, the coefficients are pairwise independent with zero mean and a small standard deviation. This procedure requires that the standard deviations of the coefficients decrease as lags increase. It is also worth noting that it preserves the atheoretical character of VAR models and allows for the possibility of significant uncertainties in the actual structure of the economy as it is not based on a particular economic theory.

The final variant of the VAR model considered in this paper is the Vector Error Correction Model (VECM) which is being more frequently used for forecasting. See Engle and Yoo (1987), Clements and Hendry (1995) and Lin and Tsay (1996). The standard VAR and VECM are related in the following way :

$$\Delta Y_t = d_0 + \Pi_0 Y_{t-1} + \Pi_1 \Delta Y_{t-1} + \ldots + \Pi_{p-1} \Delta Y_{t-p+1} + \eta_t \qquad (2)$$

with

$$\Delta Y_t = Y_t - Y_{t-1}, \; \Pi_i = -\sum_{j=i+1}^{p} \Phi_j, \quad i=1,\ldots,p\text{-}1, \Pi_0 = -\Phi(1)$$

The Johansen (1988) FIML estimation procedure is used to determine the number of cointegrating vectors and estimates of the long-run relationships $\hat{\beta} Y_t$ between the variables. The latter are then used to define the error-correction terms to be included in the VAR model and estimate the resulting VECM model. The following forecast function is then derived:

$$\Delta Y_{t+h/t} = d_0 + \Pi_0 Y_{t+h-1/t} + \sum_{i=1}^{p-1} \Pi_i \Delta Y_{t+h-i/t} \qquad (3)$$

Section II:
The State Space Approach

The State Space (SS) approach to estimation and forecasting may be traced back to the seminal work of Kalman (1960a, 1960b). A large amount of the work went initially into the application of dynamic optimisation techniques and of calculation of variations to obtain optimal trajectories for economic policy variables. See Chow (1975), Preston (1974), Aoki (1976), Pagan and Preston (1982), Kendrick (1976) and Murata (1982). The techniques of estimation, solution and simulation of the economic models relied heavily on the contributions of Bellman (1954), Pontriaguine et al. (1974) and Kalman (1960a, 1960b). By the early 1980s, the proponents of this modelling approach had developed an abundant literature. Fundamentally, they proposed a methodological framework generalising the Theil-Tinbergen framework for the analysis of dynamic properties of economic models and the evaluation of optimal economic policies.

During the late 1980s, interest in this approach dwindled following the debate generated by Lucas (1976) and Kydland and Prescott (1977). Renewed interest in state space modelling is due largely to the new methodology proposed by Aoki (1983, 1987a). Based on the theory of stochastic processes, this methodology aims at building a state model directly from the observed data. These models are obtained using mathematically sophisticated techniques and a procedure which solves simultaneously problems of model selection and parameter estimation. The procedure has been well described in the Aoki papers, so we limit ourselves to the essentials here.

Let $\{y_t: t=1, 2, ...N\}$ be a set of zero mean stationary observations of a y vector which regroups q variables representing the evolution of an economic phenomenon observed at the points $t = 1, 2, ..., N$ and let the 'innovation form'[3] of the system be :

$$z_{t+1} = Azt + Ge_t \quad (4a)$$

$$y_t = Cz_t + e_t \quad (4b)$$

3 The term 'innovation form' comes about because of the presence of the same innovations in the state equation and the observation equation. There is no loss in generality resulting from this.

Equation (4a) is the state equation and (4b) the observation equation. The innovations e_t are serially independent, with covariances Δ_e, and independent of the state variables z_t. Estimation of *(A, G, C)* and solution of the system are explained in the appendix to this paper.

Since Aoki's (1983) seminal work, other theoretical and empirical studies have considerably enriched the field of system theoretic methods in the econometric literature. Otter and Van Dal (1987) formulated a variant of the original Aoki method which uses a Hankel matrix derived from the covariances between the innovations and the data. Havenner and Criddle (1989) suggest a procedure which relies on a Hankel matrix constructed from standardized transformations of data. Mittnik (1989) studied several identification schemes from a state representation in which the state vector is brought up to date from the output observed at instant *t* instead of the innovation of this same point in time. Dorfman and Havenner (1992) developed a Bayesian procedure which uses full posterior distributions for parameters and simplifies the problem of model specification.

Empirical studies include the work of Vinod and Basu (1995) which uses American data to estimate a model for consumption, income and interest rates. In a very recent work, Aoki and Havenner (1997) have put together a set of articles which present a wide range of economic applications. Fiorito (1997) investigates the impact of co-movements in the labour and goods markets on aggregate fluctuations in the US economy after the first oil shock. Using a vector of real GDP, labour force, employment, real wages and money stock, they apply the standard Aoki algorithm to estimate a state-space model and associated residuals. From these residuals, they compute impulse response functions, examine structural shocks and give an interpretation to the business cycle co-movements in the US over the period 1976 to 1990. Another interesting example is Östermark (1997) which looks at the impact of Japanese stock prices on the Finnish derivatives market. By means of a state-space model they obtain an approximation of the common trend and cyclical components of the variables considered and analyse their content by spectral analysis.

SECTON III:
PRELIMINARY DATA ANALYSIS

We use a five variable system which is usually used in the analysis of business cycles. The first three - GDP (y_t), the level of unemployment (u_t) and the index of retail prices (p_t) - are real sector variables. The other two - the Treasury Bill Rate (r_t) and bank deposits (d_t) - are monetary sector variables. The time series cover the period 1971, first quarter, to 1996, fourth quarter. The data used here are the same as those employed in Watson (1997). The source and construction of data items are explained there. The data used are unadjusted following Wallis (1974) and Ghysels (1994) who argue that the use of adjusted series may introduce distortions which may lead to misinterpretation of the dynamics of econometric models. Since seasonality is inherent in various economic series, instead of resorting to procedures which eliminate seasonal variations, it is more advisable to deal with unadjusted data.

The variables are first tested for unit roots. Preliminary examination of the plots provides evidence of a structural break in 1982 so we use procedures proposed by Perron (1989) (rather than the standard Dickey-Fuller tests) with a dummy equal to zero for all values observed on or before the fourth quarter of 1982 and equal to 1 thereafter. Results for the variables in level as well as for the first differences are reported in Table 3.1. For all series, we cannot reject the null hypothesis of a unit root in the presence of a structural break.

TABLE 3.1
PERRON UNIT ROOTS TESTS
(critical value for *t*-statistics is -3.96)

	GDP	Unemp	Prices	Deposits	TBR
In level	-1.870	-2.576	-3.148	-2.115	-3.402
In differences	-6.131	-5.811	-5.874	-10.36	-7.496

SECTION IV: MODEL ESTIMATION AND VALIDATION

Our models will be selected from the classes of models presented in the first section : Sims VAR (SVAR), Litterman (Bayesian) VAR (BVAR), VAR Error Correction (VECM) and State Space (SS) models. The best specification in each class is retained on the basis criteria using the in-sample forecast errors. The best overall model will be the one providing the best out-of-sample forecasts. The sample data is divided into two sub-samples

: one covering the period 1971 to 1992 to be used in the estimation exercise and the other covering the period 1993 to 1996 to be used for obtaining the out-of-sample forecasts. All the VAR models are estimated using RATS, 4.2.

The first model is an unrestricted VAR (SVAR) that we estimated initially with 8 lags and retained the specification using 2 lags since this minimises the Hannan-Quinn (HQ) loss function. The second model is a Bayesian VAR (BVAR) with a lag of 8 for each variable. We found values 0.2, 0.5 and 1 for parameters w, z and d.

The best VECM is derived from the best SVAR. The Johansen (1988) tests were applied to the 2-lag SVAR to determine the number of cointegrating vectors. Under the null hypothesis, there is a linear trend in the ECM and an intercept in the VAR. The results are summarised in Table 3.2 below where, using the λ_{trace} or the $\lambda_{\max}$ statistics, the hypothesis of one cointegrating vector is clearly accepted at the 95% or 90% significance levels.

TABLE 3.2
TESTS FOR THE NUMBER OF COINTEGRATING VECTORS

Ho	$r=0$	$r\leq 1$	$r\leq 2$	$r\leq 3$	$r\leq 4$
Eigenvalues (two lags)	0.4003	0.2326	0.1701	0.0404	0.0305
λ_{trace}	86.92	43.97	21.73	6.07	2.61
λ_{max}	42.95	22.24	15.66	3.46	2.61
λ_{trace} critical values (5%)	68.52	47.21	29.68	15.41	3.76
(10%)	64.84	43.95	26.79	13.33	2.69
λ_{max} critical values (5%)	33.46	27.07	20.97	14.07	3.76
(10%)	30.90	24.73	18.60	12.07	2.69

In the case of the state space model, we carried out all the algebraic numerical computation with the Speakeasy software. We examined several specifications and selected the one that provided the best forecasts. The best specification is obtained with $r = f = 1$. The Hankel matrix size is 5×5 and the associated singular values:

σ_i : 2.79 1.68 0.272 0.0128 0.00189

There is a gap from the third value to the fourth value which suggests that we should use only 3 state variables to synthesise adequately the joint dynamic evolution of the five variables. The estimation results are presented in Table 3.3

TABLE 3.3

ESTIMATION RESULTS FOR THE VECTOR $(y_t, u_t, p_t, d_t, r_t)$

Coefficients

$\hat{A}$				$\hat{G}$					$\hat{C}'$			
0.963	0.0306	0.0417	0.27	-0.431	-0.437	-0.596	-0.0965	-0.0861	-0.204	-0.722	-0.875	-0.925
-0.024	0.967	-0.063	-2.98	0.726	0.451	-0.499	0.253	-0.134	0.187	-0.06	-0.306	1.29
-0.027	-6.5E-4	0.845	1.11	-5.46	-0.327	0.485	0.884	0.0168	-0.103	0.00202	-0.0308	0.672

Covariances

$\hat{\Pi}$			$\hat{\Delta}_e$					$\hat{\Delta}_0$				
0.968			0.0019					0.0272				
0.0038	0.978		8.5 E-4	0.0060				-0.00859	0.0917			
0.0206	-0.0279	0.919	0.0043	0.0093	0.0338			0.0725	0.141	0.542		
			0.0072	0.0107	0.0415	0.0598		0.12	0.131	0.672	0.894	
			-0.0025	0.0111	0.0409	0.0279	0.278	-0.0833	0.362	0.601	0.4	3.05

SECTION V
FORECASTING PERFORMANCES

For short-term forecasting, the quality of a model must be judged by its ability to reproduce the path of the historical data and in particular its ability to anticipate and adapt to the peaks and troughs. A graphical analysis is therefore useful in comparing actual and predicted values. The in-sample and out-of-sample forecasting performances of the 5 models are illustrated in Figures 3.1 to 3.5. Based on the out-of-sample forecasts over the period 1993-1996, the message from the examination of these graphs is quite clear. Overall, the VECM and SS methods outperform by far the SVAR (Sims) and BVAR methods. Indeed, it is not difficult to see that the VECM and SS methods account better for the regime shift. It is quite difficult, however, to separate these two on performance.

However, visual examination of graphs like these is not sufficient to establish which among the four methods is best. It is for this reason that we calculated some useful summary statistics which are shown in Table 3.4. The four measures shown are the Mean Absolute Error (MAE), the Root Mean Square Error (RMSE) and Theil's well known U1 and U2 statistics. For GDP and unemployment, all the statistics result in the same classification : the SS method is the best overall followed by the VECM, then the BVAR and finally the SVAR method. For the remaining three variables, the VECM method seems to be the best.

Figure 3.1

Plots of Actual and Fitted Values for the Gross Domestic Product

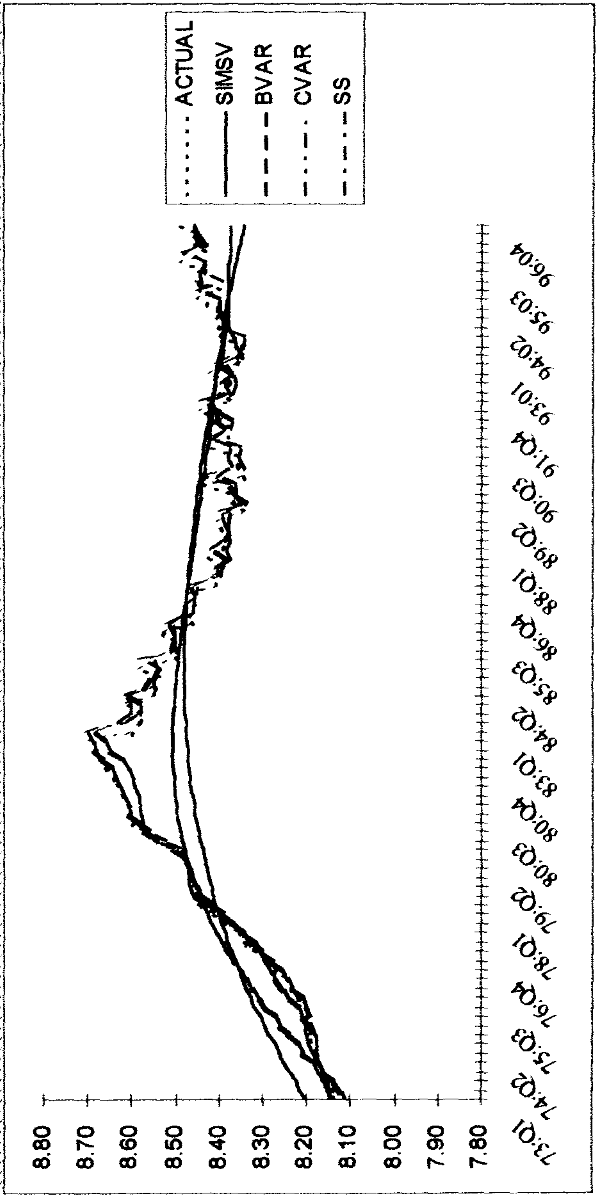


FIGURE 3.2

PLOTS OF ACTUAL AND FITTED VALUES FOR UNEMPLOYMENT

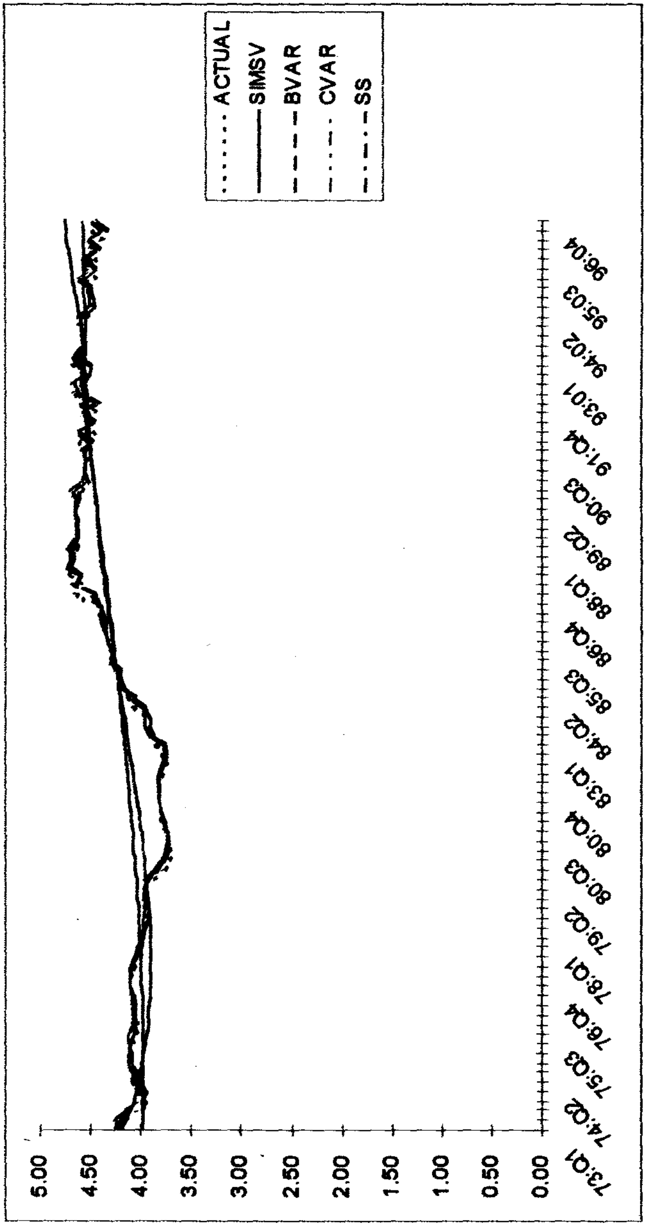


FIGURE 3.3

PLOTS OF ACTUAL AND FITTED VALUES FOR PRICES

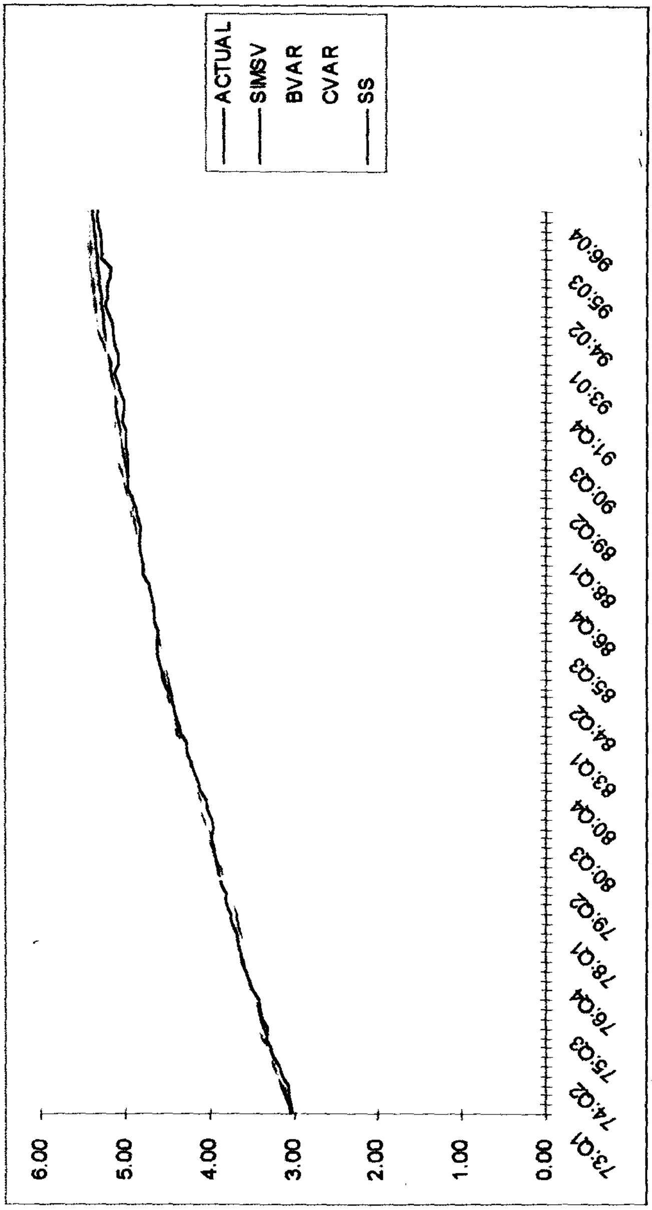


FIGURE 3.4
PLOTS OF ACTUAL AND FITTED VALUES FOR DEPOSITS

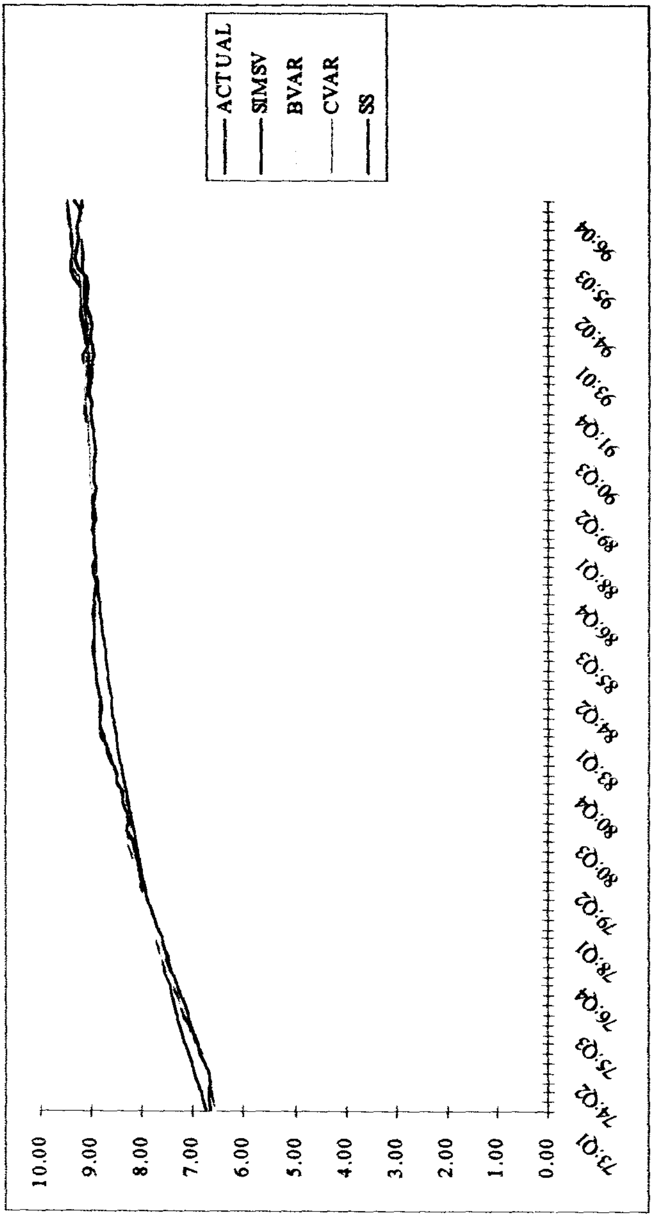


FIGURE 3.5

PLOTS OF ACTUAL AND FITTED VALUES FOR TREASURY BILL RATE

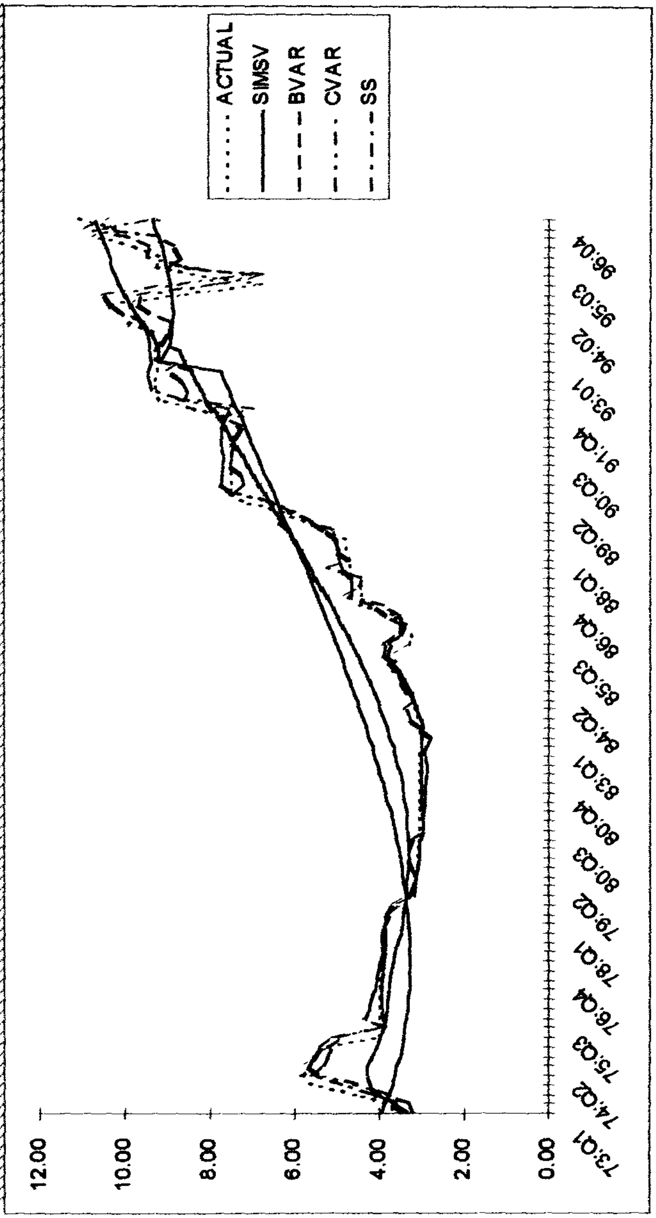


Table 3.4: Errors as a % of Actual for Out-Sample Forecasts

	GDP				UNEMP				RPI			
DATE	SVAR	BVAR	CVAR	SS	SVAR	BVAR	CVAR	SS	SVAR	BVAR	CVAR	SS
93:Q1	-0.50	-0.47	-0.50	-0.27	1.60	2.04	1.48	3.34	-0.08	-0.12	-0.14	2.79
93:Q2	-0.58	-0.53	-0.13	0.03	-0.17	0.30	-2.10	-1.10	0.61	0.49	0.55	2.56
93:Q3	-0.63	-0.54	-0.03	-0.20	-0.25	0.24	-0.32	0.12	1.10	0.92	0.33	3.04
93:Q4	0.01	0.04	0.64	0.34	0.25	0.91	0.40	0.51	1.44	1.22	0.18	3.45
94:Q1	0.10	0.14	0.12	0.20	0.29	1.18	0.07	0.98	1.34	1.06	-0.27	2.85
94:Q2	0.25	0.27	0.15	0.35	-2.23	-1.04	-2.43	-1.10	1.34	1.01	-0.18	2.16
94:Q3	0.19	0.20	-0.08	0.03	-2.67	-1.20	-0.36	0.85	1.38	0.98	-0.18	2.97
94:Q4	0.77	0.74	0.55	0.54	-2.61	-0.87	0.15	1.16	1.42	0.95	-0.20	3.00
95:Q1	0.30	0.24	-0.50	-0.55	-2.68	-0.69	0.03	0.88	1.42	0.88	-0.23	3.78
95:Q2	0.97	0.87	0.71	0.15	-5.20	-2.90	-2.25	-3.55	1.55	0.96	-0.04	4.22
95:Q3	0.80	0.66	-0.07	-0.15	-3.49	-0.95	1.92	1.63	1.57	0.92	-0.06	2.64
95:Q4	1.47	1.28	0.62	0.65	-5.96	-3.08	-2.38	-1.67	1.47	0.77	-0.27	2.86
96:Q1	0.88	0.64	-0.58	-0.44	-5.05	-1.93	0.80	1.98	0.86	0.11	-0.84	2.43
96:Q2	1.15	0.85	0.24	0.16	-8.27	-4.77	-3.09	-2.33	0.89	0.10	-0.20	2.17
96:Q3	1.30	0.95	0.13	0.03	-5.54	-1.87	2.48	3.61	0.93	0.09	-0.21	1.80
96:Q4	1.85	1.44	0.45	0.45	-7.01	-3.04	-1.49	0.17	0.96	0.09	-0.27	2.27
AVE.	0.0440	0.0360	0.0092	0.0069	0.1365	0.0487	0.0195	0.0163	0.0610	0.0349	0.0069	0.1504
MAD	0.0618	0.0520	0.0290	0.0239	0.1490	0.0757	0.0610	0.0705	0.0615	0.0357	0.0139	0.1504
RMSE	0.0057	0.0038	0.0012	0.0008	0.0344	0.0085	0.0058	0.0074	0.0042	0.0017	0.0003	0.0237
U1	0.0007	0.0005	0.0001	0.0001	0.0076	0.0019	0.0013	0.0016	0.0008	0.0003	0.0001	0.0044
U2	0.1568	0.1049	0.0342	0.0232	0.4642	0.1142	0.0777	0.1000	0.2003	0.0826	0.0139	1.1209

TABLE 3.4: ERRORS AS A % OF ACTUAL FOR OUT-SAMPLE FORECAST (CONT'D)

	TOT_DEP				TBR			
DATE	SVAR	BVAR	CVAR	SS	SVAR	BVAR	CVAR	SS
93:Q1	0.26	0.31	0.25	1.13	1.29	0.72	-0.73	7.56
93:Q2	0.64	0.78	0.42	1.38	2.44	0.74	-1.64	6.22
93:Q3	0.77	0.98	0.21	1.79	3.46	0.27	-1.81	1.19
93:Q4	0.91	1.16	0.22	1.78	4.78	-0.36	-1.34	3.95
94:Q1	1.00	1.27	0.18	1.28	10.32	3.49	3.39	9.88
94:Q2	0.79	1.06	-0.16	1.02	12.31	3.85	-0.01	6.81
94:Q3	0.85	1.12	0.06	1.59	13.75	3.96	-0.23	5.87
94:Q4	2.09	2.33	1.19	2.71	-3.99	-17.13	-22.42	-12.88
95:Q1	2.51	2.73	0.36	1.55	-30.90	-48.56	-27.94	-13.91
95:Q2	2.32	2.50	-0.16	0.77	-6.88	-21.83	16.30	19.42
95:Q3	2.01	2.15	-0.12	0.95	2.43	-11.46	6.11	3.57
95:Q4	2.42	2.52	0.45	1.50	1.19	-13.00	-3.69	5.35
96:Q1	2.18	2.22	-0.25	1.01	6.43	-7.09	3.47	9.19
96:Q2	2.56	2.56	0.33	1.74	13.95	1.44	6.72	13.85
96:Q3	2.91	2.84	0.26	2.47	9.31	-3.97	-6.43	-2.02
96:Q4	2.83	2.71	-0.30	1.39	15.91	3.54	6.76	18.97
AVERAGE	0.1579	0.1705	0.0170	0.1397	0.4336	0.5090	0.0800	0.5441
MAD	0.1579	0.1705	0.0286	0.1397	0.8119	0.7400	0.5895	0.8261
RMSE	0.0318	0.0350	0.0014	0.0218	1.0351	1.2677	0.7139	0.9602
U1	0.0034	0.0038	0.0001	0.0023	0.1088	0.1332	0.0750	0.1009
U2	0.7344	0.8093	0.0315	0.5037	1.2045	1.4752	0.8307	1.1173

SECTION VI
IMPULSE RESPONSE ANALYSIS

IMPULSE RESPONSE ANALYSIS WITH VAR MODELS

Since Sims (1980), the impulse response function is widely used to determine the appropriateness of a VAR model for economic policy purposes. The impulse responses are roughly the equivalent of the dynamic multipliers of structural econometric analysis. The aim of Sims' "atheoretical" method is to provide, using the framework of equation (1), an empirical model that best captures the internal dynamics of the interrelated economic variables. This approach has been criticised on the grounds that the estimated parameters and the resulting residuals do not lend themselves easily to economic interpretation. To deal with this, Sims himself proposes the introduction of a *priori* restrictions founded in economic theory.

Consider a vector y_t which includes variables which may be instruments or targets (or neither) of economic policy. The movement of the economy from one state to another is given by:

$$B_0 y_t = B(L) y_t + v_t \qquad (5)$$

B_0 is a $n \times n$ invertible matrix, *B(L)* a matrix of lagged polynomials and v_t a vector of disturbances with covariance Σ_v. Since the parameters of (5) are not directly estimable, we turn to the reduced form:

$$y_t = B_0^{-1} B(L) y_t + B_0^{-1} v_t \qquad (6)$$

This is analogous to the standard form defined in (1) and may be written:

$$y_t = \left(I - B_0^{-1}B(L)\right)^{-1}\varepsilon_t \text{ with } \varepsilon_t = B_0^{-1}v_t \qquad (7)$$

It is well known that, in order to identify the parameters and structural shocks to the system defined by (5), restrictions must be imposed on the covariance matrix of the innovations, Σ_ε. For, $v_t = B_0\varepsilon_t$, Sims recommends the use of structural orthogonal shocks for ε_t and a lower triangular matrix for B_0. This imposes a recursive structure for the current value variables in (5) and the Choleski decomposition is widely used for this purpose.

When certain stability conditions are satisfied, we get:

$$y_t = \left(I - B_0^{-1}B(L)\right)^{-1}\varepsilon_t = \sum_{i=0}^{\infty}\Gamma_i\varepsilon_{t-i} = \Gamma(L)\varepsilon_t \qquad (8)$$

which provide impulse response functions in terms of the ε_{it} sequences. With $v_t = B_0\varepsilon_t$ and the identification relation (8), we get thus the matrices $\Gamma_i, i = 0,1,2...$ of the impulse functions responses in terms of the structural shocks :

$$\left(I - B_0^{-1}B(L)\right)^{-1}\Gamma(L) = B_0^{-1} \qquad (9)$$

We use the following set of restrictions to identify five structural shocks:

$$\begin{cases} r = v_r \\ d = a_1 r + a_2 y + a_3 p + v_d \\ y = a_4 r + a_5 u + v_y \\ p = a_6 r + a_7 y + v_p \\ u = a_8 y + a_9 p + v_u \end{cases} \qquad (10)$$

or, in matrix notation:

$$\begin{bmatrix} v_r \\ v_d \\ v_y \\ v_p \\ v_u \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -a_1 & 1 & -a_2 & -a_3 & 0 \\ -a_4 & 0 & 1 & 0 & -a_5 \\ -a_6 & 0 & -a_7 & 1 & 0 \\ 0 & 0 & -a_8 & -a_9 & 1 \end{bmatrix} \begin{bmatrix} r \\ d \\ y \\ p \\ u \end{bmatrix}$$

This system is overidentified since there are 11 restrictions on the matrix. Indeed, we know that for a system with 5 variables exact identification requires $\frac{5\times 4}{2} = 10$ restrictions. The first equation in the system shows the treasury bill rate as completely autonomous. The second equation is a money demand function. It is the same as Sim's (1980) formulation. Following the example of Barro (1977), it could have been explained by interest rates, prices and the GDP, and interpreted as a monetary shock. The third equation explains GDP as a function of the treasury bill rate and employment. The fourth equation explaining prices may be interpreted as a supply function. The fifth equation may be viewed as an application of Okun's law with prices.

Following Bernanke (1986), another set of identification restrictions may be imposed on Σ_v. The recursivity of the above system implies an order and a hierarchy of the variables which indicate that they are those which take precedence over others. Consider an alternative model which aims at determining whether or not money can be used as a policy instrument. This supposes that money is exogenous and so influences short term activity. This factorisation implies that it is the ν innovations, and not the ε, which are orthogonal. The formulation retained is the following:

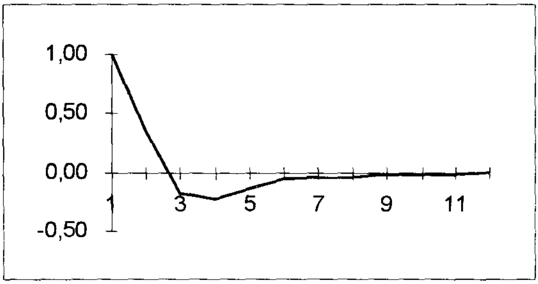
$$\begin{cases} \varepsilon_d = v_d \\ \varepsilon_p = b_1\varepsilon_d + v_p \\ \varepsilon_y = b_2\varepsilon_d + v_y \\ \varepsilon_u = b_3\varepsilon_d + v_u \\ \varepsilon_r = b_4\varepsilon_d + v_r \end{cases} \Leftrightarrow \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -b_1 & 1 & 0 & 0 & 0 \\ -b_2 & 0 & 1 & 0 & 0 \\ -b_3 & 0 & 0 & 1 & 0 \\ -b_4 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} v_d \\ v_p \\ v_y \\ v_u \\ v_r \end{bmatrix} = \begin{bmatrix} \varepsilon_d \\ \varepsilon_p \\ \varepsilon_y \\ \varepsilon_u \\ \varepsilon_r \end{bmatrix} \quad (11)$$

Since the VECM was the best VAR model, it is the one used here. This time, the model is estimated using the entire sample set. The Johansen test leads us to accept the presence of two cointegrating vectors. Since the variables are measured in different units, we standardize the responses by dividing each of them by the standard deviation of the corresponding residual variance.

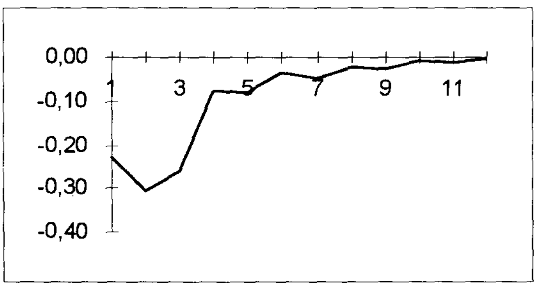
The system defined by (9) is used to obtain impulse responses resulting from a shock to the Treasury Bill Rate (TBR). These are illustrated in Figure 3.6. Figure 3.7 shows the results coming from system (10).

Figure 3.6
Impulse Response Functions Based on a Shock to the Treasury Bill Rate

Treasury Bill Rate

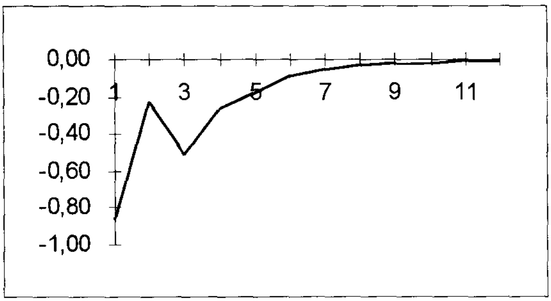


Deposits

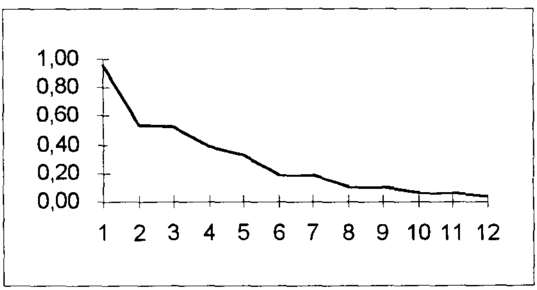


GDP

Prices



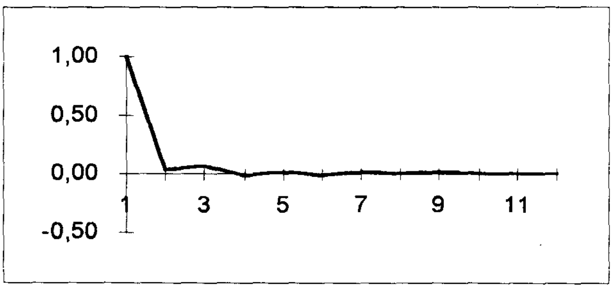
Unemployment



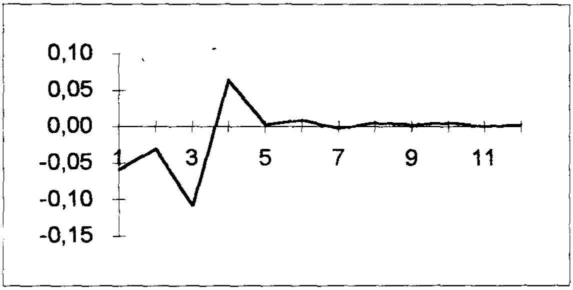
In Figure 3.6, we notice that the treasury bill rate increase results in a fall in deposits which reach their lowest level after two periods and remain at a level slightly lower than the no-shock case. This is consistent with the IS-LM framework. The price level also falls but it reaches its minimum point after only one period. The quantity theory of money predicts a decline in GDP but there is no marked evidence that this is happening here. For the first period, unemployment increases in a manner similar to that of GDP. But the effects of the TBR on unemployment lasts much longer than its effects on GDP.

FIGURE 3.7
IMPULSE RESPONSE FUNCTIONS FOR A MONETARY SHOCK (WITH DEPOSITS)

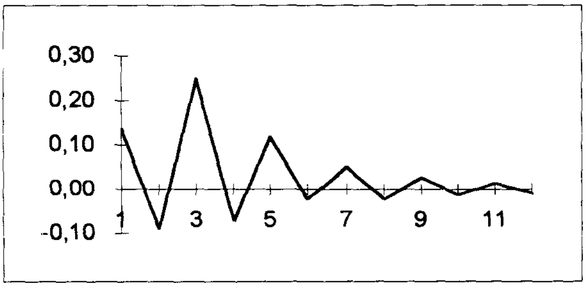
Deposits



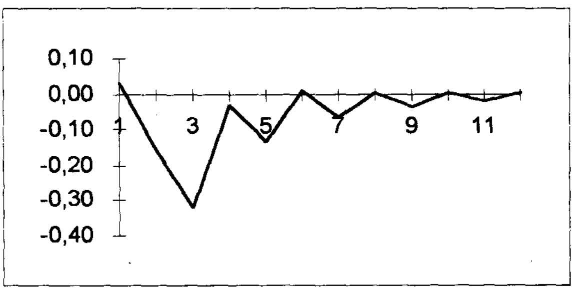
Prices



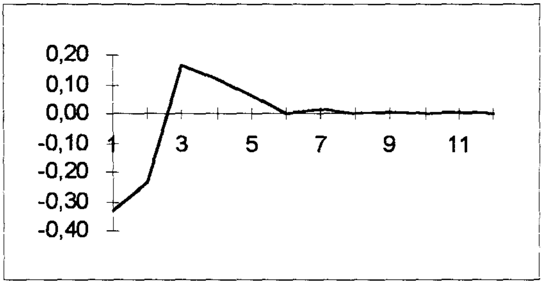
GDP



Unemployment



Treasury Bill Rate



The graphs shown in Figure 3.7 indicate that, in most cases, monetary shocks have significant effects in the short-run but not in the long-run. Prices are negatively correlated to deposits for three periods. After this, the effect is positive for two periods. In the case of unemployment, the effect is negative, its level falls and one can observe that the minimum is reached after three periods. Compared with the response of unemployment due to a shock of treasury bill rate, we see that the pattern is asymetric : in one case, the effect is negative, in the other one the effect is positive. The graph which presents the response of GDP exhibits a seasonal pattern; it reaches its minimum after two periods and its maximum after three periods. The treasury bill rate falls after one period and increases to reach a maximum after three periods.

Shock Analysis With State Space Models

In the past and even up to now, the econometric literature has shown how much system theory has contributed to the analysis and resolution of problems related to policy-making. Control theory, developed during the 1970s and the 1980s, and the theory of difference games, developed more recently, offer different strategies for determining optimal trajectories for economic policy variables. Furthermore, compared to the traditional econometric approach, they allow for a qualitative analysis of the models. In particular, using a dynamic generalisation of the Tinbergen and Theil static theory, they provide well-grounded concepts to check the existence, unicity, and feasibility of an economic policy. It is well known that these dynamic properties can be properly characterized by stability, controllability and observability criteria. In practice, before attempting to evaluate an economic policy, it is recommended that it be verified before hand whether these conditions have been met. Then a logical step in the study is to obtain the dynamic multipliers that represent quantitative measures of the reaction of the system when this policy has been put into place.

How well we interpret the system responses to these innovation shocks clearly depends on the quality of the multipliers. The concept of the multiplier is intimately related to the stability of the model over time. In the first place it is a quantitative expression of the system responses and secondly, it provides a measure of the qualitative characteristics of these responses. In the state space representation, the transition of the economy from t to $t+1$ is regulated by the system of difference equations in (4). From a mathematical viewpoint, the stability of the evolution of the variables making up y_t will be determined by the characteristic roots of A. Since this matrix is obtained from information contained in the series $y_{it}, i = 1,..q$, it is equally important to examine the stationarity properties of these series.

In fact, the evolution of an economic variable results from different movements that, in combination, generate the observed values of the series. Under these circumstances, any attempt to identify or describe the process generating the series must involve a model that decomposes the initial evolution of the variables to take into account the influence of each movement on the variability of the series under study.

In the case of a state model like (4), such a decomposition is carried out using the concept of dynamic aggregation. From the raw series, a model of aggregated state is constructed using a 2-step procedure. The first step allows for the building of state space models for the trend and the second one the construction of state space models for the remaining components. The procedure does not require prior detrending of time series but it explicitly models the trend, cyclical and residual components.

This approach is applied to series which are not stationary. For them, a partition of the eigenvalues leads to distinguishing the slower dynamic modes associated with the trend and the faster dynamic modes associated with the cyclical components. In this way, a new coordinate system based on the subspaces of the corresponding eigenvectors spanned by matrices P (slow dynamics) and R (fast dynamics) is considered. This decomposition yields for the state vector $z_{t+1} = P\tau_t + Rx_t$ and then $y_t = CP\tau_t + CRx_t + e_t$. With the system matrices estimated on initial data, one can define the errors $w_t = y_t - CP\tau_t = CRx_t + e_t$ and consider that they are generated by the system

$$\begin{cases} \tau_{t+1} = A\tau_t + Gw_t \\ y_t = C\tau_t + w_t \end{cases} \tag{12}$$

In the second step, the same procedure is applied to the weakly stationary series w_t and produces a vector e_t of serially uncorrelated residuals.

$$\begin{cases} x_{t+1} = Fx_t + Je_t \\ w_t = Hx_t + e_t \end{cases} \tag{13}$$

With these two systems the data vector y_t is modelled by an aggregate state space model

$$\begin{cases} \begin{pmatrix} \tau_{t+1} \\ x_{t+1} \end{pmatrix} = \begin{pmatrix} A & GH \\ 0 & F \end{pmatrix} \begin{pmatrix} \tau_t \\ x_t \end{pmatrix} + \begin{pmatrix} G \\ J \end{pmatrix} e_t \\ y_t = \begin{pmatrix} C & H \end{pmatrix} \begin{pmatrix} \tau_t \\ x_t \end{pmatrix} + e_t \end{cases} \tag{14}$$

The multipliers are obtained through the introduction of the lag operator in the transition equation of the system (14) :

$$z_t = \Pi L z_t + \begin{pmatrix} G \\ J \end{pmatrix} e_t$$

with $z_t = \begin{pmatrix} \tau_t \\ x_t \end{pmatrix}$ and $\Pi = \begin{pmatrix} A & GH \\ 0 & F \end{pmatrix}$.

This allows us to write

$$z_{t+1} = [I - \Pi L]^{-1} \begin{pmatrix} G \\ J \end{pmatrix} e_t$$

In the same way we obtain for the observation equation :

$$y_t = \begin{pmatrix} C & H \end{pmatrix} [I - \Pi L]^{-1} \begin{pmatrix} G \\ J \end{pmatrix} e_t$$

The observation variables are directly linked to the innovations by the matrix $(C \quad H)[I - \Pi L]^{-1}\begin{pmatrix} G \\ J \end{pmatrix}$ which is known as the transfer matrix in system theory.

Given that, under conditions of stationarity:

$$[I - \Pi L]^{-1} = \lim_{T \to \infty} \sum_{i=0}^{T} \Pi^i L^i$$

it follows the relation $y_t = (C \quad H)\left(\sum_{i=0}^{T} \Pi^i L^i\right)\begin{pmatrix} G \\ J \end{pmatrix} e_t$ which provide the dynamic multipliers :

$$M_k = (C \quad H)\Pi^k \begin{pmatrix} G \\ J \end{pmatrix}, k = 1,2\ldots \qquad (15)$$

Aoki (1987) interprets them as follows : "the *j-th* column vector of the matrix M_k shows how the current observation is affected by an exogenous impulsive disturbance to the *j-th* component of the data vector of *k* period ago."

At this juncture we might wish to compare the two approaches for obtaining impulse response functions. The algebra of the state space approach, as can be seen from (15) is much simpler than those obtained from (8), which is nothing more than the famous Wold decomposition. Furthermore, we obtain an analytic expression for the state space model which is not always the case for the VAR models.

We applied this procedure on the vector y_t and computed impulse response with one standard error innovation increase in the variable used as policy instrument.

The model for the first stage of the Aoki procedure is shown in Table 3.3. Using the residuals from this model, we obtain the following results:

$$F = \begin{pmatrix} 0.883 & -0.0406 & 0.0171 \\ 0.133 & 0.627 & -0.135 \\ 0.12 & -0.139 & 0.74 \end{pmatrix}, \quad J = \begin{pmatrix} 1.13 & 6.65 & -16.3 & 3.29 & 0.0576 \\ -22.5 & -9.93 & 1.95 & 12.7 & -0.654 \\ -5.18 & -5.04 & 20.5 & -5.2 & -1.71 \end{pmatrix},$$

$$H = \begin{pmatrix} 0.00591 & -0.00967 & -0.00419 \\ -0.00906 & -0.0224 & -0.0143 \\ -0.0394 & -0.00855 & 0.0186 \\ -0.0267 & 0.0257 & -0.0179 \\ -0.117 & -0.118 & -0.0886 \end{pmatrix}$$

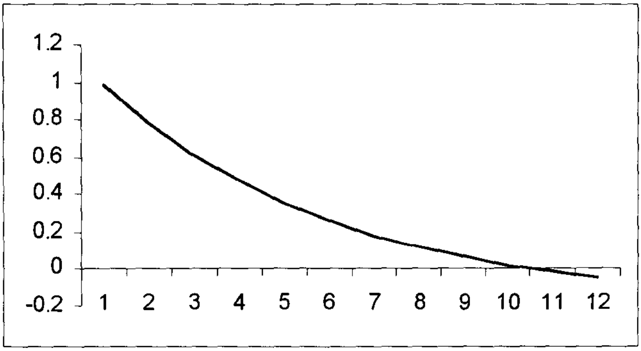
$$\Omega = \begin{pmatrix} 7.13 & & & & \\ -5.08 & 28.7 & & & \\ 0.0806 & 0.413 & 4.31 & & \\ 2..93 & -1.56 & 0.924 & 10.9 & \\ 7.42 & -46.5 & 7.08 & -6.24 & 684 \end{pmatrix} \times 10^{-4}$$

The eigenvalues of the F matrix in (11) are {0.548, 0.814, 0.887}. As expected, these values are lower than the eigenvalues of the A matrix in (10) which are {0.86, 0.958-0.016i, 0.958 + 0.16i}. This result, together with the values of the residuals from model (11), allows us to conclude that the fit is adequate.

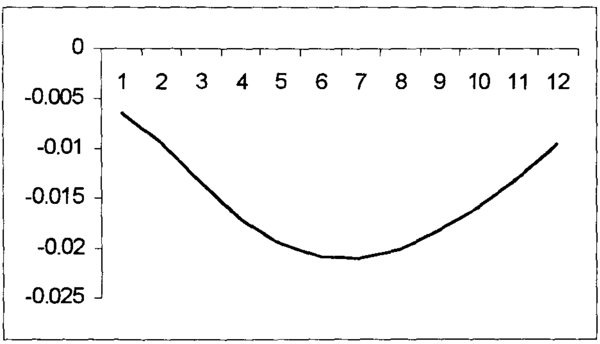
Shocks were applied to the Treasury Bill Rate without any restriction and the impulse responses are shown in Figure 3.8:

Figure 3.8
Impulse Response Functions based on a Shock to the Treasury Bill Rate (state space model)

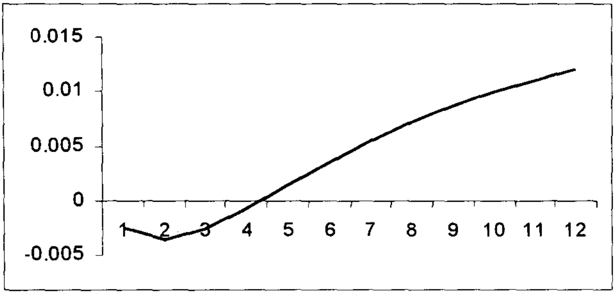
Treasury Bill Rate



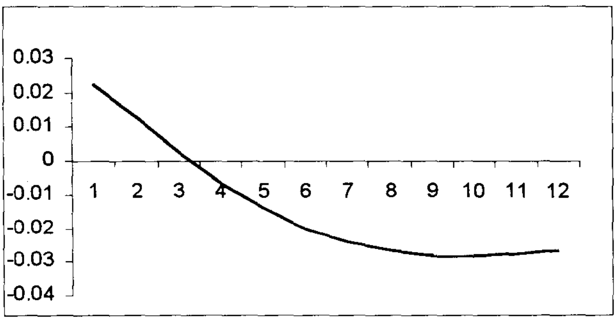
Deposits



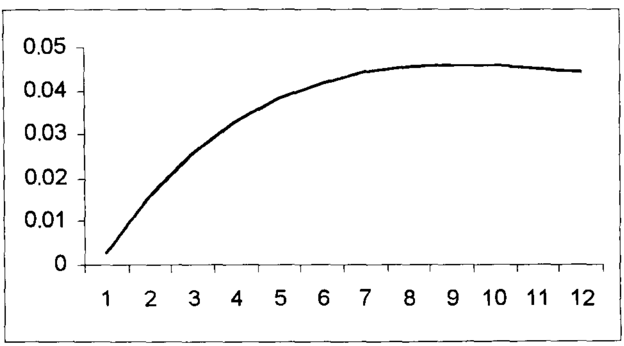
GDP



Prices



Unemployment



The results show that an increase in the Treasury Bill Rate results in a fall in deposits. The price level also falls. We also notice a remarkable symmetry between the GDP and Prices time paths which may be explained as follows. In Trinidad & Tobago, investment falls following an increase in interest rates. At the same time, however, falling prices lead to an increase in consumer spending which is stronger than the fall in investment. In such a scenario, the "price" effect is stronger than the "investment" effect. Unemployment increases quite logically as a result of falling investment.

Conclusion

Quantitative macroeconomic work is a necessity in economics if only because it may lead to policy orientations which allow greater insight into the wider debates about economic policy, permitting eventually the optimisation of public choice in both the short and long run.

As econometric techniques improve, studies show up inadequacies and even differences of opinion resulting from these techniques. Exercises involving the comparison of forecasting methods and causality analysis over the short term such as we have proposed here are becoming more and more popular in the literature. Our contribution is in the tradition of those which compare forecasts obtained from econometric models of policy-making institutions with those obtained from VAR models. Furthermore, we looked beyond the diversity of VAR models into the domain of state-space models which have been increasing in popularity over the last few years.

Our results are in keeping with the growing realisation that state space models will be used more and more to study and forecast economic variables. Indeed, in the context of forecasting, the performance of state space models appears superior to that of VAR models with the possible exception of the VECM. But even in the latter case, VECM models generate forecasts errors which are comparable to those of state models. Further to that, as far as the impulse responses go, we have shown that the state-space approach is just as attractive as the VAR for economic analysis.

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APPENDIX 3.1
ALGORITHM FOR THE STATE SPACE METHOD

In this appendix, we present the main steps of the Aoki procedure for estimating the parameters *(A, G, C)* which "solves" the system represented by (4a), (4b) in the main text and forecasts future values of *y*. The structure of the algorithm is in the form of a pseudo-code close to the syntax of the Pascal language.

ALGORITHM FOR THE STATE SPACE METHOD

Step 1. Compute an estimate $\hat{H}$ of the Hankel matrix H

(i) From the observations $\{y_t; t = 1, \ldots, N\}$, estimate the autocovariance function $\{\Delta_k\}$.

For y_t and y_{t+k}, $\hat{\Delta}_k$ is defined by : $\hat{\Delta}_k = \frac{1}{N}\sum_{t=1}^{N-k} y_{t+k} y_t$

(ii) Construct $\hat{H}$ in the following way:

$$\hat{H} = \begin{bmatrix} \hat{\Delta}_1 & \hat{\Delta}_2 & \cdots & \hat{\Delta}_r \\ \hat{\Delta}_2 & \hat{\Delta}_3 & \cdots & . \\ . & . & \cdots & . \\ . & . & \cdots & . \\ . & . & \cdots & . \\ \hat{\Delta}_f & \hat{\Delta}_{f+1} & \cdots & \hat{\Delta}_{f+r-1} \end{bmatrix} \quad (1)$$

r and *f* are, respectively, the number of block-columns and the number of block-rows by columns. *r* is the maximum lag and represents the memory of the process. f is an integer which depends on the forecast horizon h $(f \geq \max(pr, h))$.

Step 2. Choice of the model order

(iii) Compute the singular value decomposition of the Hankel matrix :

$$\hat{H} = \hat{U}\hat{\Sigma}\hat{V} \qquad (2)$$

(iv) Define the number of states n of the model by the rank of $\hat{H}$, i.e. define n as the number of non-zero singular values of $\hat{H}$.

Step 3. Calculation of the matrices $\hat{A}$, $\hat{G}$ and $\hat{C}$

(v) Calculate the matrices $\hat{A}$, $\hat{\Omega}$ and $\hat{C}$ by :

$$\begin{aligned} \hat{A} &= \Sigma^{-\frac{1}{2}} U^t \bar{H} V \Sigma^{-\frac{1}{2}} \\ \hat{\Omega} &= \Sigma^{-\frac{1}{2}} U^t H^{\Omega} \\ \hat{C} &= H^C V \Sigma^{-\frac{1}{2}} \end{aligned} \qquad (3)$$

The matrices H^C, H^{Ω} and $\bar{H}$ are defined as follows :

$$H^C = \begin{bmatrix} \hat{\Delta}_1 & \hat{\Delta}_2 & \cdots & \hat{\Delta}_r \end{bmatrix} \qquad (4)$$

$$H^{\Omega} = \begin{bmatrix} \hat{\Delta}'_1 & \hat{\Delta}'_2 & \cdots & \hat{\Delta}'_f \end{bmatrix} \qquad (5)$$

$$\tilde{H} = \begin{bmatrix} \hat{\Delta}_2 & \hat{\Delta}_3 & \cdots & \hat{\Delta}_{r+1} \\ \hat{\Delta}_3 & \hat{\Delta}_4 & \cdots & \hat{\Delta}_{r+2} \\ . & . & \cdots & . \\ . & . & \cdots & . \\ . & . & \cdots & . \\ \hat{\Delta}_{f+1} & \hat{\Delta}_{f+2} & \cdots & \hat{\Delta}_{f+r} \end{bmatrix} \quad (6)$$

(vi) Calculate $\hat{G}$ which requires the matrix Π, solution of the following Riccati equations

$$\Pi = A\Pi A' + (\Omega - A\Pi C')(\Delta_0 - C\Pi C')^{-1}(\Omega - A\Pi C')' \quad (7)$$

$$\hat{G} = (\Omega - A\Pi C')(\Delta_0 - C\Pi C')^{-1} \quad (8)$$

Step 4. Compute the forecasts $\hat{y}_{t+h|t}$

(vii) $\hat{y}_{t+h|t}$ is the h-step ahead forecast performed at time *t*. It is obtained by solving the system (4a, 4b) using an estimate of the initial state, x_1. For this, the backcasting technique of Box and Jenkins (1976) may be used. From the following recursive system

$$(9) \quad \begin{cases} \hat{x}_{t+1} = \hat{A}\hat{x}_t + \hat{G}\hat{e}_t \\ \hat{e}_t = y_t - \hat{C}\hat{x}_t, \quad t = 1,\ldots, N-1 \\ \hat{x}_0 = 0 \end{cases}$$

we first obtain an estimation of x_T by looking further back in time. Then from this estimation $\hat{x}_T$, we calculate forecasts backwards till we get to $\hat{x}_1$.

END OF THE ALGORITHM

The singular value decomposition may be done using the Golub-Reinch algorithm which employs QR factorisations. The setting up procedure that we use in this paper is close to the one outlined in Forsythe et al. (1977) and corresponds in fact to the standard version used in the EISPACK and LINPACK software. It is the standard procedure used to obtain the singular value decomposition of a matrix. It has good numerical properties which result from the fact that it uses Householder transformations. It is well known that orthogonal matrices, and particularly Householder matrices, minimise calculation errors resulting from iterations because they are always well conditioned.

CHAPTER 4

THE PERSISTENCE OF SHOCKS ON BARBADIAN ECONOMIC ACTIVITY

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Olivier Manioc
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The Persistence of Shocks on Barbadian Economic Activity

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Olivier Manioc[2]
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ABSTRACT

The aim of this paper is to measure the persistence of shocks on sectoral and aggregate output in Barbados and the eventual links that might exist between them. Measures of persistence of sectoral and macro-economic shocks are discussed and then applied to the Barbadian economy within the framework of a constrained VAR model.

Keywords : VAR, Shocks, Persistence, Cointegration, Monetary Policy.

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1. Introduction

Studies done by Nelson and Plosser (1982) have shown that most macroeconomic variables tend to be stochastic. Since then, there has been a resurgence of work on the business cycle. Indeed, it is claimed that one could manage to eliminate macroeconomic fluctuations through better defined policies, including monetary policy. But this view has been challenged, principally because many analysts question the persistence of shocks on GDP and other economic variables. The concept of persistence has in fact become the cornerstone of any analysis of economic shocks.

This has already been the subject of a number of studies, focusing primarily on the analysis of aggregate time series data, such as Blanchard and Quah (1989). They specified a small VAR model of output and unemployment under the assumption that supply shocks can have permanent effects on the level of output while demand shocks can have only temporary effects. One problem with the Blanchard and Quah model is that it allows only two underlying shocks to the economy. It is for this reason that Shapiro and Watson (1988) used a system of equations which includes real output, total labour hours, inflation and real interest rate. This set of variables allowed them to account for four different disturbances, two to aggregate supply which they identified as shocks to labour supply and technology, and two to aggregate demand which they referred to as IS and LM shocks. These authors found that aggregate demand shocks had a smaller impact on real GDP than Blanchard and Quah did.

The aim of this paper is to measure the persistence of shocks on output within the framework of multisectoral model. This work is similar to that of Pesaran *et al.* (1993) and is based on an economy with n sectors in which shocks generated by the i^{th} sector can affect the j^{th} sector in the long-run sector either directly or indirectly through possible links with other sectors.

The rest of the paper is organised as follows. In section 2, we present the framework of Pesaran *et al.* (1993) for the measurement of a sectoral persistence index while in section 3, we do the same for a macroeconomic persistence index. In section 4 we calculate sectoral indices for the Barbadian economy using a constrained VAR (CVAR) model while in section 5, we measure the persistence of monetary shocks on the same system. In section 6 we conclude the paper.

2. Persistence Index Based on Sectoral Shocks

Pesaran *et al.* (1993) propose a disaggegrated approach of persistence given the constraints imposed by aggregation of macroeconomic data. Given an (n´1) vector of I(1) sectoral outputs

$$y_t = (y_{1t}, y_{2t}, \dots, y_{nt})'$$

they lead off with the following model:

$$y_t = \beta + \Phi(L)\varepsilon_t$$

$$\text{with} \quad \Phi(L) = \sum_{i=0}^{\infty} \psi_i L^i \qquad (1)$$

where β is an $(n,1)$ vector of constants, ε_t is an $(n,1)$ vector of white noise innovations with

$$E(\varepsilon_t) = 0 \text{ and } E(\varepsilon_t \varepsilon_t') = \Sigma(\sigma_{ij}) \qquad (2)$$

The ψ_i are square matrices of order n with $\psi_0 = I_n$.

According to Pesaran *et al.* (1993), the measure of persistence P_{ij}, which represents the effects of a shock of the sector j on the sector i, is represented as follows:[3]

$$P_{ij} = \frac{e_i'\Phi(1)\sum\Phi(1)'e_j}{e_j'\sum e_j} \qquad (3)$$

e_k is the k^{th} column of the identity matrix I_n. Under these conditions, P_{ij} measures the cumulative effect of a shock initiated in the sector j on GDP in the sector I (it in fact measures the long-run response of the variable i). The aggregate output level y_t will be the sum of sectoral outputs weighted by a vector of relative weights w:

$$y_t = \sum_{i=1}^{n} w_i\, y_{it} = w'y_t \qquad (4)$$

From (1), it is obvious that:

$$\Delta y_t = w'\beta + w'\Phi(L)\varepsilon_t \qquad (5)$$

Pesaran *et al.* (1993) propose the following aggregate measure of persistence:

$$P^2 = \frac{w'\Phi(1)\sum\Phi(1)'w}{w'\sum w} \qquad (6)$$

3 In the univariate case, $\Phi(1)$ is the persistence index proposed by Cambell and Mankiew (1987).

If we assume that only output in the i^{th} sector is stationary, equation (6) may be written as:

$$P^2 = \frac{\sigma_{ii} w_i^2}{w' \sum w} P_i^2 \qquad (7)$$

If the innovations are uncorrelated, we then have :

$$P^2 = \frac{w_1^2 P_{11} \sigma_{11}}{w_1^2 \sigma_{11}} \qquad (8)$$

$$P = P_i \qquad (9)$$

The relation between P and P_i implies that $P = 0$ if $P_i = 0$ for all i. However, $P_i = 0$ does not necessarily imply that $P_i = 0$. All we need do is retain the hypothesis of cointegration between the sectors and set out that the weight w as proportional to one of the cointegrating vectors. From (3), we then obtain:

$$e_j' \sum e_j P_{ij} = e_j' \Phi(1) \sum \Phi(1)' e_j \qquad (10)$$

From (6) and noting the cointegration relation $\alpha' P = 0$, we have:

$$\left(w' \sum w\right) P^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \sigma_{ij} P_{ij} \qquad (11)$$

One particular case of importance arises when there are only two cointegrating vectors. If in addition there are only two sectors in the model and the cointegrating vector is :

$$\begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} = \alpha$$

we then have

$$\sigma_{ij}P_{ij} = \sigma_{jj}P_{ij} \qquad (12)$$

We can then write :

$$\sigma_{11}P_{21} = \sigma_{22}P_{12} \qquad (13)$$

But also:

$$\begin{aligned} \alpha_1 P_{11} + \alpha_2 P_{21} &= 0 \\ \alpha_2 P_{12} + \alpha_2 P_{22} &= 0 \end{aligned} \qquad (14)$$

We obtain the following expression if α_1 and α_2 have the same sign

$$\left(w'\sum w\right)^{\frac{1}{2}} P = \left| w_1\sqrt{\sigma_{11}}P_1 - w_2\sqrt{\sigma_{22}}P_{22} \right| \qquad (15)$$

Alternatively, if α_1 and α_2 have opposite signs

$$\left(w'\sum w\right)^{\frac{1}{2}} P = w_1\sqrt{\sigma_{11}}P_1 + w_2\sqrt{\sigma_{22}}P_{22} \qquad (16)$$

The value of the persistence index at the aggregate level therefore depends a lot upon the signs of the components of the cointegrating vector. Let us look more closely at the case which occurs frequently in practice where $\frac{\alpha_1}{\alpha_2} < 0$. From the last equation we obtain:

$$P = \left(\frac{w_1^2\sigma_{11}}{w'\sum w}\right)^{\frac{1}{2}} P_1 + \left(\frac{w_2^2\sigma_{22}}{w'\sum w}\right)^{\frac{1}{2}} P_2 \qquad (17)$$

Setting $\lambda_i = \left(\frac{w_i^2\sigma_{ii}}{w'\sum w}\right)^{\frac{1}{2}}$, the previous formula can be written as the weighted sum of the sector-based indices:

$$P = \lambda_1 P_1 + \lambda_2 P_2 \tag{18}$$

In similar fashion, it can be shown that if the sectoral outputs are cointegrated and positively correlated, the aggregate persistence index may be expressed as a linear combination of the disaggregated persistence indices:

$$P = \sum_{i=1}^{n} \lambda_i P_i \tag{19}$$

where P_i is a sector-based index of persistence defined by

$$P_i = P_{ij}^{\frac{1}{2}} \tag{20}$$

and where P_{ij} is a specific measure of persistence of shocks in sector j on the level of output in sector i.

3. Persistence Index Based on Macroeconomic Shocks

The previous expression is limited to the case where the variables considered are affected by shocks emanating from one or more of the sectors. This model is an oversimplification since it does not take into account the possibility of other macroeconomic shocks which may emanate from outside of the sectors. In order to deal with such eventualities, consider the following model:

$$\Delta y_t = \mu + C(L)v_t + \Phi(L)\varepsilon_t \tag{21}$$

with $\quad E(v_t) = 0, E(v_t^2) = \sigma_v^2 \;\; C(L) = c_0 + c_1 L + c_2 L^2 + \ldots$

$$c_j = \begin{pmatrix} c_{1j} \\ . \\ . \\ . \\ c_{jn} \end{pmatrix}$$

Here v_t represents macroeconomic innovations (for example, money supply innovations) which can be written as follows:

$$\Delta x_t = \beta' z_t + v_t \qquad (22)$$

where z_t represents a vector of exogenous variables. We assume that $Cov(\varepsilon_t, v_t) = 0$.

It is easily verified that:

$$P^2 = \lambda P_x^2 + (1-\lambda)P_s^2 \qquad (23)$$

where P_s is a measure of persistence resulting from sectoral shocks while P_x is the persistence due to variable x. It is easily verified that:

$$P_s = \left[\frac{w'\Phi(1)\sum \Phi(1)'w}{w'\sum w} \right]^{\frac{1}{2}} \qquad (24)$$

and

$$P_x = \left[\frac{w'C(1)}{w'c_0} \right] \qquad (25)$$

and that

$$\lambda = \frac{\sigma_v^2 (w'c_0)^2}{\sigma_v^2 (w'c_0)^2 + w'\sum w} \qquad (26)$$

We may obtain measures of sectoral persistence from these formulae if we replace w by e_i.

4. Persistence of Sectoral Shocks on Barbadian GDP

Data used in this study are obtained from Lewis (1997). They measure the contribution to real GDP of five (5) sectors of the Barbadian economy (sugar, non-sugar agriculture and fishing, construction, wholesale, retail, and tourism) over the period 1974, 1st quarter, to 1995, 4th quarter. We first test for unit roots in sectoral output and the results of the tests shown in Table 4.1 suggest that GDP of all the sectors is a random walk process.

Table 4.1
Unit root Tests
Sample : 1975:1-1995:4

	Comments
Sugar	I(1)
Tourism	I(1)
Construction	I(1)
Nsaf*	I(1)
Wholesale & Retail	I(1)

* Non-sugar agriculture and fishing.

The tests for unit roots are followed by tests for the existence of cointegrating relationships among the various sectors. Most of the sectors are not cointegrated.

Table 4.2 shows the persistence indices obtained from the CVAR model with three lags:

Table 4.2
Persistence Index
Sample: 1975:1-1995:4

	P_i
Sugar	0.90
Tourism	0.39
Construction	0.22
Nsaf	1.19
Wholesale & Retail	0.85
P	**0.41**

The aggregate index (P) is calculated using equation (19). Use of equation (6) yields quite a different result (in the case of the CVAR the value calculated is 1.25 as compared to that of 0.41 shown in Table 4.2). This is hardly surprising given that the sectors are not cointegrated.

5. Persistence of Monetary Shocks on Barbadian GDP

The macroeconmic shocks considered in this paper are those resulting from monetary policy measures. Tests of the implications of the monetary policy require measures of expected and unexpected money growth to be constructed for subsequent use in the output equation as proxies for monetary shock. Previous empirical studies have typically used the predicted values and residuals from money growth models of the type estimated by

Barro (1977). Recently some studies have shown the instability of money growth models and their inability to explain the behaviour of money during the two last decades. For instance Baba et al. (1992) have proposed another model which they claim is stable. Our specification is similar to theirs.

The monetary shocks are obtained as the residuals from equation (27) which is shown below:

$$\Delta\left(\frac{m}{y}\right)_t = \underset{(0.82)}{0.011} - \underset{(-2.11)}{0.295}\,\Delta\left(\frac{m}{y}\right)_{t-1} - \underset{(-0.91)}{0.352}\,\Delta\pi_{t-1} - \underset{(-1.30)}{0.045}\,\Delta i_t - \underset{(-2.14)}{0.087}\,\Delta i_{t-1}$$
$$- \underset{(-1.07)}{0.046}\,\Delta i_{t-2} - \underset{(-0.82)}{0.0314}\Delta i_{t-3} + \underset{(0.79)}{0.037}\Delta g_t + \underset{(1.01)}{0.056}\Delta g_{t-1}$$
$$+ \underset{(0.06)}{0.036}\Delta g_{t-2} - \underset{(-1.01)}{0.040}\,\Delta g_{t-3} - \underset{(-4.36)}{0.908}\,ecm_{t-1} + v_t \qquad (27)$$

$$R^2 = 0.59 \qquad See = 0.035 \qquad DW = 1.87$$

$$ecm_t = \left(\frac{m}{y}\right)_t - \underset{(-4.85)}{2.24} - \underset{(-4.30)}{0.239}\pi_t + \underset{(2.20)}{0.031}i_t - \underset{(-1.63)}{0.059}g_t \qquad (27')$$

$$R^2 = 0.82 \quad DW = 1.16 \quad See = 0.045$$

In this equation, $m_t, i_t, \pi_t, g_t, y_t$ are, respectively, the real growth rate of money supply, interest rate, the consumer price index, government expenditure and real GDP. ecm_t is the error correction mechanism. This equation is similar to a monetary authority reaction function (see Barro, 1977).

Equation 21 suggests the procedure to follow in order to measure the importance of monetary shocks on output. Equations (21) and (27) show clearly that they can be viewed as a new classical model in which money supply does not affect GDP in the long run. If we limit our concern to the first two periods, we may conclude that the effect of the monetary shock on GDP will be very weak in the long run if $c_0 + c_1 = 0$. It is clear that this condition does not give any information about the short run. Indeed, it is easy to show that (21) may be written as

$$\Delta y_t = \mu + c_0 \Delta v_t + (c_0 + c_1) \sum_{i=1} \Delta v_{t-i} + \Phi(L)\varepsilon_t$$

Clearly, if $c_0 + c_1 = 0$, monetary shocks cannot affect GDP in the long term but can affect it in the short term ($c_0 \neq 0$) or not affect it ($c_0 = 0$). It is a well known tenet of the classical school that monetary effects on the real sector are negligible in the long run and it will be interesting to test this hypothesis in the current context. So, if monetary shocks do not affect output levels (in the short run and in the long run) we must have $c_0 = c_1 = 0$. We employ a Wald test to do this.

The results obtained show that, among the 5 sectors considered, only two of them are affected in the short and long run by monetary supply shocks. These are the tourism and the wholesale & retail sectors. As a consequence, we may set $c_0 = c_1 = 0$ for the other sectors. The measures of persistence derived thereafter are shown in Table 4.3 below:

TABLE 4.3
PERSISTENCE MEASURES OF MONETARY SHOCKS
SAMPLE: 1975:1-1995:4

	P_s	P_x	P
Sugar	0.22	0.00	0.18
Tourism	1.18	0.18	0.82
Construction	1.04	0.00	1.03
Nsaf	0.82	0.00	0.77
Wholesale & Retail	1.65	2.46	2.30
P	0.81	0.87	0.79

Our major finding is that the aggregate persistence is not very different from one due to the sector specific shocks (the first and the third columns of the table show this very clearly). In spite of a rather high monetary persistence, the effect of a monetary shock on output is negligible. The value of P_x (0.81) is quite misleading.

CONCLUSION

We made an attempt to investigate the possibility of establishing a link between the persistence of shocks at the aggregate and sectoral levels. We calculated their values based on the Pesaran et al. (1993) approach. To get a better picture, we considered the consequences of shocks generated not only by a single sector, but also by shocks common to all sectors (monetary shocks in this instance). In the case of the sectoral shocks, we saw that, if the sectors are pairwise co-integrated, the aggregated persistence may be presented as a weighted measure of sectoral persistence. But it was not possible empirically to establish any such relation. In the case of the monetary shocks, we concluded that only two sectors are affected.

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CHAPTER 5

TOURISM MATURITY AND DEMAND

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ABSTRACT

Tourism maturity means increasing difficulty in attracting tourists despite marketing efforts. But why do destinations mature? The tourism life-cycle literature suggests that tourism interaction has an ultimate negative utility for tourists as a destination matures (i.e advances along the Butler S-curve). Thus, existing models of tourism demand (which focus on income and price factors) are of limited utility as they need to be modified for tourism maturity phenomena and related externalities. This paper presents a single equation constrained optimisation Lagrangian model of tourism demand which encompasses both the externality and the income/ price factors. Alternative models were tested on data for Barbados, one of the more mature Caribbean destinations. It was found that the standard models are not very applicable to this destination but an improved explanation may be obtained by the addition of tourism interaction externalities such as the tourism density ratio and the relative tourism density ratio. While this result is not unexpected, the value of this effort is in modelling and testing the impact of tourism externalities in a rigorous econometric framework. The significance of the results is the provision of a basis for modelling tourism maturity and confirming the implication of life cycle studies that maturity of a destination alters the demand for the tourism product, irrespective of price/ income factors.

Keywords: maturity, life-cycle, externality, demand, model.

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1. Introduction

The development of rigorous and reliable estimations of the demand for the tourism product is an important first step in modelling the impact of alternative economic policies on tourism in the developing world. Demand models typically focus on income and price factors but little attempt has been made to model non-price phenomena. Yet, the tourism life-cycle and other literature suggest that there are underlying maturity factors and externalities which influence the reception of the tourism product in the market place. In addition, there is a growing tendency for composite demand generation via multiple destination packaging. If these maturity and composite demand phenomena could be modelled the explanation given by traditional price/income approaches might be greatly improved.

This paper aims to explain the variation of tourism output in maturing Caribbean destinations. A desegregated approach is advocated, focussing on the demand characteristics of the sub-markets generating a significant proportion of the visitors to a given destination. Alternative demand models developed in the literature are considered and modified, based on the peculiarities of the Caribbean. However, this study only analyzes the dominant US tourism source market. Testable models are developed to explain US tourism demand in Barbados and evaluated.

2. Alternative Theories of Tourism Maturity

The concept of the maturity of a tourism destination refers to the eventual slowing of the rate of growth of arrivals, or bednights, with the likelihood of an eventual decline. The most obvious theory which suggests an explanation of this phenomenon is the product life cycle theory. The underlying rationale for the product life cycle is the observation in industry of limits to product innovation by producers and acceptability, or adoption, by consumers (Kotler 1988). As a product moves along the cycle, over time some marketing strategies would, therefore, become obsolete (such as gaining market share by making more consumers aware of the existence of the product) and others would be more effective (such as finding new uses for the product - Levitt (1965)). This approach originated in industry studies to explain the tendency for the sale of industrial products to level off eventually or even decline.

The life cycle concept has been applied to tourism for three decades. But Butler (1980) was the first to identify a specific S-shaped curve of the product life cycle which, he suggested, was applicable to most destinations. He cited Mexico as an example and suggested that destinations evolve through six growth stages: exploration, involvement, development, consolidation, stagnation, and decline or rejuvenation. Choy (1992) in his study of the Pacific Islands, lamented the fact that the importance of the life cycle phenomenon has not been modelled in demand studies.

The field of environmental psychology has supplied two interesting concepts, 'image' and 'crowding,' which have been applied in tourism studies - see Fridgen (1984) and Stringer (1984). Pearce and Stringer (1991) suggest that the individual tourist brings to social interaction in the tourist destination certain requirements for personal space. Thus, Riley and Palmer (1976) carried out studies to determine the images which people have of seaside resorts while Morello (1983) had Dutch and Italian students rate seven countries as holiday destinations on a 'semantic differential.'

Crowding has traditionally been studied because of its association with increasing urbanisation and the resultant stress to urban residents. From a tourism perspective crowding may be seen as a constraint upon desired tourist experience (Schreyer and Roggenbuck 1978); West (1982); Womble and Studebaker (1981). Graefe and Vaske (1987) suggested that tourism itself impacts on the quality of the tourists' experiences.

Thus, maturity from crowding arises from growing numbers applied to the same land area, or size of population. This suggests consumption of a good with an ultimate negative externality which will eventually impair the repeat visitor process. Innovative marketing and advertising can, of course, be used to construct images which counter, to some degree, the realistic environmental impairment associated with maturity. Thus, a mature destination can undergo what Butler (1980) terms regeneration. Nevertheless, we expect that the underlying maturity factor should still be observable. For example, the ageing of plant is associated with a reduced rate of return so that more advertising is necessary to attract an additional customer. Also, we would expect real effective rates on hotel rooms to appreciate more slowly as the plant ages. In summary, the maturity of a destination may be explained in terms of a destination life cycle phenomenon which is influenced, inter alia, by four main loss factors:-

(a) **image loss:** the visible ageing of hotel plant and associated fixtures or other impairment of the image of the environment;

(b) **space loss:** the diminishing of free space per tourist owing to over-crowding;

(c) **service loss:** the impairment of customer service owing to success induced attitudes of complacency, unwillingness to work overtime as wage rates increase, etc.; and

(d) **fear/privacy loss:** owing to increasing visitor harassment.

Thus, the implication of maturity studies is that supportive non-price, non-marketing strategies need to be put in place to counteract the maturity syndrome. For example, Conlin (1995) advocates the need to re-orient labour attitudes while Carnegie (1995) advocates the need to criminalise behaviour likely to be offensive to tourists. Thus the maturity of a destination should be interpreted not only in relation to age, but as a determinant of the demand for a destination (see Whitehall, 1997).

3. Modelling the Demand for Tourism

Survey of the Literature

Econometric studies of the demand for the tourism product have traditionally used the framework of consumer demand theory (Eadington and Redman (1991). The behaviour to be analysed is commonly defined as a single equation constrained optimisation problem where utility U is maximised subject to a budget constraint i.e.

$$Max\ U = U(A_1, A_2, \dots A_N): U_1, U_2, \dots UN>0 \qquad (1)$$

subject to

$$Y = P_1 A_1 + P_2 A_2 + \dots \; P_N A_N \qquad (2)$$

where Y is money income available for expenditure on goods and services, $A_1, A_2 \dots A_n$, at prices $P_1, P_2 \dots P_N$, respectively (with appropriate exchange rate adjustment having been made). The solution requires the construction of a simple Lagrangean extremum problem which is solved using the Implicit Function Theorem.

Thus, the tourism demand function has traditionally been expressed as the impact on the demand for the tourism product of the price of each service provided by the tourism destination and the money income available to purchase tourism products.

$$i.e. \; A = f\left(P_1, P_2, \dots P_N, Y\right) \qquad (3)$$

Using travel expenditure to measure demand, researchers have found demand to be highly income elastic in nearly all cases, (Witt and Martin, 1987 and Carey, 1991), and the relationship appears to be more marked when a real income variable is used. They have also found the expected negative relationship between travel expenditure and price factors. In general, the closer the proximity of the tourism source country to the destination, the lower the price-inelasticity of travel expenditure (Eadington and Readman 1991). Thus, the 'standard' model of tourism demand tends to be comprehensive with the inclusion of the price of air transport T, (and often the value of promotional expenditures, but the latter information is often not readily available). One variant of the standard model is thus

$$A = f\left(\frac{Y}{P_s},\ P, T\right) \qquad (4)$$

where P_s is a price deflator in the tourism source country.

Transportation may be thought of either as a good from which the consumer derives utility directly or, more properly, as a variable whose consumption is linked to consumption of other aspects of the product of the tourist destination. Data problems have, however, resulted in this variable being proxied by relative prices of gasoline (Di Mateo and Di Mateo, 1996) or by the geographical distance (Carey, 1991) from the source country to the tourism destination. In both studies good results were obtained. Gasoline prices were used in the Di Mateo, (1996) because the focus was on cross-border automobile visits of Canadian tourists to the US.

Researchers such as Di Mateo and Di Mateo (1996) have suggested a convenient specification of the utility optimisation problem in two-variable space i.e $U = U(A_s A_d)$, where A_s is a good offered in the tourism source country and A_d is the product of the tourism destination. Thus,

$$Y = \left(P_s A_s + P_d A_d\right) \qquad (5)$$

The maximisation process yields a demand function in relation to the real exchange rate (relative prices between the tourism source country and the tourism destination) and the real income of the tourism source country i.e.

$$A = f\left(\frac{y}{P_s}, \frac{P_d}{P_s}\right) \qquad (6)$$

This model is applicable to the empirical context of the present paper i.e. tourists from the US choosing between visiting US or Caribbean destinations or combinations of the two classes of destination.

The 'standard' demand models represented by equations (4) and (6) are useful. However, such models still require additional modification in order to realistically describe the process by which visitors decide to visit Caribbean destinations where maturity trends are observed together with multiple destination packages.

4. Building a Model for a Maturing Destination

It is observed that US tourists from a given city in the US may be found on a given day in both Barbados and Bermuda. Thus, it is fair to assume that tourists are aware of both destinations. The average tourist may seem to have a networked demand for travel in the two destinations, depending on the relative popularity of each, relative prices, and, of course, the information set available. This 'networked' demand is considered because some tourists simply want to be able to say that "I visited Barbados in the Caribbean and it was just as good as my network said it would be!" Changes in the specified variables are presumed to affect the relative propensity of the average tourist to visit one destination more so than another, e.g. the tourist may elect to spend 5 days in Barbados and none in Bermuda or 3 days in Barbados and 2 in Bermuda, and the converse. Thus, we begin by assuming that the average tourist (a) is aware of the tourism product of at least two alternative destinations, and (b) would obtain utility from consuming units of each, singly, or in some combination.

$$i.e.\ U = (A_{d1}, A_{d2}) \qquad (7)$$

We further assume that the average tourist allocates some fixed fraction K of his income Y towards the expenditure for foreign travel on the product offered by the two destinations, depending, inter alia, on destination prices paid.

$$kY = P_{d1} A_{d1} + P_{d2} A_{d2} \qquad (8)$$

Here, kY is the sum of budgeted market expenditure on the two tourism destinations. One Lagrange solution for the demand for a given destination, say destination two, is as follows:

$$A_{d2} = A_{d2}\left(\frac{Y}{P_{d2}}, \frac{P_{d2}}{P_{d1}}\right) \qquad (9)$$

This solution expresses the demand for A_{d2} in terms of the real value of the tourist's income when spent (on tourist services) in destination two and the relative prices of tourism services in the alternative destination.

Earlier we mentioned that the destination life-cycle was influenced by image, space, service and fear/privacy factors. This suggests the presence of externality factors affecting the demand for a destination. The presence of externalities may be modelled by disaggregating the destination prices and quantities into the marketed values, denoted $P_i A_i$ (including transportation element $P_T A_T$) and the non-marketed or externality values denoted $P_{1e} A_{1e}$. i.e.

$$P_{d1} A_{d1} = P_1 A_1 + P_{1e} A_{1e} + P_{1T} A_{1T}$$

and $$P_{d2}A_{d2} = P_2A_2 + P_{2e}A_{2e} + P_{2T}A_{2T}$$

Thus destination prices may now be expressed in relation to marketed and non-marketed values as follows:

$$P_{d1} = (P_1A_1 + P_{1e}A_{1e} + P_{1T}A_{1T})/A_{d1}$$

$$= \alpha_{11}P_1 + \alpha_{1e}P_{1e} + \alpha_{1T}P_{1T} \qquad (10)$$

where $\alpha_{11} = A_1/A_{d1};\ _{1e} = A_{e1}/A_{d1};\ \alpha_{1T} = A_{1T}/A_{d1}$

and $$P_{d2} = (P_2A_2 + P_{2e}A_{2e} + P_{2T}A_{2T})/A_{d2}$$

$$= \alpha_{22}P_2 + \alpha_{2e}P_{2e} + \alpha_{2T}P_{2T} \qquad (11)$$

where $\alpha_{22} = A_2/A_{d2};\ \alpha_{2e} = A_{2e}/A_{d2};\ \alpha_{2T} = A_{2T}/A_{d2}$

Substituting the expressions in equations (15) and (16) for P_{d1} and P_{d2} into equation (14), allows us to generate an externality based demand function which includes both externality and price/ income variables; i.e.

$$A_{d2} = A_{d2}\left[\frac{Y}{\alpha_{22}P_2 + \alpha_{2e}P_{2e} + \alpha_{2T}P_{2T}}, \frac{\alpha_{22}P_2 + \alpha_{2e}P_{2e} + \alpha_{2T}P_{2T}}{\alpha_{11}P_1 + \alpha_{1e}P_{1e} + \alpha_{1T}P_{1T}}\right] \qquad (12)$$

next we simplify to separate explicit observable prices from notional externality prices.

Denoting $$\rho_1 = \frac{\alpha_1P_1}{\alpha_1P_1 + \alpha_eP_{1e} + \alpha_{1T}P_{1T}} = \frac{\alpha_1P_1}{Pd_1}$$

and, similarly, $\rho_2 = \alpha_2 P_2 / P_{d2}; \rho_{1e} = \alpha_{1e} P_{ie} / P_{d1}; \rho_{iT} = \alpha_{1T} P_{1T} / P_{d1}$

$$A_{d2} = A_{d2}\left[\frac{Y}{P_2}\left[\frac{\rho_2}{\alpha_2}\right] + \left[\rho_1 \frac{\alpha_2}{\alpha_1}\right]\frac{P_2}{P_1} + \left[\rho_{1e}\right]\frac{\left[\alpha_{2e}\right]}{\left[\alpha_{1e}\right]}\frac{P_{2e}}{P_{1e}}\right] + \rho_{1T}\frac{\alpha_{2T}}{\alpha_{1T}}\frac{\rho_{2T}}{P_{1T}} \quad (13)$$

This leads to the general functional form which expresses demand in relation to the real value of income of the tourist in the destination, i.e. Y/P_2, relative observable prices of tourism services in alternative destinations i.e. P_2/P_1, relative observable transport cost P_{2T}/P_{1T} and relative unobservable externality prices in alternative destinations. ie. P_{2e}/P_{1e}:

$$A_{d2} = f\left[\frac{y}{P_2}, \frac{P_2}{P_1}, \frac{P_{2e}}{P_{1e}}, \frac{P_{2T}}{P_{1T}}\right] \qquad (14)$$

Developing Testable Models

The next step is to derive testable proxies of the relevant variables. The difficulty in determining the externality prices can be partly alleviated by considering what an 'externality price' would mean conceptually. An externality price is a measure of the variation in the value of a good or service which is consumed indirectly but not marketed. As previously discussed, the relative maturity of a destination should induce changes to plant, environment etc., resulting in observable, though non-marketed, externality benefits or losses. The models to be tested are as follows, with expected signs of the coefficients above the variables:-

$$A = f_1\left(\frac{\overset{+}{y}}{p_s}, \overset{-}{p}_2, \frac{\overset{-}{T}}{P_s}\right) \qquad \text{Model (1)}$$

$$A = f_2\left(\frac{\overset{+}{y}}{P_s}, \overset{-}{P}_2, \frac{\overset{-}{T}}{P_s}, T\overset{-}{D}R_2\right) \qquad \text{Model (2)}$$

$$A = f_4\left(\frac{\overset{+}{Y}}{P_s}, \frac{\overset{-}{P_2}}{P_s}, \frac{\overset{-}{T}}{P_s}, \frac{T\overset{-}{D}R_2}{P_s}\right) \qquad \text{Model (3)}$$

$$A = f_5\left(\frac{\overset{+}{Y}}{P_2}, \frac{\overset{-}{P_2}}{P_1}, \frac{\overset{-}{T}}{P_s}, \frac{T\overset{-}{D}R_2}{TDR_1}\right) \qquad \text{Model (4)}$$

where:

A	=	US arrivals to Barbados as a proxy for tourism product
Y	=	US nominal income
P_s	=	US Consumer Price Index
T/P_s	=	Real US Average Unit Price of Air Transport as a proxy for transport cost
P_2	=	Barbados Tourism GDP Deflator

P_1	=	Bermuda Tourism GDP Deflator
TDR_2	=	Barbados Tourism Density Ratio (total arrivals to population)
TDR_1	=	Bermuda Tourism density ratio

Choice of Variables

Model (1) is a fairly standard price/income demand model based on equations (9) and (11). This model is tested to determine its applicability to the Caribbean. Models (2) and (3) reflect modifications of the standard Model (1) to discover whether the inclusion of externalities in the utility function improves explanatory power. Model (4) is a more intuitive modelling of the presence of externalities based on equation (14). In Models (2) and (3) the externality used is the tourism density ratio in the given destination (say Barbados) while in Model (4) we use the relative tourism density ratio between Bermuda and Barbados. In the previous section we derived Model (4) and it should be fairly obvious that all of the models are derivable using the same procedure of disaggregating destination prices into observable and externality prices.

The tourism density ratio is regarded as a good proxy of tourism interaction, crowding etc. It is calculated as the total arrivals to the destination divided by population in the given year. This is a proxy for crowding owing to tourism interaction since, of the factors associated with maturity, crowding is the simplest to measure. For mature destinations such as Barbados and Bermuda a tourism density ratio may indicate the presence of visitor crowding and resultant unpopularity. Thus, the sign of the coefficient of this variable is expected to be negative for Barbados and Bermuda because, with success at mass tourism, the destinations may be perceived to be losing some of their uniqueness. Conversely, the sign may well be positive for virgin destinations which are becoming more popular because others are going there. Models (1) through (4) are tested for arrivals from Barbados, A_{d2}. The Barbados data set is generally lengthy and as reliable as any for econometric purposes and a series on tourism arrivals has been compiled from 1956 onwards. However, the series on tourism bednights is not as lengthy or reliable. In the absence of a reliable series on bednights, most researchers use the volume of arrivals as the independent variable. This approach is taken here, where the independent variable is US arrivals to Barbados. Carey (1991) also found that the results are better when the number of persons staying in hotels is used in place of arrivals, particularly when the price variable used is the hotel rack rate or a close proxy. The price variable used in this study is the tourism GDP deflator. In the absence of a series on airfares, transport costs are proxied by the real cost of air transport in the US.

5. Econometric Analysis

The focus of cointegration theory is on the temporal properties of economic time series. Most economic time series are non-stationary which invalidates some classical inferences. In this regard, a tourism demand model which represents a long-run equilibrium relationship may not reveal a 'true' relationship when its estimation is done using the conventional regression approach. However, cointegration theory asserts that if there exists a linear combination of these nonstationary series that is stationary, then valid inferences are possible. Thus, the first step in our econometric analysis is to test for the order of integration of all the series involved in our analysis. The test for stationarity is given by:

$$\Delta x_t = \alpha + \beta_t + \delta_0 X_{t-1} + \sum_{j=1}^{j} \delta_k x_{t-j} + \varepsilon_t$$

J is chosen to be sufficiently large to ensure that the error term is free of significant serial dependence. This is the (Augmented) Dickey Fuller (ADF) test. The null hypothesis that x_t follows a random walk is rejected if the coefficient on x_{t-1} is significantly negative. The results are shown in Table 5.1 below.

Since the ADF test may lose power when the i.i.d assumption is invalid, see Phillips (1987), the residuals (ε_t) are tested for serial correlation using a Lagrange multiplier test and a variant of White's (1980) test for heteroskedasticity. For all the raw series, the null hyposthesis of nonstationarity is not rejected at the 5% level. After first differencing, the null is rejected at the 5% level for all of the series with the exception of the negative price series P_2/P_s. All the series are therefore $I(1)$, except P_2/P_s, which is $I(2)$.

The next step in the analysis is to estimate the long-run demand equation for each model. Using Ordinary Least Squares, we begin by estimating Model (2) since this equation is merely a modification of Model (1) with an additional variable (TDR_2). The following results were obtained.

$$A_{d2} = -44.1142 + 2.1017\, Y/P_s + 1.1038\, P_2 - 1.3995\, T/P_s - 0.0681\, TDR_2 \quad (20)$$
$$(1.99) \quad (2.74) \quad (3.29) \quad (-4.19) \quad (-2.16)$$

$R^2 = 0.963507$ SSR $= 0.887764$ $DW = 1.10$

$\bar{R}_2 = 0.937425$ $DF = -3.7373(-2.9705)$ $ADF = -3.0421(-2.9705)$

Table 5.1: Test for Stationarity 1965-1994

Variables	ADF Without Trends	Trends	Variables	ADF Without Trends	Trends
A	-2.576251	-3.096399	$D(P_2/P_s,2)$	-4.539597	-4.511928
D(A)	-3.553927	-3.951595	(TDR/P_s)	-2.254963	-2.292169
P_2	-1.672781	-0.873210	$D(TDR/P_s$	-2.979633	-3.369678
$D(P_2)$	-4.301804	-5.042666	Y/P_2	-1.479299	-1.161316
T	-0.657847	-1.813300	$D(Y/P_2)$	-4.086897	-4.497251
D(T)	-2.645135	-2.589634	(P_2/P_1)	-0.26401	-1.830280
Y/P_s	-0.310958	-4.189799	$D(P_2/P_1)$	-4.665598	-5.198482
$D(Y/P_s)$	-4.469946	-4.392749	TDR_2/TRD_1	-1.439174	-3.530561
TDR_2/PS_2	0.227943	-2.447971	$D(TDR_2/TDR_1)$	-3.722377	-3.649360
$D(TDR_2)$	-3.794372	-3.009247			
(P_2/P_s)	-2.153327	-1.362553			
$D(P_2/P_s)$	-2.569997	-3.173484			

SSR is sum of squared residuals. Both the *DF* and the *ADF* tests reject the hypothesis of nonstationarity of the residuals at the five percent level. These results, along with the relatively high value of the Durbin-Watson statistics, indicate that a co-integrated set has been obtained. There is a further issue to be asserted at this point. Banerjee *et al* (1986) have shown that there would be substantially small sample bias in the cointegrating vector estimates. Their theorem 2 shows that $(1\text{-}R^2)$ can be used as an indicator of the bias in the OLS estimates, and the bias goes to zero as R^2 goes to 1. Given that our reported R^2 is 0.963507, the bias may be small in our case.

To build a short run model we then used the Johansen maximum likelihood procedure to identify the number of co-integrating vectors and to deal with the issue of simultaneity. Table 5.2 shows that there exist two co-integrating equations for the five variables of interest.

Further analysis shows that the ECM enters only one of the co-integrating equations, hence weak exogeneity is not violated and OLS estimates of the parameters of our model would be efficient.

Therefore equation (20) constitutes a valid long-run relationship and we can proceed to the second stage of the Granger - Engle procedure: the error correction mechanism (ECM). The error correction model contains contemporaneous and lagged conditioning variables - see Davidson *et al* (1978), Hendry *et al* (1984) and Salmon (1982) - along with the lagged value of the residual from the long-run co-integrating equation. Starting with an over parameterized model containing contemporaneous variables, the ECM lagged one period, and two-period lags of all other

Table 5.2: Johansen Cointegration Test

Sample: 1965-1995
Included Observations: 27
Test Assumption: Linear Deterministic Trend in the Data
Series: A, Y/P_s, P_2, T/P_s, TDR_2
Lags Interval: 1 to 3

Eigen value	Likeli-hood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypo-thesized No. of CE(s)
0.834423	97.92006	68.52	76.07	None**
0.591279	49.36551	47.21	54.46	At most 1*
0.486778	25.20797	29.68	35.65	At most 2
0.191338	7.197695	15.41	20.04	at. most 3
0.052764	1.463583	3.76	6.65	At most 4

*(**) Denotes rejections of the hypothesis at 5% (1%) significance level.

L.R. Test indicates 2 cointegrating equations *(s)* at 5% significance level.

variables, we systematically eliminated redundant regressors until a parsimonious representation of the data generating process was achieved.

The model was subjected to a battery of diagnostic checks. The Jarque-Bera normality test statistic indicates that the residuals are normal but the implied marginal significance of the test is 0.78102. Further investigations, however, showed that the moments of the scaled residuals (skewness - 0.0555 and Kurtosis 2.624470) are not significantly different from those of a standard normal distribution. ARCH is Engle's k^{th} order autoregressive conditional heteroscedasticity test, which is chi-squared distributed with K degrees of freedom. The results validate the hypothesis that the coefficient of the lagged squared residuals are all zero. Ramsey Reset is Ramsey's specification error test using the square of the fitted residuals; the low F-statistic rejects the null hypothesis of specification error. Further tests on the residuals are the Breusch-Godfrey Serial Correlation LM Test and White's Heteroskedasticity Test (WHT). The model passed on both accounts. Based on the battery of diagnostic tests, we concluded that the model presented in Table 5.3 represents a valid error correction model. Hence, Model (2) can be judged as an adequate specification of the demand for the tourism product in Barbados.

Since Model (2) contains only one additional variable (TDR_2), we performed a variable redundancy test on Model (2) to ascertain whether the TDR_2 variable should be dropped entirely from both the long-run and the short-run equations. The F-statistic from the test indicates that the TDR_2 variable should remain in the model. When made redundant, the resulting R^2 is significantly lower (falling from 0.96 to 0.79). Also, the larger Akaike information and

Schwarz criterion values point to the preferred model as Model (2). Hence, we can safely accept Model (2) as superior to Model (1). This important result underscores the improved explanatory power from modifying the standard model for externality factors.

We now turn our attention to Model (3). The model passed all of the preliminary tests for cointegration. Table 5.4 summarises the results for the long run equation along with the error correction model.

Neither the relative price variable nor the transportation variable has any effect in the long run, whereas in the short run, each variable comes into play with different lag structures. Hence Model (3) is quite an acceptable model. The final results for Model (4) are shown in Table 5.5.

All the variables were significant in the long-run equation, while in the short run error correction model, both the relative price variable and the income variable were insignificant.

TABLE 5.3: ERROR CORRECTION MODEL

LS/Dependent Variable is D(A)
Sample Adjusted: 1968-1993
Included Observations: 26 after adjusting endpoints

Variable	Co-efficient	Std. Error	t-Statistics	Prob.
D(Y/Ps)	4.727948	0.977362	4.837459	0.0002
D(Y/Ps(-2))	2.800472	0.977636	2.864534	0.0118
D(p2)	0.440031	1.211885	2.076748	0.0554
D(P2(-1))	0.720480	0.215369	3.345334	0.0044
D(P2(-2))	0.826162	0.204700	4.035967	0.0011
D(T/Ps)	-0.571424	0.240354	-2.377427	0.0312
D(TDR2(-2)	-0.536162	0.193980	-2.764015	0.0145
C	-0.224917	0.060806	-3.698942	0.0021
D(TDR2)	-0.043885	0.018770	-2.338068	0.0336
ECM2(-1)	-0.586304	0.138476	-4.233958	0.0007
D(A(-1))	0.598777	0.124305	4.817017	0.0002

R-squared	0.912052	Mean Dependent var	0.051157
Adjusted r-squared	0.976753	D.D. Dependent var	0.155289
S.E. of Regression	0.071711	Akaike info Criterion	-4.974125
Sum Squared Resid	0.077136	Schwarz Criterion	-4.441854
Log Likelihood	38.77123	Ramsey Reset F-stat.	0.0314
Durbin-Watson Stat	1.927519	ARCH: F-statistics	0.210394
Serial Correlaiton:			
F. statistics	1.609949		

Table 5.4: Model 3

Dependent Variable is A
Sample (adjusted): 1965 1993
Included observations: 29 after adjusting endpoints

Variable	Co-efficient	Std. Error	t-statistic	Prob.
Y/PS	2.468329	0.170778	14.45347	0.0000
TDR /PS	0.699545	0.159616	4.382673	0.0002
C	-57.66709	4.936897	-11.68084	0.0000

R-squared	0.973172	Sum squared resid	0.982780
Adjusted R-squared	0.944955	Durbin-Watson stat	0.325141
S.E. of Regression	0.194420		

ERROR CORRECTION MODEL

Variable	Co-efficient	Std. Error	t-statistic	Prob.
D(Y/PS(-1))	-1.962908	0.8397060	-2.3376140	0.031900
D(P2/PS(-1))	-0.685534	0.3516300	-1.9495890	0.067900
D(TDR /PS)	0.523052	0.1466190	3.5674120	0.002400
D(TDR2/PS(-2))	-0.374549	0.1210010	-3.0954120	0.006600
D(T/PS)	-0.607746	0.2452370	-2.4781950	0.024000
D(T/PS(-2))	0.859517	0.2802340	3.0671390	0.007000
ECM3A(-1)	-0.042395	0.0215540	-1.9669100	0.065700
D(A(-1))	0.596007	0.1417060	4.2059470	0.000600
C	1.34207	0.6449870	2.0807780	0.052900

R-squared	0.850412	Mean dependent var	0.051157
Adjusted R-squared	0.780018	S. D. dependent var	0.155289
S.E. of regression	0.072834	Akaike info criterion	-4.971712
Sum squared resid	0.090182	Schwarz criterion	-4.536217
Log likelihood	36.73985	F-statistic	12.08068
Durbin-Watson stat	2.527883	Prob(F-statistic)	1.200E-05

Table 5.5: Model 4

LS /Dependent Variable is A
Sample (adjusted): 1965 1991
Included observations: 27 after adjusting endpoints

Variable	Co-efficient	Std. Error	t-statistic	Prob.
Y/P2	-1.501268	0.395782	-3.793166	0.0010
P2/P1	-0.888305	0.471343	-1.884626	0.0728
T/PS	-1.177006	0.364343	-3.230492	0.0038
TDR2/TDR1	1.000691	0.259272	3.859614	0.0008
C	51.27484 1	2.58103	4.075567	0.0005

R-squared	0.927520	Sum squared resid	0.828244
Adj. R-squared	0.910706	Log likelihood	8.726505
S.E. of Regression	0.194029	Durbin-Watson stat	0.933164

ERROR CORRECTION MODEL

Variable	Co-efficient	Std. Error	t-statistic	Prob.
D(T/PS)	-0.824673	0.3182210	-2.5915100	0.017900
D(T/PS(-2))	1.006568	0.3226560	3.1196320	0.005600
D(TDR2/TDR1)	0.502262	0.1861 650	2.6979410	0.014300
D(TDR2/TDR1(-1))	-0.412452	0.1836210	-2.2462150	0.036800
D(A(-1))	0.885651	0.1631210	5.4294030	0.000000
ECM5(-1)	-0.274019	0.1423590	-1.9248520	0.069400

R-squared	-0.824673	Mean dependent var	0.052444
Adj. R-squared	1.671336	S. D. dependent var	0.158350
S.E. of regression	0.090781	Akaike info criterion	-4.593052
Sum squared resid	0.156582	Schwarz criterion	-4.300522
Log likelihood	27.93968	F-statistic	10.80459
Durbin-Watson stat	2.028267	Prob(F-statistic)	4.900E-05

The standard model did not perform well in terms of the significance of the variables and attained a lower level of explanatory power when compared to Model (2) which included the tourism density ratio. As in other studies, the real income variable tended to be the most significant, particularly in the long run. The sign was positive in Model (2) but negative in Model (4) which uses the price index of the destination as the deflator. This indicates that the equation may need to be modified, or better proxies developed. The transport and relative price variables were significant, with negative signs, as expected, but the domestic price variable was positive, indicating that demand responds positively to higher prices. This would be true of up-market destinations but would be difficult to explain in Barbados which is usually considered mass market. The tourism density ratio was significant and negative as expected in a maturing destination. However, the relative tourism density ratio is negative, indicating that Barbados is considered relatively less mature than Bermuda by the market. Overall, the results suggest that the modelling of externalities improves explanatory power. However, more research needs to be undertaken to determine (a) the consistency of the results across alternative destinations and (b) the best specification of an externality-based model.

6. Conclusion

The underlying impetus for this paper has been to gain a greater understanding of why tourism destinations mature, recognising that maturity means increasing difficulty in attracting tourists despite continued, and often, increasing marketing efforts. The tourism life-cycle literature suggests that tourism inter-action has an ultimate negative utility for tourists as a destination matures (i.e. advances along the Butler S-curve). Thus, existing models of tourism demand (which focus on income and price factors) are of limited utility in some instances, as they need to be modified for tourism maturity phenomena and related externalities. This paper presented a single equation constrained optimisation Lagrangian model of tourism demand which encompasses both the externality and the income/price factors. Alternative models were tested on data for Barbados using the co-integration approach. It was found that the standard model is not very applicable to this destination but an improved explanation may be obtained by the addition of tourism inter-action externalities such as the tourism density ratio and the relative tourism density ratio. The significance of the results is two-fold. Firstly, we can now begin the process of developing a more rigorous framework for modelling the phenomenon of tourism maturity. Secondly, we have uncovered tentative evidence which seems to confirm the implication of life cycle studies that the maturity of a destination may alter the demand for the tourism product, irrespective of price/income factors. Since maturity affects demand, rejuvenation planning is vital. But rejuvenation requires increased cash flow to the tourism sector. Thus, mature destinations may need to reconsider the advice of those who suggest that taxes on the tourism product should be increased (see Bird, 1992).

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CHAPTER 6

INTEREST RATES, SAVINGS AND GROWTH IN GUYANA

Patrick Kendall

INTEREST RATES, SAVINGS AND GROWTH IN GUYANA

*Patrick Kendall**

INTRODUCTION

In the context of reduced financial flows to the Caribbean region from traditional donors, the generation of domestic savings assumes critical importance. This implies the implementation of macroeconomic policy that is conducive to savings growth. Of particular importance in this regard is the appropriateness and effectiveness of monetary policy intervention. The purpose of this study is to evaluate government's interest rate policy in Guyana during 1965-95 to determine its appropriateness and effectiveness *vis-a-vis* savings and growth objectives.

Section A gives a brief review of the literature on financial repression and its impact on savings and growth. An overview of the Guyanese economy follows in Section B, underlining the appropriateness of this analysis in the Guyana context. Section C discusses the model, and is followed by a presentation of the empirical results in Section D.

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A. Literature Review

The seminal work in the early seventies of Shaw (1973) and Mckinnon (1973) placed at the heart of the development debate the issue of financial and monetary policy. Mckinnon and Shaw were of the view that financial repression had retarded the growth of many less developed countries (LDCs).[1] At the centre of the debate was interest rate policy which often resulted in the imposition of below market rates thereby creating a disincentive to save and retarding the process of financial deepening. The results were a shortage of investible resources, and growth retardation. On the basis of this experience, Shaw and Mckinnon argued strongly for interest rate liberalisation as a critical input into the process of growth and development. An important contribution to this argument was that of Fry (1995) who reviewed extensively the theoretical and empirical work on this issue and provided further theoretical and empirical support for the Mckinnon-Shaw model. The growing acceptance of the model eventually led to financial reform becoming a standard element in structural reform programmes recommended by international financial institutions.

Nevertheless, the debate has continued about whether interest rate liberalisation is as critical as these authors maintain. Several studies of the McKinnon-Shaw model have been done. The empirical results have not provided a consensus on the validity of the model. Fry (1978, 1979,1980); Leite and Makonnen (1987); Yusuf and Peters (1983);Watson (1992); Roubini and Sala-i-Martin (1992) and Modeste (1993) have found some empirical

1 Financial repression is defined as the holding of interest rates below market levels.

support for the Mckinnon-Shaw model. One of the more innovative and interesting approaches to testing the McKinnon-Shaw hypothesis was that of Roubini and Sala-i-Martin (1992) who, expanding on the growth model of Barro (1991), showed that financial repression, proxied by a dummy variable capturing three ranges of the real interest rate, has been a factor in retarding growth in Latin America during the period 1960 to 1985. On the other hand, Giovanini (1983, 1985) and Dornbusch and Reynoso (1989) and Watson (1991) have not found empirical support for the McKinnon-Shaw hypothesis.

B. Guyana - 1965 to 1995

Table 6.1 below highlights some important macroeconomic indicators for Guyana over the period 1965 to 1995.

Table 6.1: Selected Macroeconomic Indicators (Percentages)

Item	1965-95	1965-87	1988-91	1992-95
Ratio of Gross Domestic Savings to GDP	20.4	18.2	25.2	28.1
Real Savings Deposit Rate	-9.7	-4.1	-54.3	4.9
Exports of Goods and Services/GDP	63.1	58.4	65.4	87.9
BOP Current Account Balance/GDP	-12.5	-10.0	-35.4	-4.0
Fiscal Current Account Balance/GDP	-9.9	-10.7	-16.1	0.5
Inflation	20.0	11.4	75.9	11.4
Real GDP Growth	1.1	0.3	-1.2	7.4

Source: IMF Financial Statistics, World Bank Economic Memoranda.

During this period, there was clear evidence of financial repression in the Guyanese economy with average real savings deposits rate of -9.7%. As indicated in Figure 1, during most of the seventies and the eighties, real savings deposit rates remained negative. It was not until the early nineties after the initiation of financial sector reform that real savings deposit rates became positive.[2]

Real GDP growth during the period was also very low, averaging approximately 1% and highly variable with a standard deviation of 5.7%. Other indirect indicators of financial repression include the explosion in the fiscal deficit on the current account which averaged 9.9% of GDP during the period. Most of this was financed by domestic debt.[3] This explains the rapid growth in the money supply that occurred during the mid-seventies to the late eighties. Another indirect indicator of financial repression was the ballooning of the current account deficit in the balance of payments which moved from approximately 3% of GDP in 1965 to 30.0% in 1990.[4] During most of the 1965-95 period, therefore, and particularly since the first oil shock of 1973, the Guyanese

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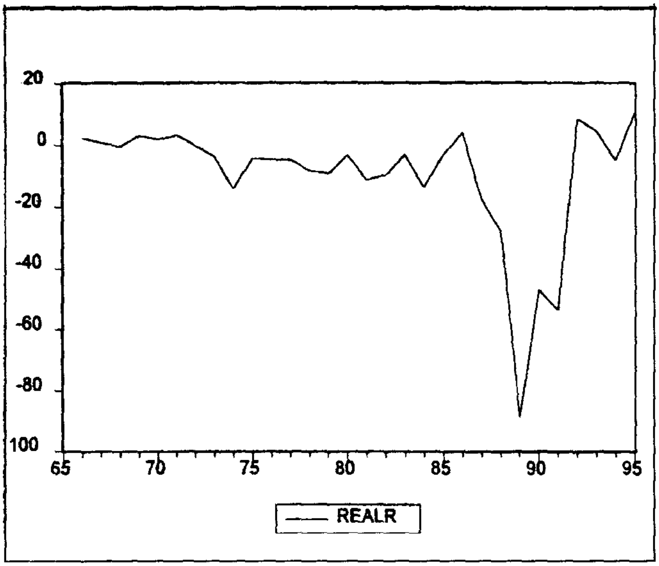
2 The return to market-determined interest rates began with a substantial increase in the Bank and Treasury Bill rates in April 1989. This was followed by the initiation of competitive bidding for Treasury Bills in June 1991 and the linking of the Treasury Bill and Bank rates in 1992.

3 Shaw (1973), in particular, notes the close relationship between weak fiscal policy and below market interest rates which permit government's access to cheap financing of fiscal deficits (p. 152). Large fiscal deficits, therefore, are looked upon as an indirect indicator of financial repression.

4 Shaw (1973) also notes the bias in favour of import-based consumption and import substitution induced by below market equilibrium interest rates leading, in many cases, to a deterioration in the balance of payments (p.204-6). He thus sees a deterioration in the balance of payments of lagging economies as another indirect indicator of financial repression.

economy exhibited the major maladies of a lagging economy or of a financially repressed economy as defined by Mckinnon and Shaw.

FIGURE 6.1: REAL INTEREST RATES, 1965-1995



In 1988, the Guyana government embarked on a structural adjustment programme with the support of the IMF and the World Bank. An important component of that programme was financial sector reform comprising the privatisation of state-owned commercial banking assets and the return to market-determined interest rates.

C. The Model

The Mckinnon-Shaw model comprises two important hypotheses with respect to the impact of financial liberalisation on savings, investment and growth. These are:

(i) that a rise in the expected real deposit interest rate leads to an increased savings income ratio; and

(ii) that income expands with the increase in expected real deposit interest rate (as the quantum of investment as well as the productivity of investment rises because of the increased lumpiness of capital, the modernisation of capital inputs and enhanced allocative efficiency in the capital market).

The study seeks to evaluate these hypotheses in relation to the Guyanese economy over the period 1965 to 1995. The savings model is presented below.

$$s_t = a_o + a_1 y_t + a_2 er_t + a_3 EXGDP_t + a_4 FSGDP_t + a_5 s_{t-1} + a_6 BBGDP_t + a_7 DEBTSERRAT_t + e_{1t} \qquad (1.a)$$

where

s_t	=	ratio of Gross Domestic Savings (S_t) to GDP
y_t	=	real GDP growth
er_t	=	expected real deposit rate of interest
$EXGDP_t$	=	ratio of exports of goods and non-factor services to GDP

$FSGDP_t$	=	ratio of foreign savings (FS_t) to GDP_t
$BBGDP_t$	=	ratio of Central Government Savings to GDP
$DEBTSERRAT_t$	=	ratio of external debt service to exports of goods and non-factor services

The income and lagged savings variables derive from several theoretical antecedents - the permanent income, relative income and life cycle savings hypotheses. The coefficients of both variables are expected to be positive. In the context of an open economy, foreign savings assume a critical role either as complement to or substitute for domestic savings. In most of the empirical literature, however, the relationship between foreign and domestic savings has been found to be negative.

Central government savings are included, given the importance of the state sector for a considerable portion of the period. Central government savings have been used as an argument in other empirical literature (Fry 1979, 1988; Modeste 1993). In this study, the expectation is that the coefficient of central government savings will be positive and lie between zero and one. A coefficient of zero would imply that a rise in central government savings simply results in a transfer of savings from the private to the public sector. There is no increase in gross domestic savings, simply a restructuring of the ownership of savings. A coefficient of one would imply no crowding-out of private sector savings because the private sector would have compensated fully for increased central government savings by reducing its consumption. This is the Ricardian equivalence argument which posits that households adjust consumption behaviour in response to fiscal policy (Barro 1989). If the coefficient lies between zero and one, some amount of crowding out is taking place. From a policy perspective, this is, of course, a very important issue in the savings debate.

The debt service ratio is included because of the substantial debt burden on the economy. During 1965-95, the ratio of the stock of external debt to GDP averaged 123.7% with a debt service ratio of 14.5%. During 1988-95, the stock of external debt averaged 270% of GDP and the debt service ratio 24.4%. The expected sign of the debt coefficient is positive since debt repayments are sourced from savings. While use of the external debt variable as an argument in savings functions is rare, it is nevertheless recognised that, depending on te circumstances of the particular economy, it may be an important influence in national savings behaviour (see Fry 1995).

The inclusion of the ratio of exports to GDP in gross domestic savings functions of LDCs has a long empirical tradition (Maizels 1968; Johnson and Chiu 1968; Leff 1968; Lee 1971). The dominant argument for its inclusion, apart from the impact due to real income growth to which export growth is a contributor, is that the changing structure of the economy, as reflected by the ratio of exports to GDP, itself induces changes in savings and in the savings rate because of the higher propensity to save in the export sector. In other words, the change in income distribution implied by the change in economic structure has an impact on the savings rate independent of economic growth. This is the famous Maizels (1968) hypothesis.[5] A subsidiary argument put forward by

5 For a succint explanation of the Maizels hypothesis, see Lee(1971), p.343-44.

Maizels (1968) has been that government savings rely heavily on trade taxes. A third argument used has been that growth in exports can induce increases in marginal savings propensities in other sectors. The empirical results indicate that the ratio of exports to GDP has generally had a positive impact on gross domestic savings. With the exception of the savings and real income variables, all variables are assumed to be exogenous.

Foreign savings are defined as

$$FS_t = M_t - X_t \qquad (1.b)$$

where

M_t = Imports of Goods and non-factor Services
X_t = Exports of Goods and non-factor Services

Based on the standard neoclassical growth model of Solow (1957), the income equation is represented as follows:

$$Y_t = Af(K_t L_t Z_t) \qquad (2.a)$$

where Y_t represents real output, A is a measure of factor productivity, K_t and L_t are the stock of capital and labour respectively and Z_t represents a vector of other variables. Expressing (2.a) in growth terms yields:

$$y_t = A^* + b_1 k_t + b_2 l_t + b_3 z_t + e_t \qquad (2.b)$$

where the lower case letters of the variables represent growth rates and A^* is the growth in factor productivity *(dA/A)*.

Alternatively, equation (2.b) may be expressed as follows:

$$y_t = b_o + b_1{}^* I_t/Y_t + b_2\, l_t + b_3 z_t + e_{2t} \qquad (2.c)$$

with b_o replacing A^* in equation (2.b), I_t/Y_t representing the ratio of investment to GDP and $b_1{}^*$ the marginal productivity of capital.[6] The coefficients b_2 and b_3 are the output elasticities of labour and of other factors z_t respectively. Equation (2.c) is the standard growth model used in a significant portion of the empirical literature. While the first two variables in equation (2.c) are standard inclusions in the empirical literature, the z_t vector has included a long list of additional variables such as the openness of the economy, imports, the inflation rate, interest on the external debt, government expenditure, government consumption, the savings rate, the interest rate on the external debt and government expenditure on primary and secondary education Khan and Reinhart (1990); Knight, Loayza and Villanueva (1993,1996); Stern (1991); Lee (1995); Walters (1995); Harrison (1996).

Using the following identity for an open economy:

$$I_t + X_t = S_t + M_t$$

and rearranging after division throughout by Y_t (GDP_t), yields

$$I_t/Y_t = s_t + FSGDP_t \qquad (2.d)$$

6 $b_1 k_t = y_t / k_t{}^* k_t = Y_t / K_t{}^* K_t/Y_t{}^* dK_t/K_t = Y_t / K_t{}^* K_t/Y_t = (b_1{}^*){}^* I_t/Y_t$

Substituting equation (2.d) into equation (2.c) and replacing s_t by equation (1.a) yields:

$$
\begin{aligned}
y_t = {} & c_o + c_1 y_t + c_2\, er_t + c_3 EXGDP_t + c_4 FSGDP_t + \\
& c_5 s_{t-1} + c_6 BBGDP_t + c_7 DEBTSERRAT_t + \\
& c_8 l_t + c_9 z_t + e_{3t}
\end{aligned}
\qquad (2.e)
$$

where

$$
\begin{array}{lll}
c_o = b_o + a_0 b_1^*; & c_1 = a_1 b_1^*; & c_2 = a_2 b_1^*; \\
c_3 = a_3 b_1^*; & c_4 = a_4 b_1^* + b_1^* & c_5 = a_5 b_1^*; \\
c_6 = a_6 b_1^*; & c_7 = a_7 b_1^*; & c_8 = b_2; \\
c_9 = b_3; & e_{3t} = b_1^* e_{1t} + e_{2t} &
\end{array}
$$

Rearranging (2.e) yields

$$
\begin{aligned}
y_t = {} & d_o + d_1 er_t + d_2 EXGDP_t + d_3 FSGDP_t + \\
& d_4 s_{t-1} + d_5 BBGDP_t + d_6 DEBTSERRAT_t + \\
& d_7 l_t + d_8 z_t + e_{4t}
\end{aligned}
\qquad (2.f)
$$

where

$$
\begin{array}{lll}
d_o = c_o/(1-c_1); & d_1 = c_2/(1-c_1); & d_2 = c_3/(1-c_1); \\
d_3 = c_4/(1-c_1); & d_4 = c_5/(1-c_1); & d_5 = c_6/(1-c_1); \\
d_6 = c_7/(1-c_1); & d_7 = c_8/(1-c_1); & d_8 = c_9/(1-c_1); \\
e_{4t} = e_{3t}/(1-c_1) & &
\end{array}
$$

The equations estimated are (1.a) and (2.f). The data cover the period 1965 to 1995, and are obtained from the IMF Financial Statistics, World Bank, Inter-American Development Bank and Bank of Guyana reports.

D. Empirical Results

The Savings Function

To address the problem of simultaneity bias arising from the inclusion of the income variable, the savings function (Equation 1.a) was estimated using two stage least squares (2SLS). The instrumental variables used for both the savings and the growth functions were the constant term, er_t, $DGPOP_t$, $DEXGDP_t$, $DFSGDP_t$, Ds_{t-1}, $DBBGDP_t$, $DDEBTSERRAT_t$, GRC_{t-1}, $DGEXRAT_t$, y_{t-1} and y_{t-2}. The prefix D is the first difference operator. Differencing was used to achieve stationarity and avoid the problem of spurious correlation. Table 6.2 gives the results of the stationarity tests.[7] Graphs of the variables are presented in Appendix 1.

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7 Given the instability in the economic indicators, especially in the structural adjustment period, it was thought necessary to supplement the ADF tests with tests suggested by Perron (1989,1990) for determining stationarity in the presence of a structural break. In this study, his Additive-Outlier (AO) model was used. The AO model is a two-stage model for determining whether a variable is stationary or non-stationary. The null hypothesis is that the variable is non-stationary subject to a single intervention/shock at a given time. The alternative hypothesis is that the variable is stationary subject to a shift in the mean after the intervention. The last column of Table 2 gives the results of the Perron test. **The Perron tests were carried out using levels of the variables.** Critical values were taken from Table 6 of Charemza and Deadman (1997). To a large extent, the Perron tests corroborate the results of the ADF tests. In the case of two of the variables, s_t and y_t, the results of the Perron test are inconclusive since the t statistics lie within the lower and upper critical limits for the test. In the case of a third variable, $DEBTSERRAT_t$, the results contradict those of the ADF test. However, given the doubts as to the power of the Perron test raised in Zivot and Andrews (1992), the decision was made to adhere to the results of the ADF test which indicate that the debt variable is nonstationary.

TABLE 6.2: STATIONARITY TEST

Variable	Computed	ADF	Computed
er_t	-2.3*	-2.0	-4.01*
y_t	-2.8**	-2.6	-3.50***
$DGPOP_t$	-4.2**	-3.7	-3.44
$DEXGDP_t$	-4.8**	-3.7	-3.07
$DFSGDP_t$	-6.7**	-2.6	-1.89
Ds_t	-6.0**	-2.6	-3.57***
GRC_t	-6.4**	-2.6	-6.32*
$DGEXRAT_t$	-4.9**	-4.4	-2.51
$DBBGDP_t$	-3.9**	-2.7	-1.09
$DDEBTSERRAT_t$	-5.7**	-2.6	-4.01*

* indicates significance at the 5% level
** indicates significance at the 1% level
*** indicates that test results are inconclusive

The critical 5% values for the Perron (1989) test for = 0.3 (based on 1988 as the intervention date) are -3.57 (lower limit) and -3.48 (upper limit).

The first difference of the ratio of exports of goods and services to GDP is represented by $DEXGGDP_t$. $DFSGDP_t$ is the first difference of the ratio of foreign savings to GDP. $DGPOP_t$ is the first difference of the growth in population which, in the absence of preferred data such as the growth in the labour force, is used as a proxy for the growth in the labour stock. $DDEBTSERRAT_t$

represents the first difference of the debt service ratio. The expected real interest rate is $er_t = r_t - P_t{}^*$, with r_t the nominal rate of interest on savings deposits, and $P_t{}^*$ the expected rate of inflation. A distributed lag model was used to estimate the expected rate of inflation. The number of lags was determined by the Akaike criterion.[8] The first difference of the ratio of gross domestic savings to GDP is represented by Ds_t. The empirical results of the model for the period 1965-95 are presented below with the t statistics in parentheses.

$$Ds_t = \underset{(1.8)}{1.10} - \underset{(1.8)}{0.46y_t} + \underset{(2.1)}{0.10er_t} + \underset{(3.1)}{0.29\,DEXGDP_t} - \underset{(3.8)}{0.20DFSGDP_t} - \underset{(0.4)}{0.05Ds_{t-1}} +$$

$$\underset{(6.4)}{0.64DBBGDP_t} + \underset{(1.3)}{0.10\,DDEBTSERRAT_t} + e_t$$

$BG(1)=0.01$; $BG(2) = 1.3$; $BG(3) = 1.8$; $BG(4) = 2.5$; $ARCH\ (1) = 0.5$;

$RESET(1)= 1.7$; $RESET(2) = 1.6$; $RESET(3) = 0.001$; $CHOW\ (1988) = 1.3$

$White = 1.8$; $R^2 = 0.80$; $DW = 2.0$; $F=11.8$; $JB= 0.5$

8 The equation used to model the expected rate of inflation was:

$$P_t^* = \underset{(3.5)}{8.2} + \underset{(4.8)}{0.46\,P_{t-1}} - \underset{(0.9)}{0.11\,P_{t-2}} - \underset{(2.3)}{0.25\,P_{t-3}} + \underset{(2.7)}{15.0\,DUM8895} + \underset{(7.6)}{0.028GEXRAT_t} + e_t$$

$R^2=0.91$; $F=43.1$; $DW= 1.7$

DUM8895 is a dummy variable used to capture the shift in inflationary expectations during the structural adjustment period. $GEXRAT_t$ is the rate of depreciation of the exchange rate . Both $GEXRAT_t$ and P_t are I(1). Other diagnostics for the function (Breusch Godfrey serial correlation test, Granger's ARCH, Ramsey's RESET, White's test of heteroskedasticity, ADF test of stationarity of the residuals and the Jarque Bera test of normality) are satisfactory.

The Breusch Godfrey (BG) test for serial correlation with up to four lags indicated no evidence of serial correlation. Engle's ARCH (autoregressive conditional heteroskedasticity) statistic, the White test of heteroskedasticity and Ramsey's RESET statistic were all insignificant. The Jarque Bera (JB) Chi square test and the ADF tests indicated that the residuals were normally distributed and stationary. The White and Ramsey RESET test are F statistics. All other tests are Chi square statistics.

With the exception of the income and lagged savings coefficients, all coefficients are of the correct sign. The performance of the income variable is likely due to multicollinearity. Auxiliary regressions revealed that next to the debt service ratio, the income variable was the most collinear of the variables.[9] The insignificance of the coefficient of the lagged savings variable is likely to be due to the low and highly variable income growth that characterised the period as a whole. Average growth per annum was approximately 1% with a standard deviation of 5.7%. The negative coefficient of the foreign savings variable, suggesting substitutability between foreign and domestic savings, was expected, and is found in other empirical work (Fry 1978, 1980, Giovanini 1985; Bowles 1987).

The coefficient of central government savings is between zero and one as expected, indicating that there has been some crowding out as a result of the savings effort of central government. The results show that a one percentage point change (0.64) in the ratio

9 See Gujarati (1995) p. 337 for the use of auxiliary regressions and the F test to determine the existence of multicollinearity.

of central government savings to GDP leads to less than a one percentage point change in gross domestic savings. The results imply a crowding out of 0.36 percentage point of GDP in private savings per percentage point rise in the ratio of central government savings to GDP, and is reflective of the low income growth that characterised the period. Low growth made it impossible for the private sector to constrain consumption enough to compensate fully for the increase in central government savings. The crowding out of 0.36 percentage point of the ratio of gross domestic savings to GDP per percentage point rise in the ratio of central government savings to GDP is close to the estimate of 0.41 by Fry (1979) for Turkey for the period 1950 to 1978.

The coefficient of the interest variable is of the correct sign and significant, providing empirical support to the Mckinnon-Shaw hypothesis that increases in the ratio of savings to GDP are due to rising real deposit rates. The results indicate that a one percentage point rise in the interest rate would have led to a 0.1 percentage point rise in the ratio of gross domestic savings to GDP. This is somewhat below the estimate 0.14 to 0.21 found by Fry (1978) in his study of seven Asian LDCs, but within the 0.1 to 0.2 range reported by Fry (1995) in his review of the empirical literature.

The Growth Function

The growth function estimated was that of equation (2.f). The additional variables included as part of the *z* vector in equation (2.f) are real growth in consumption, GRC_t, and the first difference of the rate of depreciation of the exchange rate, $DGEXRAT_t$. Real growth in consumption was included because of its impact on aggregate demand. Consumption, especially government consumption, is found as an argument in the growth function in other empirical literature (Landau 1983; Kouassy and Bohoun 1994). The consumption variable was included as an endogenous variable.

Given the openness of the economy and its vulnerability to exchange rate shocks, $DGEXRAT_t$ was included as an exogenous variable in the growth function. During the late eighties and early nineties, there were substantial exchange rate changes. In recent years increasing attention has been paid to the impact of macroeconomic instability on real GDP growth. That instability was most often modelled using the rate of inflation (Dornbusch and Reynoso 1989; Roubini and Sala-i-Martin 1992 and Sarel 1996). In the context of Guyana, however, it is arguable that exchange rate changes more accurately reflect the macroeconomic instability that has plagued the economy in recent years. The expected sign of the exchange rate coefficient is negative.

Other possible inclusions in the z vector such as the rate of growth of imports, the ratio of the foreign debt to GDP and the ratio of foreign financing to GDP were explored but rejected since they added little explanatory power to the model. The model was estimated using 2SLS to minimise the problem of simultaneity bias. The empirical results for the period 1965-95 are given below with the t statistics in parentheses.

$$y_t = 1.59 + 0.14er_t + 0.14\ DEXGDP_t - 0.01DFSGDP_t + 0.07Ds_{t-1} + 0.24\ DBBGDP_t$$
$$(1.8)\quad (2.5)\quad (1.9)\quad (0.2)\quad (0.5)\quad (2.6)$$

$$+\ 0.03\ DDEBTSERRAT_t - 1.27\ DGPOP_t + 0.34\ GRC_t - 0.02\ DGEXRAT_t + e_t$$
$$(0.2)\quad (0.8)\quad (3.4)\quad (1.9)$$

BG(1) =0.004; BG(2) = 3.9; BG(3) = 4.4; BG(4) = 6.4 ; ARCH(1)=0.7;

RESET(1)= 0.1; WHITE = 1.6: CHOW= 0.4 (1988);

R^2*=0.72 F= 4.3 ; DW = 2.0; JB=3.9*

Breusch Godfrey tests using up to four lags indicated no evidence of serial correlation. The Ramsey RESET test statistic for model misspecification was insignificant. Neither Engle's ARCH nor White's test revealed heteroskedasticity in the residuals. Both the Jarque Bera test of normality and the ADF test of stationarity of the residuals were satisfactory.

With the exception of the $DGPOP_t$ coefficient, all coefficients have the expected sign. The insignificance of the $DGPOP_t$ coefficient is probably due to poor data quality. The significant impact of growth in real consumption is not surprising, given the fact that consumption during the period accounted, on average, for approximately 80% of GDP. Neither the debt service variable nor the foreign savings variable shows any significant influence on growth. The result with respect to the debt service variable should be treated with caution, given the problem of multicollinearity. As in the savings function, the debt service ratio was found to be the most collinear of the regressors. The coefficient of lagged savings is insignificant, and is consistent with the outcome in the savings function. However, the coefficient of government savings on real GDP growth is significant. The significant influence on growth of exports is expected, given the export dependence of the economy. The coefficient of $DGEXRAT_t$ is also significant at the 90%

level. The results with respect to foreign savings, government savings and export growth reflect those of Modeste (1993).

As in the case of the savings function, the performance of the interest rate variable provides empirical support to the Mckinnon-Shaw hypothesis. The results indicate that a one percentage point rise in the expected real deposit rate provided a 0.14 percentage point rise in the growth of real GDP. This result is somewhat below that found in other empirical literature (Fry 1979, 1980; Watson 1992; Modeste 1993), and is reflective of the relatively low capital output ratios reported by the World Bank.[10]

CONCLUSION

The study provides empirical support for the Mckinnon-Shaw hypothesis and underscores the inappropriateness of the policy of financial repression. Indications are that interest rate liberalisation much earlier in the period could have led to increased savings, investment and growth. At a more general level, the study also points out the low efficiency of capital, an issue that needs to be addressed if the increased savings of a liberalised financial sector are to have maximum impact on general economic activity. In this context, there is clearly need for efficiency enhancing initiatives in the construction, operations and maintenance of economic infrastructure. Additionally, policies to stimulate the importation and diffusion of new technologies ought to be a top priority.

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[10] See World Bank, Economic Memorandum on Guyana, 1976, p. 16 and World Bank, Guyana : A Proposal for Economic Recovery, 1986, p.14.

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APPENDIX 6.1

FIGURE 6.2
REAL EXPECTED INTEREST RATE

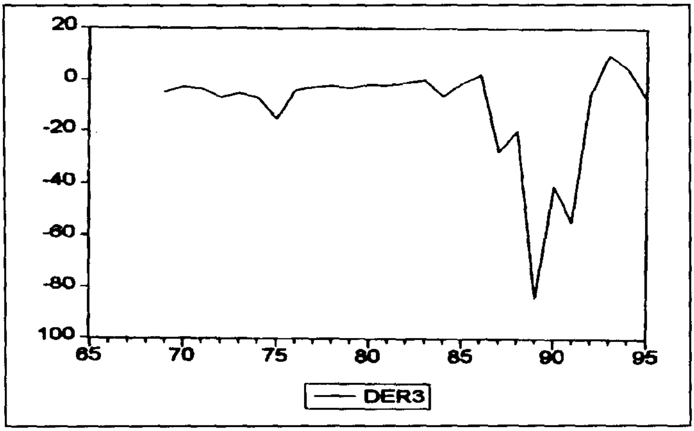


FIGURE 6.3
FIRST DIFFERENCE OF RATIO OF EXPORTS TO GDP

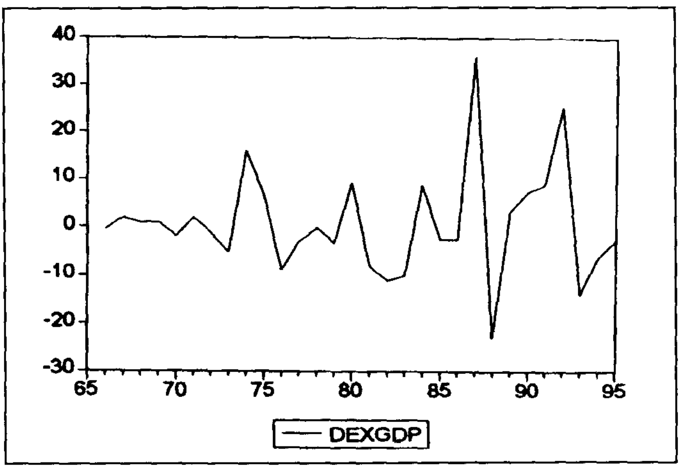


FIGURE 6.4
FIRST DIFFERENCE OF POPULATION GROWTH

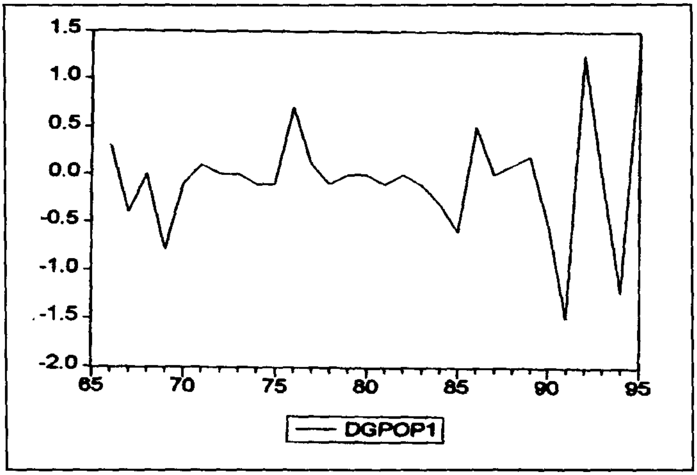


FIGURE 6.5
GROWTH IN REAL (GDP(y)

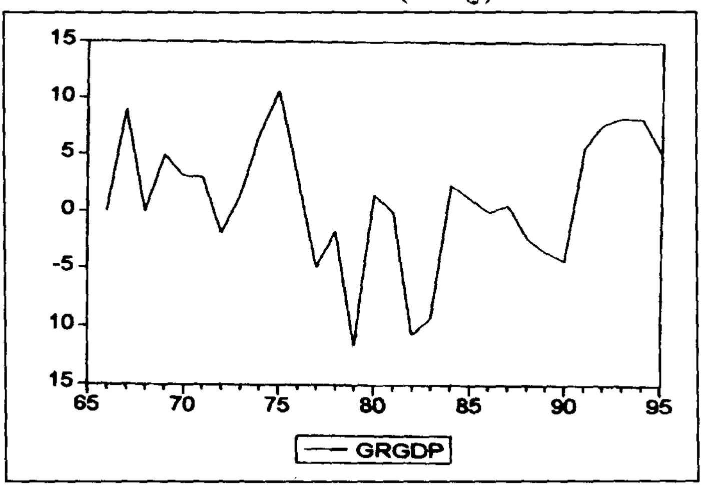


Figure 6.6
First Difference of Gross Domestic Savings

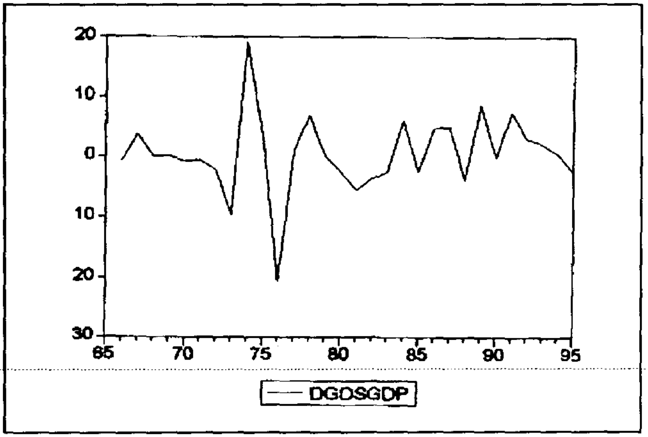


Figure 6.7
First Difference of Foreign Savings to GDP

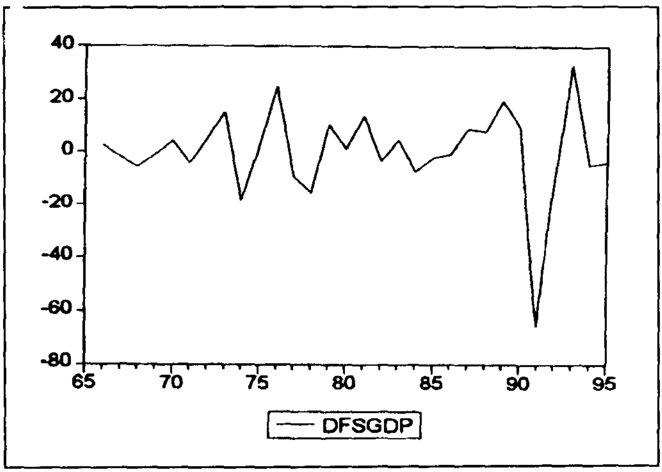


FIGURE 6.8
REAL GROWTH IN CONSUMPTION

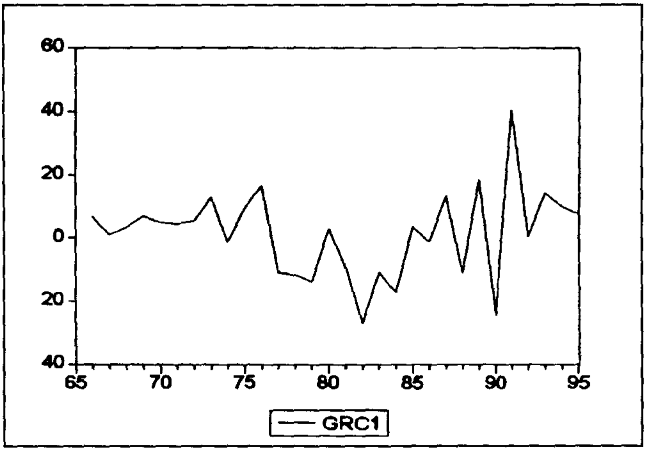


FIGURE 6.9
FIRST DIFFERENCE OF EXCHANGE RATE DEPRECIATION

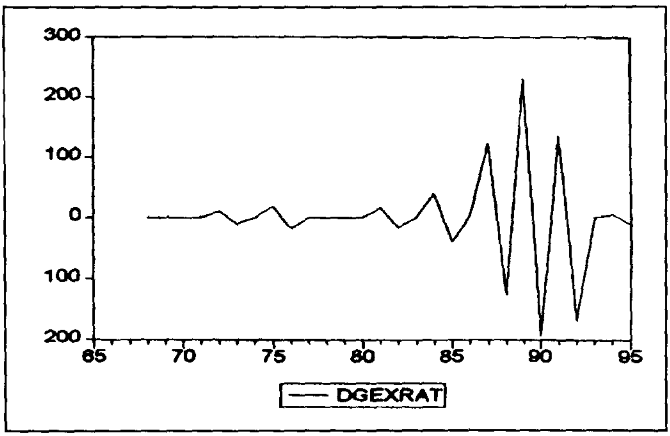


FIGURE 6.10
FIRST DIFFERENCE OF CENTRAL GOV'T SAVINGS

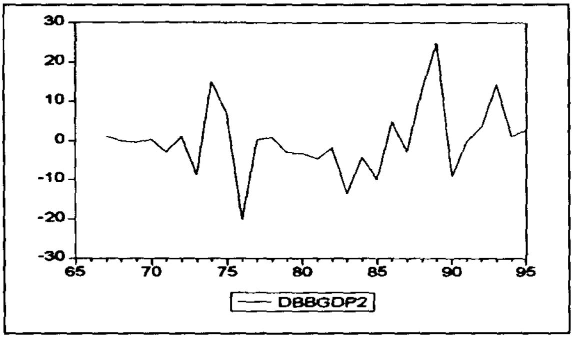


FIGURE 6.11
FIRST DIFFERENCE OF DEBT SERVICE RATIO

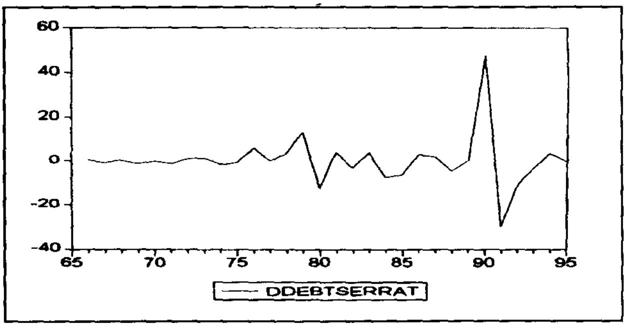
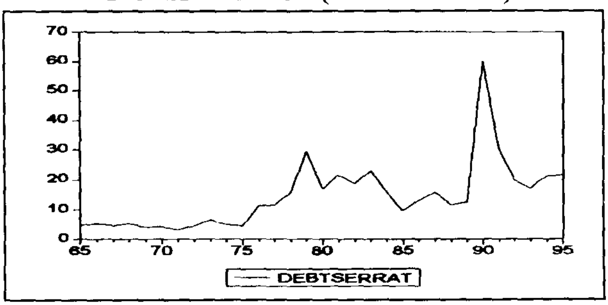


FIGURE 6.12
DEBT SERVICE RATIO (DEBTSERRAT)



CHAPTER 7

DEFINING AND ESTIMATING A MONETARY CONDITIONS INDEX FOR JAMAICA: THEORETICAL AND EMPIRICAL ISSUES

Claney Lattie

Defining and Estimating a Monetary Conditions Index for Jamaica: Theoretical and Empirical Issues

Claney Lattie[1]

ABSTRACT

This paper explores the development and estimation of an MCI for Jamaica to augment the existing monetary policy framework. MCIs are applicable to the Jamaican economy especially since deregulation and liberalization of the financial sector in 1991. Various works, including the current work, validate the appropriateness of a monetary conditions index within the existing monetary policy decision process. To estimate the weights of the index for Jamaica, the analysis is couched in a paradigm consistent with that of a small open economy. The standard MCI is a weighted average of changes in an interest rate and an exchange rate, relative to their base period. The results obtained suggest that the index is most useful when the market exhibits stable conditions, and would be a useful tool in the simultaneous management of the foreign currency and domestic money markets. The results also suggest that extending the current framework to include the MCI as an auxiliary operating target would be useful since it retains its simple property of ease of calculation and displays close association with domestic inflation.

Keywords: Monetary Conditions Index, Monetary Policy Framework.

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INTRODUCTION

Central banks of developed countries have included, and in some instances fully adopted, the use of a monetary conditions index (MCI) in their monetary policy framework. The MCI is a simplified numerical indicator of the relative 'tightness' or 'looseness' of monetary policy. It captures the degree of pressure that monetary policy exerts through interest rate and exchange rate changes on the economy, and hence inflation. When the index increases, it is interpreted as a loosening of monetary conditions with respect to the defined base period. An MCI is specified as a weighted average of the measured effects of interest rate and exchange rate changes on the final target.

These MCIs were developed in response to a need to identify alternative variables to function as intermediate or operating targets and information variables in the conduct of monetary policy. The search for new variables has been motivated by the weakened relationship between monetary aggregates and inflation and, the desirability of explicitly measuring the influence of exchange rate developments on output and inflation.

The current exposition focuses on the development and estimation of an MCI for Jamaica to improve the existing monetary policy framework. The theoretical arguments that justify the examination of alternative information variables for Jamaica is validated empirically by various works (including the current one) that describe Jamaica's inflationary process. The conclusions of the paper lend support to the long-standing view of the existence of close contemporaneous relationships between exchange rate changes and domestic inflation, and therefore warrant the current focus of estimating the relative impact of both interest rate and exchange rate changes on inflation.

An MCI has several attractive features. It recognizes the impact of exchange rates in small open economies and focuses analysis on the combination of interest rates and exchange rates that may be important in understanding the economy's behaviour. Also, an MCI is easy to calculate and is intuitively appealing to central banks as an operational target for monetary policy. Finally, it generalizes interest-rate targeting to include the effects of exchange rates on an open economy.

The analysis is developed in three sections. Section I provides an assessment of Jamaica's monetary framework and outlines the thrust to broaden the framework to include a monetary conditions index for Jamaica. Section II outlines some frameworks for the conduct of monetary policy, and provides the foundation arguments for the continued progress towards developing MCIs. Section III gives the empirical estimation and results used for deriving the relative weights of the index. This information is subsequently used to calculate an MCI for Jamaica. In section IV, the computed index is examined in a more intuitive fashion with concluding comments presented in section V. Supplementary notes, tables and charts complete the work.

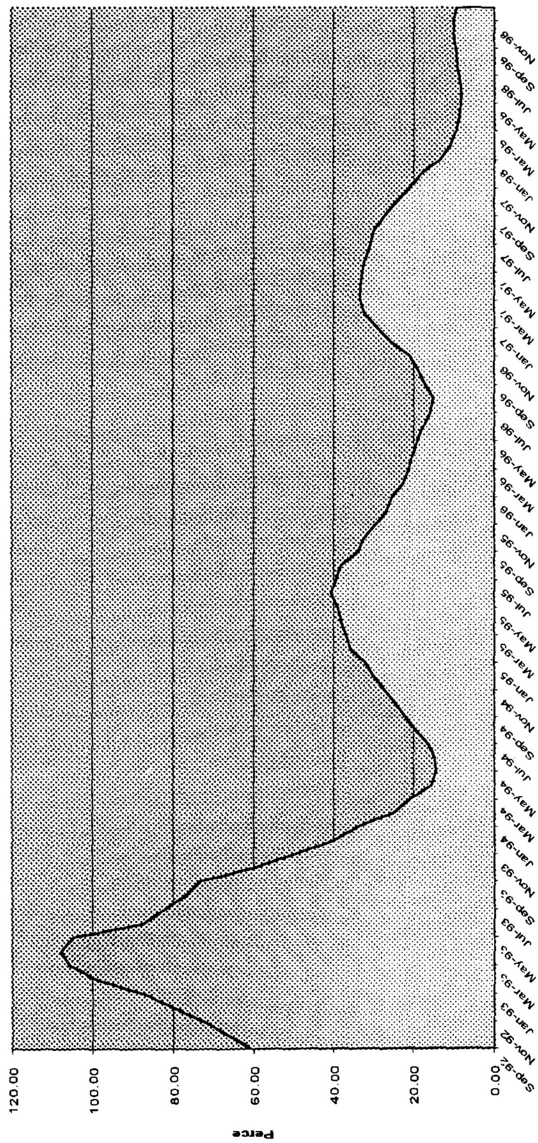
Section I
Jamaica's Monetary Policy Framework

The Evolution of Domestic Prices and the Monetary Policy Process 1991-1998

Jamaica's experience of inflation has been one of very high annual growth rates in domestic prices which peaked at a high of over 100 percent in February 1992. Following on the heels of liberalization of the foreign exchange and financial markets in 1991 and within a context where domestic money supply was not under strict control, domestic prices rose sharply to coincide with the sharp depreciation in the exchange rate. The country's inflation problem persisted as the depreciation and inflation spiral permeated the economic landscape and encouraged the demands for compensating wage claims by the labour force. With monetary policy during the period being largely accommodative, the consequence was a continuation of exchange rate depreciation that influenced further inflation, at least until mid-1996. Figure 7.1 below illustrates.

The persistent exchange-rate depreciation and high inflation environment created uncertainty within the country's macroeconomic environment. The instability in the foreign exchange market and the associated inflation created incentives for hedging and speculative activity rather than investing in productive real sector activity. This resulted in the blossoming of a 'new' era of financial management, as the opportunities for making capital gains from foreign exchange trading and the domestic money market became evident. With productive activity severely stifled by various competing uses of resources, the central bank embarked

FIGURE 7.1
12-MONTH INFLATION FOR JAMAICA, SEPTEMBER 1991-DECEMBER 1998



on stabilization policies to limit unwieldy exchange rate fluctuations, to reduce the level of liquidity within the system and to achieve low inflation while preserving the value of the domestic currency.

Within the country's monetary policy experience, such stabilization policies marked the beginning of new challenges for monetary policy management. Indirect policy instruments were adopted that required the use of intermediate and operating targets to assess the effects of monetary policy changes on the ultimate inflation objective. This mechanism replaced the monetary targeting framework that was abandoned with liberalization. The money market represented the channel for transmitting monetary policy decisions, although interest rates in the domestic money market mirrored the past experiences of chronic inflation that influenced inflationary expectations and kept interest rates exorbitantly high. Empirical evidence that describes Jamaica's inflationary process suggests that disorderly fluctuations in the exchange rate exert a significant influence over domestic prices. Within this context, the central bank envisioned that the control of inflation could only be attained by effecting monetary restraint to reduce the growth in monetary aggregates that has fuelled excessive exchange rate volatility. In April 1996, the central bank adopted an alternative monetary policy framework that was based on base money management and money supply targeting.

This monetary policy framework relies on the links between monetary aggregates (as intermediate and operating targets) and inflation. The reliance on the measures of base money and the broader aggregate M3 [2] assume that their relationship to inflation

2 M3 is defined as the sum of currency in circulation, demand, time, savings and other deposit liabilities of the banking system.

is stable and predictable. However, like in other economies that have liberalized and have experienced the transformation of the financial sector, the stability of that relationship cannot be taken for granted. It has in fact been observed that even after the transition from high inflation to lower inflation rates, monetary aggregates continue to expand at a faster rate than prices [3]

While the foregoing may be a true monetary phenomenon emerging within the Jamaican economy, the monetary authorities have maintained their vigilance in keeping low and steady inflation. For the first eight months of 1999, monthly inflation averaged 0.51 percent, with a 12 month annual inflation rate of 5.09 percent. This represented a decline in inflation relative to corresponding periods of previous years, where the 12-month inflation rate was 8.2 percent and 8.6 percent in 1997 and 1998 respectively.

To underwrite monetary stability in the Jamaican economy, the Central Bank has, in practice, adopted a combination of approaches. Two important aspects that have contributed to securing this continued low inflation environment are:

(a) tight base money management, which reflects the continuous reliance on liquidity management to restrict monetary expansion, and

(b) maintaining relative stability in the value of the domestic currency, which in practice has provided a strong nominal anchor for the system.

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3 See Appendix 7.1, which details the evolution of monetary aggregates and inflation since September 1992.

Further analysis of the effects of changes in base money and M3 on inflation reveals the non-existence of even weak causal relationships. The results of the F-tests for the exclusion restrictions of the effects of lagged values of both the monetary aggregates and exchange rates on inflation are presented in Table 7.1. It is observed that based on the results of the Granger-causality test, the evolution of base money and money supply (M3) aggregates do not Granger-cause the observed changes in CPI inflation or headline inflation. The exchange rate, however, exhibits some causal relationship with inflation.

TABLE 7.1: SUMMARY RESULTS OF F-TESTS OF EXCLUSION RESTRICTIONS ON LAGGED BASE MONEY M2 AND EXCHANGE RATES ON INFLATION

	Test Statistics
Base Money	0.87
Exchange Rate	5.30*
Money Supply (M3)	0.87

* *denotes significance at the 5% level.*

Sample: 84: 1991(09) to 1998(12)

Empirical justification for broadening Jamaica's monetary policy framework has emerged from previous work.[4] Robinson and Robinson (1997) validate the argument for incorporating a monetary conditions index within the Central Bank's policy framework, as there is evidence that suggests persistent influence of deposit rates and exchange rate on CPI inflation. After examining the transmission process of monetary policy impulses, they suggest that the reverse repurchase rate may be an effective tool in the process since it directly influences deposit rates offered by financial intermediaries. However, the effectiveness of changes in the reverse repurchase rate could be diminished, since it functions through base money that is characterized by exogeneity properties, which make it inefficient to function as a 'true' policy lever. Changes in the base predominantly reflect expenditure decisions and therefore mirror the actual transaction decisions with respect to the central bank's domestic and foreign assets and liabilities. In this regard, Robinson and Robinson conclude that the linkage between base money and inflation is potentially thwarted and would distort the clear transmission of interest rate changes to the inflation target.

Robinson and Robinson (1997) identify one main transmission path: changes in the reserve repurchase rate exert influence on domestic deposit rates and the effect of this eventually feeds through to the exchange rate to impact the CPI. An alternative transmission is isolated directly through monetary aggregates – base money and money supply – then to deposit rates and finally

4 From Robinson and Robinson (1997) block exogeneity tests indicate that the reverse repurchase rate and the exchange rate were the only two variables that exerted some causal relationship on the evolution of CPI inflation.

through the exchange rate to influence domestic prices. More predominantly, however, the impulse function shows direct causal influences of exchange rate changes on CPI inflation and real output, and places the exchange rate at the core of the transmission process. It is evident from this that some combination of interest and exchange rates would be beneficial to the policy decision process and this goes a long way in justifying the need to develop an MCI for Jamaica.

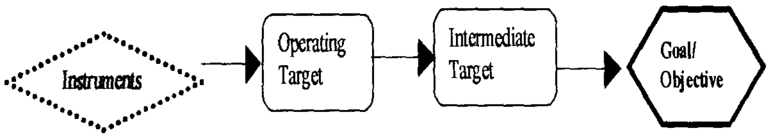
SECTION II
FRAMEWORKS FOR THE CONDUCT OF MONETARY POLICY

The conduct of monetary policy relies on the process of transmission from the policy variable to the final objective. Central banks have assumed the mandate of controlling the rate of growth in prices or some measure of nominal output, which in liberalized economies cannot be directly set. Therefore, the central bank has used a general conceptual framework that relies on economic variables including operating targets, intermediate targets, and information variables to link its policy actions to the ultimate goal.[5] A schematic representation of monetary transmission is presented in Figure 7.2, in which it is observed that the set comprises some combination of variables functioning as operating or intermediate targets, through which policy signals are transmitted to the final target. Variables that function as operating targets most often include short-term interest rates and the monetary base, and are

5 A clear distinction is made in defining the components of a monetary policy framework. 'Goal' refers to the ultimate but typically non-operational objective of the Central Bank, while 'target' refers to an operational variable that takes precedence in the actual conduct of monetary policy. See the Hoggart (1996) for further reference.

variables that the monetary authority can directly influence. The set of intermediate targets predominantly comprises money or credit aggregates, the exchange rate, and the rate of growth of nominal gross domestic product (GDP), variables that can serve as a nominal anchor for the system.

FIGURE 7.2
SCHEMATIC REPRESENTATION OF THE MONETARY TRANSMISSION PROCESS



As illustrated in Figure 7.2, at the beginning of the transmission process are instrument(s) conceptually defined as the variables that the central bank actually manipulates on a daily or weekly basis to achieve its monetary policy target. These instruments may comprise various direct and indirect means of control – namely, reserve ratios and open market-type operations that primarily influence the availability of domestic liquidity in the money market. Other indirect non-market methods of control that rely on imposing quantity and/or price restrictions are not usually applied in liberalized economies.

Within a liberalized economic framework, since there is no unique link between monetary policy instruments and the final objective, the process assumes a closely linked relationship between the intermediate targets, operating targets, information variables and the final target. In this regard, the key perceived advantage of using intermediate targets is that it enables the authorities to adjust instrument settings faster and more accurately in response to a shock to the system than it could if it focused solely on the final goal. Further, it is believed that the intermediate target variable leads the ultimate target and provides the monetary authorities with some measure for monitoring and evaluating the impact of its actions during the period between policy change and the impact on the final target. A critical assumption in the transmission process, therefore, is that the changes in the policy instrument influence these intermediate variables.

The two most likely contenders as target variables are inflation and growth in nominal spending. An appropriate selection criterion between these two is to choose the variable that corresponds most closely to the central bank's views about social objectives that are influenced by monetary policy. This gives inflation the natural edge, as it is perceived among many central bankers that the best contribution that they can make to long-term economic growth is maintaining orderly price movements. This is also justified because of empirical and theoretical deficiencies in using the nominal income measure. First, a large number of policy makers believe that, in the long run, monetary policy has no substantial effect on adjusting actual output to its desired or full employment level. They believe, too, that even if monetary policy influenced the optimal level of output, the effects would be temporary since one-off policy changes will influence liquidity conditions only once and the effects will exhibit diminishing returns to policy. Second, measurement of full employment output creates difficulty and controversy as it relates to defining the adjustment that would be required to bring actual output in line with potential output. Furthermore, the magnitude of measurement errors of output far exceeds the potential measurement errors of changes in relative prices. The third reason stems from the ease with which information on inflation measures may be conveyed to the public, relative to output data.

It is important to distinguish between variables to be selected as an intermediate or operating target. This distinction becomes necessary since the range of options – monetary base, interest rates, exchange rates, and money or credit aggregates - is wide. The selection of intermediate or operating targets is more complicated as the existence or non-existence of a stable and predictable relationship between the choice variable and the ultimate target becomes very crucial. The choice of variables that will represent the intermediate link between the policy instrument(s) and the final objective is primarily dependent on the stability and consistency of the empirical relationship between the variable and the final target. In the case of inflation, the intermediate target should serve as a reliable guidepost to the evolution of prices. In addition, the links between policy instruments and ultimate targets through intermediate channels rely on the assumption that the central bank is able to exert predictable control over the variable. In this regard, appropriateness of the variable rests on the ability of the monetary authorities to guide the intermediate variable towards its target.

Over the years, several choice variables have been identified as appropriate intermediate and operating targets, depending of course, on how the transmission process is conceptualized. On the one hand, if the monetary policy process is characterized by stating the final objectives in general terms, such as low inflation, then the central bank could see the growth in a particular monetary aggregate or the exchange rate as an adequate guidepost for achieving the low inflation objective. In this regard, the broader monetary aggregates, credit growth, or the exchange rate would be intermediate targets that would require changes in the policy instrument to steer the variable to its target. This framework may be broadened to include operating targets, since the central bank identifies the need to monitor a variable that it can observe with a greater frequency and exert control. In this case, a narrow definition of money such as the monetary base, or interest rates, would suffice as an operating target. Several caveats apply to the use of a nominal exchange rate anchor for the system, hence the gravitation towards the use of monetary aggregates,[6] whether as operating or intermediate targets for the monetary policy framework.

The use of monetary aggregates as intermediate targets for monetary policy stemmed from the theoretical arguments that were popular in the 1970's and 80's. Then, scholars and policy makers advocated the importance of 'rules' and the advantages, in particular, of using a money rule instead of an interest-rate rule due to the perceived difficulties with precisely identifying which of the credit or money channels of the transmission process exerted the more dominant effect. While this has led most central banks to adopt monetary aggregates as policy targets, another difficulty emerges, as the selection of the aggregate to target becomes the issue. Hoggarth (1996) suggests as a solution that countries target more than one aggregate. In this regard, the intention would be to monitor aggregates that satisfy a range of criteria that are easily measurable, controllable, and comprehensive enough to capture the effect of movements in bank liabilities on inflation.

6 Further reference on the selection of the exchange rate as a nominal anchor is cited in Hoggarth (1996).

Economic thinking in the 1990's recognises that the advantage of using monetary aggregates as reliable intermediate targets has eroded. The consensus , at least among developed nations, is that the conditions that existed during the 1980's that warranted adoption of monetary aggregates have long disappeared. This is in light of numerous transformations in financial sectors and of economies as a whole, since the beginning of the century, which have brought into question the empirical relationship between monetary aggregates and the ultimate target – inflation. For example, where the use of monetary aggregates relies on a quantity theory framework, the velocity of circulation could become unstable and unpredictable. This is because of the increased sophistication and innovations in financial markets globally, resulting from financial liberalisation and macroeconomic stabilization. This would violate the requirement of a stable velocity of circulation for policy decisions structured within the quantity theory framework.[7] Pursuing money growth targets within an environment plagued with uncertainty of money velocity could have the disadvantage of causing frequent short-run swings in interest rates and real output.

THE MONETARY CONDITIONS INDEX OR INDICATOR

The framework outlined so far comprises intermediate and operating targets that have been dominated by a select group of money and exchange rate variables. Recent experiences have

7 Economies in transition from a high inflation environment to a low inflation environment may experience a shift in the velocity. This may not be a precursor to higher future inflation, which if not recognized may lead policy makers to react unnecessarily.

demonstrated that the set of intermediate parameters is not limited to this defined group as some countries have successfully conducted policy by relying on a single indicator variable or set of information parameters that provide leading or contemporaneous information about the potential movements in the final target. The success of this approach is a reflection of the weakening relationship between monetary variables and inflation and output, and has led many central banks to calculate a monetary conditions index for use in assessing monetary policy decisions.

The MCI has emerged as an alternative to monetary targeting. While there remains some uncertainty about the relative strengths of the money and credit channels, the monetary conditions index conceptually captures both channels in a single composite relationship. Combining both sides of the transmission process through the incorporation of an exchange rate and interest rate variable, MCIs have been largely accepted as intermediate and indicator variables that have shown significant correlation with final targets. Consequently, MCIs have gained widespread use among developed economies such as Canada, New Zealand, Norway, and Sweden, which publish an index and, to varying degrees, use their respective indices to inform policy decisions.

The Bank of Canada (BOC) utilizes the index most extensively in its policy framework as changes in the monetary policy stance are, to a large extent, determined by observed shifts in the index. In adopting the MCI as its operating target, the BOC has replaced the short-term interest rate as an operating target. To incorporate the index within the operating framework, an inflation target is announced, and the evolution of the path for the interest rate and the exchange rate is examined to derive the corresponding measure of monetary conditions that would be consistent with achieving this inflation target. Economists from the Bank of Canada note that, while monetary policy is adjusted to bring the actual index in line with its desired level, the process is not mechanical, since initiating the adjustments require tactical timing of policy changes.[8]

Several monetary economists have concluded that both interest rates and exchange rates are relevant where policy changes are transmitted through these variables, rather than money and credit aggregates. Freedman (1994) argues for the thrust to broaden the concept of monetary conditions to include the exchange rate. His justifications are embedded in two main spheres of reasoning. First, operating in a flexible exchange rate regime, monetary policy impulses are transmitted directly through two channels – interest rates and exchange rates. Secondly, there is the need for policy makers to offset the effects of exogenous exchange rate shocks on aggregate demand and domestic price changes.

The arguments for adopting MCIs are premised on the need to fully encapsulate, within an assessment of the transmission process, the nexus between interest rate and exchange rate changes. Freedman (1994) justifies his arguments by suggesting that where policy changes are effected in interest rates, the contemporaneous movement in the exchange rate that results may vary wildly. In this regard, misinterpretation of shifts in economic parameters may result in excessive adjustment in policy levers, exerting adverse

8 More detailed exposition of the MCI used by the BOC is presented in Freedman (1994).

influences on other economic sectors. The focus on the combination of interest rate and exchange rate changes enables the central bank to avoid the potential error of implementing inappropriate interest rate policy to influence the economy. His other contention is for a more practical use of the index aimed at facilitating the immediate reaction to changes in monetary conditions due to exogenous shifts in economic variables.

The MCI construct allows the central bank to quickly identify changes in monetary conditions, resulting from internal shifts in the domestic economy, or exogenous shocks, and provides a direct mechanism signalling the need to take action to offset the monetary conditions that emerge. Adopting a monetary conditions index, in this regard, helps to ensure that appropriate attention is paid to exchange rate and interest rate changes in the transmission process. It is noted that the index measures the degree of ease or tightening in monetary conditions from an arbitrary date, and no meaning is attached to the *level* of the MCI.

Section III
Econometric Examination and Estimation

The task of defining relative weights for the components of the MCI begins with an examination of the econometric relationships between inflation and other economic variables. The paper adopts a model framework that is consistent with a small open economy and is similar in approach to work on New Zealand done by Nadal-De-Simone (1996).

The selected model is designed to capture the effects of imported inflation on domestic inflation, which stem from changing input costs and the additional component of exchange rate variability. Furthermore, the removal of capital restrictions makes the economy susceptible to free capital movement, and according to theory, the country will experience these effects where interest rate and exchange rate differentials are inadequate to attract and maintain funds within the domestic economy.

The system of equations as specified is intended to capture these issues as a part of the dynamics of monetary management in the Jamaican economy. The system is solved to produce a reduced form price equation which is estimated. The coefficients of concern in this equation are those attached to the exchange rate and the domestic interest rate, and they are used further in the work to calculate the MCI for Jamaica.

The Model

All the variables, except interest rates, appear in the model as logs. Since the economy is described as 'open', it produces and consumes goods from domestic and foreign markets, (with '*' indicating corresponding foreign parameters). The model equations are outlined as follows:

$$y_t^d = a_0 - a_1 r_t + a_2 q_t + a_3 y_t^* + v_t \qquad [3.1]$$

$$r_t = r_t^* + E_{t-1}(q_{t+1} - q_t) \qquad [3.2]$$

$$q_t = e_t + p_t^* - p_t \qquad [3.3]$$

$$y_t^s = \bar{y}_t + d(p_t - E_{t-1} p_t) + u_t \qquad [3.4]$$

$$P_t = p_t + (1-\alpha)(e_t + p_t^*) \qquad [3.5]$$

$$e_t - e_{t-1} = \{c - E_{t-1}(p_{t+1}{*} - p_t{*})\} - \lambda\{E_{t-1}(P_{t+1} - P_t) - c\} \qquad [3.6]$$

For completeness the LM equation is added:

$$m_t - P_t = b_0 + b_1 y_t - b_2 i_t + \chi_t \qquad [3.7]$$

where: y_t^d = demand for domestic output
r_t = real interest rate
q_t = real exchange rate
y_t^s = supply of domestic output
$\bar{y}_t$ = potential output
e_t = nominal exchange rate
P_t = general price level
$y_t{*}$ = foreign output
$r_t{*}$ = foreign real interest rate
$p_t{*}$ = price of foreign output
p_t = price of domestic goods
m_t = measure of liquidity
i_t = nominal interest rate
v_x = Disturbance term for the demand for domestic output
u_t and χ_t = disturbance terms for supply and money demand respectively
c = the one-month proportional rate of inflation that gives the centre of the inflation target per annum.
E = expected operator

Equation 3.1 represents the equilibrium of the goods market that is supported by the corresponding money market equilibrium defined in equation 3.7. Equation 3.2 posits the condition for uncovered interest rate parity (UIP) and recognises that the foreign interest rate and the exchange rate expectations should play an important part in a small, open economy. In this regard, the domestic interest rate is not characterised as an active monetary management tool. The role for interest rates is defined to the extent that free capital movements occur within a context where the interest rate differential across economies and the expected change in the spot rate are equated. Equation 3.5 defines the general price level within the domestic economy as a weighted average of domestic prices and foreign prices. In this regard, it takes into account the pricing of tradeables as well as non-tradeables within the economy. The final equation represents a reaction function for the monetary authority and relies on the monetary model of exchange rate determination. Within this context, having evoked the UIP condition, the transmission process for interest-rate changes holds when capital mobility and minimal transaction costs are assumed. In this regard, it is assumed that there is full adjustment in the actual price level to the price expectations within a context of perfect capital mobility.

This structural form is solved to obtain the reduced-form equation for the general price level P_t:

$$\begin{aligned} P_t = & \left[\frac{\alpha a_0}{a_1 + a_2} + c(1+\lambda)\right]\frac{1}{1-\lambda} - \frac{\alpha}{a_1 + a_2}\left(\frac{1}{1-\lambda}\right)\overline{y_t} - \frac{\alpha a_1}{a_1 + a_2}\left(\frac{1}{1-\lambda}\right)r_t^* + \frac{1}{1-\lambda}e_{t-1} + \\ & \frac{\alpha a_3}{a_1 + a_2}\left(\frac{1}{1-\lambda}\right)y_t^* + \frac{2(a_1 + a_2) - \alpha a_1}{a_1 + a_2}\left(\frac{1}{1-\lambda}\right)p_t^* - \frac{\alpha}{a_1 + a_2}\left(\frac{1}{1-\lambda}\right)E_{t-1}e_{t+1} + \\ & \left(\frac{\alpha}{a_1 + a_2} - \lambda\right)\left(\frac{1}{1-\lambda}\right)E_{t-1}P_{t+1} - \frac{2a_1 + a_2 - \alpha a_1}{a_1 + a_2}\left(\frac{1}{1-\lambda}\right)E_{t-1}p_{t+1}^* + \\ & \frac{\alpha}{a_1 + a_2}\left(\frac{1}{1-\lambda}\right)v_t \end{aligned} \qquad [3.8]$$

This reduced-form equation offers some intuitive appeal in the context of a small open economy, since external shocks will most likely affect these economies. Conceptually, the equation defines the effects of foreign output, prices and interest rates on the domestic price level. Given the underlying economic structure of small open economies, this derivation is consistent with their vulnerability to various external shocks. Interestingly, the inclusion of the effect of the foreign interest rate on the domestic price level would imply that the capacity of the domestic monetary authority to alter domestic monetary conditions is limited, in so far as the foreign interest rate and exchange rate movements are its determinants.

As suggested by the theories on transmission of monetary policy impulses, where interest rate changes occur, the transmission is initially through relative changes in the availability of domestic resources available to acquire goods and services. As interest rates rise and domestic liquidity declines, the impact is a lowering in the rate of increase in domestic prices, as the market reallocates the scarce liquidity resources among its competing end-uses.

Domestic prices also respond to exchange rates changes. Developing economies that have flexible exchange rate regimes inevitably face this type of economic relationship as the patterns of production and consumption frequently reflect the demand for imported goods. It is therefore expected that as the exchange rate depreciates, or there are expectations for depreciation in the domestic currency, domestic prices will move in tandem with the djustments in exchange rates.

DATA CAPTURE

Monthly data for domestic variables for the period September 1991 to December 1998 are obtained from the Bank of Jamaica Statistical Digest and are used in carrying out the estimation. This data period was selected to avoid issues relating to financial liberalisation which could create difficulties of parameter stability and constancy in the estimated weights. Expanding the data set to periods prior to economic liberalization would require alternative specification and estimation of systems of equations that would adequately incorporate the effects of changing MCI ratios in the presence of dynamic multipliers (Eckhold and Beaumont 1994).

The variables include some measure of the long-run trend for domestic output $\bar{Y}$. Potential output is derived by applying the Hodrick-Prescott (HP) filter to the domestic GDP series. When using this filter with quarterly data, a smoothing parameter of 1600 is usually employed. Since monthly data are being used here, the smoothing parameter λ is increased to 14,400 to transform current output to its long-run path.

Additional domestic variables include the end of period exchange rate, (e), defined as Jamaican dollar per US dollar, and the consumer price index. Foreign variables used are the Federal Reserve discount rate, (r^*), US GDP, (y^*), and the US consumer price index, (p^*). Values for these were obtained from the International Financial Statistics (IFS) publications of the International Monetary Fund.

Empirical work in developing economies has been largely constrained by the data deficiency. The current work is limited to the extent that there is no existing measurement for monthly Jamaican output. Monthly data were obtained from the interpolation of quarterly data estimates of the Statistical Institute of Jamaica (STATIN) by assuming a constant growth rate. Statistical biases may therefore arise in the estimated coefficients and caution needs to be exercised in interpreting regression results and their ultimate use for policy analysis.

Expectations for exchange rates and foreign prices are defined as three-period moving averages and are represented as $E_{t-1}e_{t+1}$ and $E_{t-1}p_{t+1}*$ respectively. The other expectations variable, $E_{t-1}P_{t+1}$, is defined as the arithmetic mean of the domestic consumer price index for the past three months.

ESTIMATION AND CALCULATION OF THE MCI RATIO

Ordinary Least Squares (OLS) is applied to equation (3.8) to yield:

$$P_t = 9.598 + 0.373e_{t-1} + 0.007E_{t-1}e_{t+1} + 0.082p_t^* + 0.001E_{t-1}p^*_{t+1} + 0.429\bar{y}_t$$
$$(0.69) \quad (3.84) \quad (-2.02) \quad (0.03) \quad (-0.30 \quad (7.85)$$

$$-1.08y_t^* - 0.007r_t^* + 0.001E_{t-1}P_{t+1}$$
$$(-2.69) \quad (2.14) \quad (14.45) \qquad [3.8']$$

$T=84(1991(12)-1998(12)$
$R^2=0.99$
$Q(14)=21.56*$

The numbers in parentheses represent the t-statistics of the estimated coefficients. The diagnostic tests on the residuals are summarised in the subsequent lines. The estimated price equation produced an R^2 of 0.99, with statistically significant coefficients on most of the foreign parameters included in the regression equation.

The one-month lagged exchange rate variable has a positive coefficient that is consistent with *a priori* expectations since any depreciation in the exchange rate is likely to translate into increases in domestic prices (as long as monetary policy does not act through interest rate adjustments to reduce money supply growth). Theory suggests, too, that exchange rate movements should act as a switching mechanism between aggregate demand for locally produced goods relative to foreign goods. If, for instance, there is a real depreciation in the exchange rate, this should influence lower demand for foreign-produced goods by domestic agents, while potentially inducing greater supply, at least in the context where supply is elastic. In Jamaica's case, the indirect effect is often swamped by its direct counterpart and the episodes of depreciation are typically accompanied by increasing inflation, in so far as money supply expansion is not prudently managed.

The results also show that current inflation is fuelled by its own expected value. This is to be expected since episodes of exchange rate depreciation, as occurred in Jamaica over the period, coincide with expectations for higher inflation. This phenomenon is associated with movements in the exchange rate, since depreciation of the rate is immediately incorporated in domestic prices.

It is noteworthy that the foreign interest rate variable is statistically significant which means that it is important in influencing domestic monetary conditions. The UIP condition that defines the dynamics of domestic interest rates in terms of foreign interest rates and exchange rate depreciation suggests that domestic interest rates adjust through a reactive mechanism to expected changes in exchange rates, since it is observed that foreign interest rates exhibit relative stability over time. Within this context, while interest rates are not explicitly reflective of an active monetary policy stance, its role in domestic monetary decisions remains important.

Both domestic and US output are statistically significant but domestic output seems to have an incorrect sign. The latter may be a result of using the interpolated data. Foreign prices are not statistically insignificant.

CONSTRUCTION OF THE MCI FOR JAMAICA

(A) DEFINING THE INDEX:

The monetary conditions index is the weighted sum of changes in the 180-day nominal treasury bill rate (r) and the nominal exchange rate *(e),* where both variables are expressed as deviations from their values in a base period. It is noted that while the central bank typically defines an interest rate signal through the reverse repurchases rate, the treasury bill rate represents the most widely or frequently used rate. Algebraically, it is convenient to write the MCI as:

$$MCI(v)_t = \theta_{v,r} * (R_t - R_0) + \theta_{v,e} * (e_t - e_0), \qquad [3.9]$$

where t is a time index ($t=0$ is the base period), θ_r and θ_e are the respective weights on the interest rate and the exchange rate, and variables in lower case denote logarithms.

(B) Measuring the Relative Weights:

The weights are chosen to reflect the impact that changes in the monetary policy instruments have on the final target. In this instance, the weight in the index represents the relative impact of interest rate and exchange rate changes on inflation. Where the MCI is used as an operational target, the weights are intended to reflect the linkages between the operating target and the final objective, with changes in the index indicating the likely changes in the final target.

The relative weights of the index are measured respectively by the estimated coefficient, of the one-month lagged exchange rate and the interest rate variable obtained from equation (3.8). These values are 0.37 and -0.007 respectively. A 1% change in the exchange rate therefore exerts a much greater influence on domestic prices over time than a 1% change in the interest rate.

(C) Assessing the Estimated MCI for Jamaica

The tightening or loosening of monetary conditions within the Jamaican economy is measured relative to January 1994, when conditions in the foreign exchange market settled at a new equilibrium. A decline in the interest rate potentially increases liquidity, and hence exerts upward pressure on domestic prices. Alternatively, for a depreciation in the exchange rate, the impact of increased costs of production is immediate and will create increasing pressure on inflation. A rise in the index is therefore interpreted as a loosening of monetary conditions.

Another useful perspective on the movements in the index is that it signifies a change in the relative attractiveness of Jamaican dollar assets relative to foreign currency assets. Thus an increase in the index would be consistent with a weakening in the demand for Jamaica dollars which can be corrected by a combination of exchange rate stabilisation and interest rate increases.

As a policy indicator, the MCI aims at tracking the relative effects of interest rate and exchange rate changes on inflation. In Jamaica's case, movements in the index are symmetrical with the fluctuations in the exchange rate (Figure 7.3). Periods of sharp depreciation in the exchange rate coincide with the precipitous loosening of monetary conditions, while periods of relative stability produce a stable index.

FIGURE 7.3: MONETARY CONDITIONS INDEX
(January 1994=0)

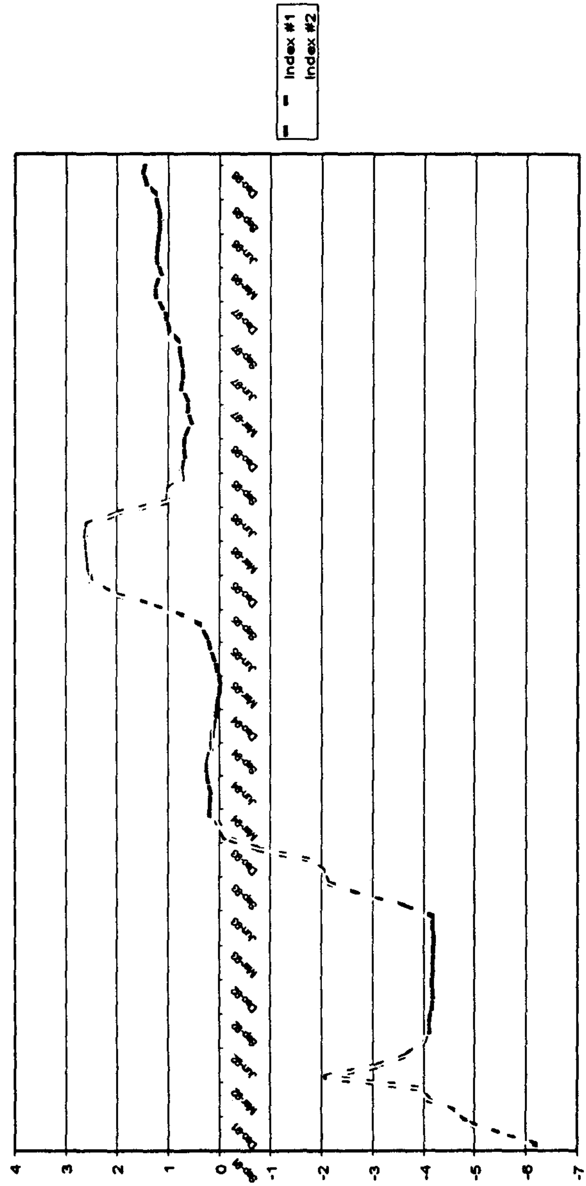
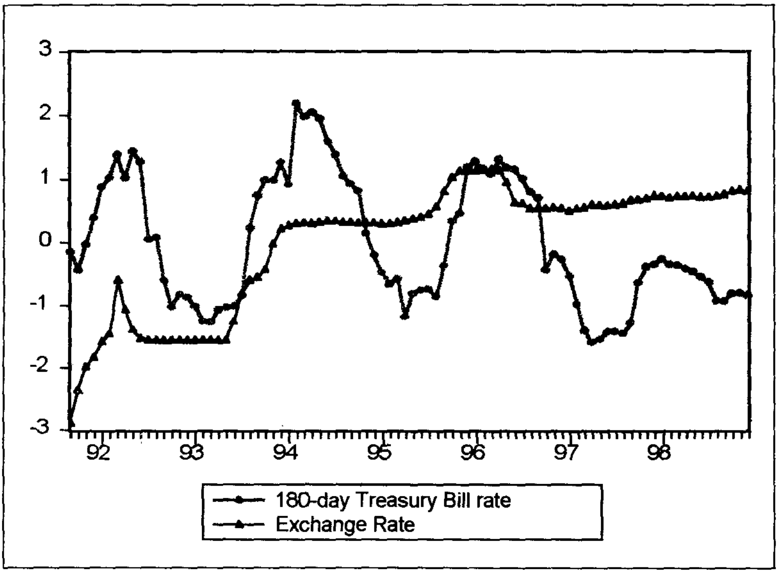


Figure 7.4
Components of the Monetary Conditions Index for Jamaica (September 1991-December 1998)



SECTION IV
USING THE INDEX IN THE CURRENT MONETARY POLICY FRAMEWORK

In the existing monetary policy framework, changes in the monetary base and monetary aggregates are used as predictors of domestic inflation. The MCI, at least in theory, serves to complement this analysis by

(a) allowing timely calculation and examination of its components to examine the imminent effect on domestic inflation

(b) providing information on indicative policy adjustments that would be required to maintain conditions and limit the potential for higher inflation in future periods, and

(c) incorporating both channels of the transmission process – interest rate effects of the domestic economy and exchange rate effects influenced by domestic and foreign conditions.

Since the estimated index mirrors the movements in the exchange rate, the pertinent question at this juncture is whether or not the computed index broadens the information base required for monetary policy formulation. A response to this question is obtained by examining two calculated MCIs, one defining the effect of interest and exchange rate changes relative to the identified base period (*denoted index #1*), and the other, the pure impact of the changes in the exchange rate from the same base (*denoted index # 2*). *Figure 7.3* depicts this comparison. In the first instance, a sharp depreciation is observed in the exchange rate from June 1993 to November 1996, with the attendant rise in interest rates not being sufficient and effective in offsetting the impact of an exchange rate depreciation on the domestic monetary conditions (*see Figures 7.3 & 7.4)*. As a result, the index increases sharply, creating conditions conducive to maintaining high monthly and annualised inflation rates. Further, it is noted that during this period, there is the marginal difference between the calculated indices, which suggests that monetary conditions are most likely unaffected by interest rate changes when there exist unstable conditions in the foreign exchange market.

On the other hand, during periods of moderate exchange rate movements (June 92-June 93, and January 1994-January 1995) and with interest rates remaining relatively high, there is some distinction in the calculated indices. The effect of interest rates becomes clear, as the degree of loosening in monetary conditions (measured by index #1) is not as sharp as that indicated by index # 2. The interest rate effects continue through to the subsequent period, where interest rates remain fairly high during periods of relative stability in the value of the currency, resulting in conditions that reflect some tightening which is consistent with the creation of the low inflation and interest rate economic environment.

This analysis suggests that there are distinct circumstances where monetary policy directed through interest rate changes were effective or ineffective in controlling inflation, and depended largely on the nature of the adjustments in the exchange rate. During periods with moderate exchange rate changes, monetary policy gains momentum in guiding inflation to the target, while during disorderly exchange market conditions, the role of interest rate adjustments was less effective.

It is indeed clear from the foregoing that domestic interest rates do not exert an overwhelming influence on the monetary transmission process. The literature on the transmission process indicates that an increase in interest rates is likely to prove more effective in reducing inflation where the financial system is open and competitive, and with more contracts set on a floating basis. A critical underlying assumption within this context is that the financial system is sound, so that monetary policy signals are appropriately transmitted through the representative money or credit channels, and finally to economic parameters. Typically, a sound banking system (defined in terms of concepts of solvency and liquidity) enhances the monetary policy process, as banks not only interpret, but also act appropriately to alter balance sheets to adequately mirror the prevailing stance of monetary authority.

In a context of a weak banking system, the central bank's expectations of linkages between policy instruments and performance in the economy will become uncertain, rendering it increasingly difficult to set and adjust policy parameters appropriately. Further, the effectiveness of policy instruments will diminish as banks become unable to respond to monetary policy signals through appropriate and timely balance sheet adjustments. The most obvious result is inefficient credit allocation, which feeds through to have negative impacts on the real domestic economy.

The transmission of monetary policy signals requires the underlying support of appropriate micro-economic conditions in the banking system, as the effectiveness of policy instruments will be determined by the extent to which banks can effect timely adjustments to their balance sheets. Guitan (1997) concludes that appropriate macro-economic policies are necessary to achieve price stability, but are not sufficient to maintain it unless supported by appropriate micro-economic conditions.

The MCI is by no means a precise measure of the effects that changes in exchange rates and interest rates exert on the domestic economy, but represents a reasonable indicator of future inflation movements. A pure examination of the contemporaneous linkage between the MCI and inflation shows a positive correlation in which the MCI acts as a satisfactory information variable in defining future movements of inflation.[9] The test for the association between these variables indicates that there is strong correlation between inflation and the monetary conditions index, and hence satisfactorily establishes some dependence between both variables.

It is clear that identifying the source of exchange rate shocks is critical to the functioning of Jamaica's monetary policy framework. However, a case is made for using the combined index. Exogenous shocks to the exchange rate, for example, if there are disorderly market conditions that would fuel a sharp depreciation and loosen monetary conditions, would require tactful and timely policy adjustment to maintain a relatively stable monetary index. Focusing on the monetary conditions index, the need for tightening action would show up directly since the index would show the easing resulting from currency depreciation, and immediate action could then be taken to return monetary conditions to their previous level. Note, however, that the index cannot define the magnitude of change required, but it does serve as an economic barometer continuously measuring the degree of inflationary pressures within the economy.

9 For full discussion on this topic see Kendall and Stuart (1967), p296.

The case is therefore made for adopting the combined index rather than the sole movements in the exchange rate. The focus of monetary policy within the current environment is to achieve simultaneous stability in the foreign exchange and money markets that will maintain the current low inflation environment. To this end, changes in the exchange rate would not be a sufficient intermediate target since it only includes one side of the economy. The central bank would therefore be limited in effecting timely changes in interest rates to temper the effects of exchange rate changes. Index #1 broadens the span of monetary policy assessment to include interest rate and exchange rate targeting to maintain a stable index, and by extension low inflation.

SECTION V: CONCLUDING COMMENTS

The principal recommendation of this paper is that both the interest rate and exchange rate should be used in examining the changes in policy and the impact on the final target. Further, in the process of estimating the MCI ratio and then deriving an index, support was obtained for the long-standing view that stability of the exchange rate will create and facilitate better macroeconomic fine-tuning. In the case of Jamaica, like most developing countries, the underlying market structures dictate that exchange rate changes have an immediate and direct impact on domestic prices. In this regard, it is imperative that as soon as exchange rate shifts occur (from whatever source), attendant adjustments should be made in domestic policy to offset the fluctuations. The index facilitates this timely assessment and adjustment since it may be continuously calculated and examined more frequently than other intermediate variables such as M3.

A limitation in using the nominal index as an intermediate target is the relatively short horizon that it covers. To extend the period of focus, an index defined in real terms, measuring the changes in real variables from their base periods, would be more useful, although in the short-term the nominal should serve as well as a real MCI. However, the calculation of a real MCI is going to be hampered even more by the absence of appropriate data.

This paper also highlights the need to adopt an additional operating target to augment the current use of base money. While it may not be superior to using the exchange rate as an intermediate target, it is clear that the index provides a basis for the monetary authorities to alter market expectations with a time-consistent, transparent operation of monetary policy linked to a single objective.

While the results of this paper support the adoption of the MCI to augment policy decisions, alternative means of assessment may be required to look at other issues. Also, the current work is only the beginning of an ongoing process for defining the relative weights for an MCI and it needs to be supplemented through the examination of alternative estimation methods, accompanied by rigorous tests for stability in weights.

As with other research dealing with this issue, the paper utilizes a traditional method of regression analysis. It has been suggested (Nadal-De Simone and Dennis 1996) that studies on MCIs be extended to include explicit testing for cointegration. If the null hypothesis of cointegration were not rejected, the examination of cointegrating relationships would allow a clearer distinction between long-run and short-run dynamics of the system.

Lastly, the adoption of the MCI as an operating target would need to be combined with more sophisticated inflation targeting than currently practised. The ability to forecast inflation six to eight quarters ahead and to associate these targets with movements in the MCI would set the stage for elevating the MCI to a more permanent place.

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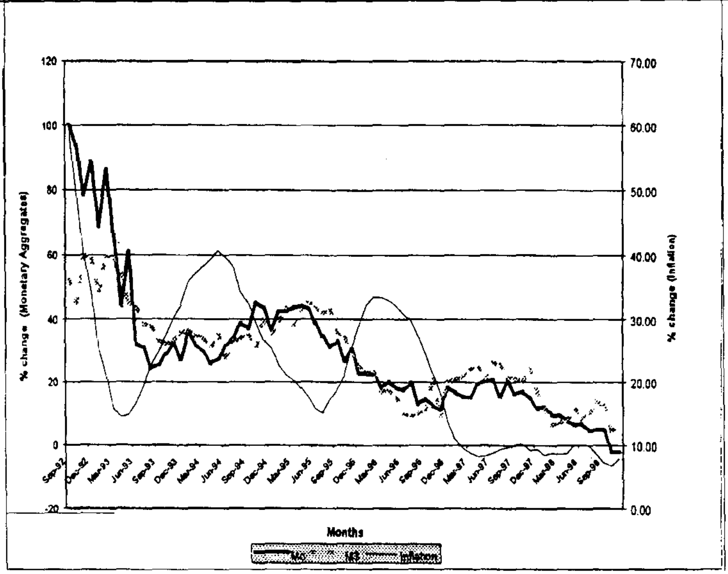
APPENDIX 7.1

GROWTH RATES IN MONETARY AGGREGATES AND INFLATION (SEPTEMBER 1992-DECEMBER 1998)



Note: Variables are measured in percentage changes, with monetary aggregates on the LH axis and inflation on RH axis.

CHAPTER 8

POLICY MAKING AND FORECASTING IN TRINIDAD AND TOBAGO USING A MEDIUM-SIZE STRUCTURAL ECONOMETRIC MODEL

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POLICY MAKING AND FORECASTING IN TRINIDAD AND TOBAGO USING A MEDIUM-SIZE STRUCTURAL ECONOMETRIC MODEL

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and
Sonja S. Teelucksingh

ABSTRACT

This paper is an exercise in econometric modelling as much as it is an attempt to derive appropriate policy measures and to forecast key macroeconomic variables of small open economies like that of Trinidad & Tobago. A medium-sized structural econometric model of the Trinidad & Tobago economy is constructed and evaluated, policy implications derived and the difficulties involved in using it to obtain forecasts are discussed.

Keywords: Structural econometric modelling, small size, monetary and fiscal policy, forecasting, cointegration.

1. Introduction

This paper has two broad objectives

- It is first of all an exercise in econometric modelling methodology. An eclectic methodology is proposed for the estimation and evaluation of a medium-to-large structural econometric model (SEM)

- Secondly, using this methodology, a medium-size macroeconometric model of the Trinidad & Tobago economy is constructed to be used principally for the evaluation of fiscal and monetary policy instruments. It can also be used to forecast the key variables of the Trinidad & Tobago macroeconomy over the short to medium term.

Trinidad & Tobago has been described as a small open petroleum economy in the spirit of Seers (1964). The term "small" may be misleading as a description of such economies and perhaps the term "micro" may be more appropriate. They are certainly much smaller than the economies of Denmark and other Nordic countries which Wallis and Whitley (1991) refer to as "small open economies" and where SEMs are employed with much the same objectives as we have in this paper.

Both the concepts of small size and SEMs may not be too fashionable in certain quarters. In this age of globalisation and the dominance of the new *laissez-faire* ideology, it is sometimes claimed that size does not matter, that there is essentially no difference between "small" and "big" economies. SEMs too have been severely criticised – see, for instance, Sims (1980). However, they still continue to enjoy some popularity. Wallis and Whitley (1991) observe that such models continue "to support internally consistent quantitative analysis of policy alternatives." So researchers responded to the criticism of Sims and others, not by abandoning their efforts, but by sharpening the econometric methodology used in the construction of their models as well as in the use of a more appropriate economic theoretical framework. Sometimes, the two combined, such as in the case of the error correction mechanism of Davidson *et al.* (1978) and the intimate relationship of this concept to that of cointegration (see Engle and Granger 1987). The model developed in this paper makes use of some of these "modern" contributions.

The SEM developed in this paper is not small and is certainly not linear. As far as its size goes, we wish to think of it as medium-size but some may even refer to it as large (it contains 138 equations of which 24 are behavioural). In the following section, the econometric methodology to be employed is developed and discussed. This first step is of vital importance as on it will depend the success of the other steps. Discussion of the methodological questions is followed in section 3 by the specification exercise which will put in place the key features of the Trinidad & Tobago economy and where the notions of "smallness" and "openness" will be precisely located. The model is then estimated and evaluated in section 4 while in section 5 the policy implications of the fitted model are discussed. The forecasting process is discussed in some detail in section 6, and section 7 concludes the paper.

2. Econometric Methodology

The model to be used in this paper is of the general form:

$$B(L)\, y_t + \Gamma(L)\, x_t = u_t,\ t = 1, 2, .., T \qquad (1)$$

where $B(L)$ is a $G \times G$ matrix and $\Gamma(L)$ a $G \times K$ matrix of polynomials in L so that equation (1) may be written alternatively as

$$\sum_{j=0}^{p} \mathbf{B}_j \mathbf{y}_{t-j} + \sum_{j=0}^{q} \mathbf{\Gamma}_j \mathbf{x}_{t-j} = \mathbf{u}_t$$

u_t is a $G \times 1$ vector of independently, identically distributed random variables with mean zero and covariance matrix Ω. The y and x variables will usually include logarithmic and other non-linear transformations of variables appearing elsewhere in the model and some of the G equations will be accounting identities and equilibrium conditions.

A fundamental problem in this exercise is the determination of an appropriate estimating procedure to establish the values of the B and Γ matrices. A considerable amount of intellectual effort in the past, inspired largely by the work of the Cowles Commission, went into determining appropriate consistent estimators. Yet Ordinary Least Squares (OLS) remained the method of choice when G and K were even moderately large, or when non-linearities (like logarithmic transformations) were present. This is notwithstanding the inconsistency of OLS and the existence, on paper at least, of consistent estimating procedures like Two Stage Least Squares (2SLS), Three Stage Least Squares (3SLS) and others. See, for instance, Klein and Young (1980) and Smith (1977).

Does the relatively new notion of cointegration introduced into the literature by Engel and Granger (1987) get us any closer to solving this problem? Hsiao (1997a), (1997b) argues, among other things, that in the structural (Cowles Commission) approach it is the standard concerns of identification and estimation (and not integration and cointegration) which are fundamental. He shows that, when the y and x variables are I(1) and cointegrated, OLS is not consistent but that the 2SLS and Three Stage Least Squares (3SLS) estimators are. Furthermore, equation (1) can be written as:

$$B^*(L)\Delta y_t + \Gamma^*(L)\,\Delta x_t + B(1)\,y_{t-1} + \Gamma(1)\,x_{t-1} = u_t \quad (2)$$

where $B(1)\,y_{t-1} + \Gamma(1)\,x_{t-1}$ *and* $B^*(L)\Delta y_t + \Gamma^*(L)\,\Delta x_t$ are the implied long-run and short- run relations between y and x (the long run component is also called the error correction mechanism). Equations (1) and (2) are linked together by a simple nonsingular linear transformation so that the coefficients of (2) are easily derivable from the coefficients of (1). There is therefore no need to directly estimate the coefficients of (2), which is a much more complicated exercise than estimating the coefficients of (1).

Hsiao's results are very useful but we are still left in the lurch when G and K are relatively large or when non-linearities are present: the consistent procedures still cannot be applied. Perhaps the solution might be found in an alternative approach to modelling the variables in Equation (1) in the form of a structural VAR:

$$A(L)\,w_t = v_t \quad (3)$$

which itself can be written as:

$$\sum_{j=0}^{s} \mathbf{A}_j \mathbf{w}_{t-j} = \mathbf{v}_t$$

This follows the pioneering work of Sims (1980) and has been called the "time series" approach to modelling. Here, the **A** matrices are square $(G+K, G+K)$, $w_t = (y_t\ x_t)'$, $v'_t = (u_t\ \varepsilon_t)$, there is no *a priori* assumption of exogeneity of the x variables (it is the data rather than economic theory which determines that) and v_t is vector of independently, identically distributed random variables with mean zero and covariance matrix Ω^*.

The time series approach uses the data to determine the presence (or absence) of cointegration; (the Cowles Commission approach, on the other hand, preassumes such presence or absence). Hsiao (1997a) establishes the restrictions that must be imposed on A in order for (1) and (2) to be equivalent to (3).

Estimation of the model in the form of (3) is not without its problems and to some extent it is also guilty of using "incredible identifying restrictions" which Sims (1980) claimed to be the exclusive domain of the SEMs. In the first place, the coefficients of the structural VAR cannot be estimated directly because its disturbances are correlated with the contemporaneous values of the w variables. The coefficients of the reduced (standard) form VAR can be consistently estimated by OLS but restrictions such as those implied by the Choleski decomposition must be imposed in order to identify the coefficients of the structural VAR. Even ignoring these problems, it is impractical to use VARs for situations involving more than just a few variables (4 or 5) and/or lengthy lags (the optimum lag length must be determined) since the degrees of freedom for estimation may be rapidly exhausted otherwise.

For completeness, the Hendry methodology will also be discussed (see Hendry *et al.* 1988 and Clements and Mizon 1991). In this case we do not start with the "incredible restrictions" usually associated with the structural form approach. Rather, we start from a standard VAR form that is considered as a "congruent" representation of the Data Generating Process (DGP). The structural form is specified as a set of overidentifying restrictions that are tested against the reduced form. But the Hendry approach cannot be applied to estimate the coefficients of the model developed in this paper since it, too, requires for its application models which are fairly small *and* linear (in fact both these words appear in the title of the Hendry *et al.* (1988) article). What are we then to do?

A possible compromise, adopted in this paper, is the application of OLS to the structural equations of (1) for very much the same reasons it was applied to large models, notwithstanding the work of the Cowles Commission to provide alternative estimators (see Klein 1960). We go some way, however, to take into account the modern technology. The following five steps will be followed:

- The behavioural equations will be specified on *a priori* economic grounds
- Each variable appearing in an equation will be subjected to unit root testing.
- Each equation will then be subjected to the Johansen cointegration test to ensure that at least the variables appearing in the equation are cointegrated with economically meaningful parameter values.

- Following this, each behavioural equation in (1) will be estimated by OLS and, in the spirit of General-to-Specific modelling, restrictions on the lags imposed and tested. Special importance will be given to testing the residuals to determine, among other things, cointegration and the absence of specification errors.

- Once the model is estimated it is solved and standard checks made on its overall fit. This includes use of the conventional Theil statistics and dynamic multiplier analysis as was done in Watson and Clarke (1997).

This approach may appear highly unsatisfactory but the existing "technology" does not provide much choice for a large non-linear model. For instance, the Johansen test is based only on a subset of variables in the overall model whereas, theoretically, it should involve all. But for G and K of reasonable size, the test simply cannot be carried out. What we are proposing here is to establish in a somewhat loose way that the variables brought together in one equation truly "hang together" in a cointegrating sense. Also, use of the Theil statistics and multiplier analysis has been highly criticised by Chong and Hendry (1986). But as Wallis and Whitley (1991) point out, "few formal tests are available for large-scale non-linear dynamic models" and evaluation must therefore proceed in a more informal manner than might be desirable in other cases (see Smith 1977).

3. Model Specification

Trinidad & Tobago is a twin island independent republic with a population of about 1.25 million. Its main resource is petroleum (this is likely to remain the case for some time to come) and as a consequence, the price of oil, which is determined independently of Trinidad & Tobago production, is an extremely important (exogenous) variable. In fact, a particular feature of economies like that of Trinidad & Tobago, not unrelated to its small size, is its heavy dependence on the outside world and in particular the absolute necessity to earn foreign exchange as a prerequisite to survival. The government of Trinidad & Tobago is an active economic agent, intervening through fiscal and monetary measures to attain goals consistent with high incomes at or close to a level that is compatible with full employment in an environment of a stable exchange rate and moderate price levels.

Are monetary and fiscal policy measures effective in a small open economy like that of Trinidad & Tobago? How effective are they? Which is the more effective? In this paper, we seek answers to these questions empirically within the framework of a medium-sized macroeconometric model of the Trinidad & Tobago economy, constructed to take into account various fiscal and monetary policy instruments. This model is rooted firmly in the IS/LM tradition. Within such a framework, theory predicts that, in a small open economy with a floating exchange rate regime, it is monetary and not fiscal policy that should be used to attain goals consistent with high incomes at or close to a level that is compatible with full employment in an environment of a stable exchange rate and moderate price levels.

Consider the effects of an expansionary fiscal policy, for instance a tax cut. Theory predicts that this would increase incomes and interest rates simultaneously (by shifting the IS curve to the right). However, the increase in interest rates causes capital inflows into the economy which in turn increase the supply of foreign exchange. This will, under a regime of floating exchange rates, cause an appreciation of the domestic currency. As the domestic currency appreciates, imported goods become less expensive relative to their domestic counterparts. This results in falls in the levels of domestic incomes and expenditures as leakages from the circular flow of income occur. Hence the initial goal to improve income and employment over time is not realised.

What about the effects of monetary policy? An expansionary monetary policy brought about, for instance, by a lowering of the prime interest rates (in this study the Treasury Bill rate) would increase incomes also (by shifting the LM curve to the right). However, this results in a simultaneous fall in interest rates (as opposed to the increase that accompanies the increase in income following the corresponding fiscal policy measure) and this would engender capital flight. This is followed by an increased demand for the existing foreign exchange receipts resulting in a depreciation of the domestic currency. There would then result a switch in consumption patterns away from imported goods to the now relatively cheaper domestic commodities. This decrease in the leakage from the circular flow of income would result in a further increase in domestic incomes (through a rightward shift of the IS curve) and employment. These increases are sustained over time.

Are these conclusions about the relative merits of fiscal and monetary policy verified in the Trinidad & Tobago context? To determine this, we develop and use a model which takes as its point of departure the Watson-Clarke (1997) model of the Trinidad & Tobago economy. The following important differences in the current and previous versions of the model are to be noted:

1. The original model employed annual data covering the period 1970-1989. The current model uses a data set that covers the period 1970-1996.

2. Behavioural equations have been modified to take into account some new economic realities, in particular the existence since 1993 of a floating exchange rate regime.

3. The econometric methodology is quite different in that the current model is estimated and evaluated using the methodology outlined above.

The model comprises 138 equations (of which 24 are behavioural) and 66 exogenous variables. It is essentially demand driven and, to that extent, will respond largely to demand management concerns. This emphasis stems not from a failure to recognize the importance of the "supply side" of the economy, particularly within a medium term planning framework. Rather, it reflects the lack of data available for the construction of such a model. It should be noted that even for the construction of the relatively aggregated model presented here the data available were only barely adequate. For instance, to meet the data requirements, a coherent data set (or something close to that) was available only in annual format and, even so, up to 1996 (although the time of writing is 1998).

The model will allow policy makers and planners in Trinidad & Tobago to project future values of key endogenous variables in the system, on the basis of assumptions about the future path of the exogenous variables in the system. The main variables to be forecast in this paper - they may also be considered as the key targets of fiscal and monetary policy - are the following "real" sector variables:

> GDP at constant prices *(GDPMP)*
> The unemployment rate *(UNEMP_RATE)*
> The retail price index *(CPI85)* and
> The (nominal) exchange rate *(EXCHAVG)*

The policy makers may seek to influence these variables through different policy mixes, and make their recommendations on the basis of the results of these simulations. The main instruments of fiscal policy appearing here (5 in all) are:

> The Corporation Tax rate on the oil sector *(OIL_CORP_RATE)*
>
> The Sales Tax rate *(SALESTAX_RATE)*
>
> Corporation Tax Rate in the non oil sector *(TAX_INC_C_RATE)*
>
> Income Tax rate on individuals *(TAX_INC_I_RATE)* and
>
> Tax rate on foreign trading activity *(TAX_TRADE_RATE)*

Only one monetary policy instrument is considered, the Treasury Bill Rate (TBR).

The instruments over which the Government has some control form but a subset of the exogenous variables in the model. It is therefore clear that the eventual outcome will depend to a large extent on the evolution of a set of "unknowns," some of which are quite important, for example, the price of oil. For obvious reasons, the chosen policy mix cannot be properly determined without careful consideration of such variables. Indeed, the chosen policy package may lead to completely unanticipated (and undesirable) consequences if the unknown variables do not behave as assumed by the planners.

The model contains five interrelated blocs. There is, first (and perhaps foremost) the aggregate expenditure bloc. This bloc contains the various identities and stochastic equations which elaborate the elements of the expenditure items on the production account. In particular, there is a private investment function that required some serious efforts to extend the data series provided by the Central Statistical Office.

The Balance of Payments (current account) bloc is of critical importance in a country such as Trinidad and Tobago. The identities and stochastic equations (explaining both import and export items) provide us with the current account balance. This feeds directly into both the aggregate expenditure bloc as well as into the financial system bloc, where it determines reserves, external indebtedness and, together with the aggregate expenditure bloc, the principal monetary variables.

Given the nature and purpose of this model, it is not surprising that the public sector bloc plays a particularly important role in its overall functioning. The Public Authorities are viewed as active agents in the economic activity of the country, able to intervene through various policy instruments like tax rates and expenditure. The overall revenue-raising and expenditure activities of these authorities which we identify in this bloc feed directly into other blocs in the system - in particular the aggregate expenditure and financial blocs. More specifically, the government's surplus/deficit on current account, which in the past has been an important component of national savings, is calculated in this bloc. So too is the Central Government borrowing requirement (the overall budget surplus/deficit with the sign reversed) which impacts directly on the national debt determined in the financial bloc.

One of the more obvious features of the treatment of this bloc is the categorization of government revenues according to whether they arise in the oil as opposed to the non-oil sector. This reflects one of the fundamental features of the Trinidad and Tobago economy: it has been, and continues to be, dominated by oil. The government is the principal conduit through which revenues earned in the oil sector enter into and affect the overall functioning of the entire economy.

The final bloc in the model is really a bringing together of a collection of sub-blocs which, in future work, will inevitably have to be sub-divided into individual blocs. It is the "Prices, Income Output and Employment" bloc which, in addition to explaining the various prices which enter into the system, also explains the formation of income (wage and non-wage), output and employment in the oil, manufacturing, government, and "other" sectors of the economy. Estimation of the price equations in this bloc presented some of the greatest difficulties of the whole exercise, and in some cases there still remains some dissatisfaction with the results obtained. Perhaps the most important price determined in this bloc is the exchange rate.

4. Estimation and Evaluation of the Model

The 24 estimated behavioural equations, together with the identities of the system, are shown in the appendix. The fitted equations are numbered (16), (17), (37)-(41), (95)-(98) and (125)-(138). They were all estimated using AREMOS ver. 5.0 and the results shown are transposed directly from the AREMOS output. The signs and sizes of the coefficient values shown can all be anticipated from standard economic theory.

The variables used in the equations were all I(1) except for *PER_DISP* (logarithm) which showed some evidence of being I(2). Consequently, it appears in equation (96) of the appendix in first differenced form. All fitted equations passed the cointegration test as discussed in section 2 of the paper.

We will illustrate the methodology employed in determining coefficient values obtained by reference to the Private Consumption equation which appears as equation (16) in the appendix. We started off with a general specification of the form:

$$\begin{aligned} Log(pfce) = \;& \alpha_0 + \alpha_1 log(pfce_{-1}) + \alpha_2 log(pfce_{-2}) + \\ & \beta_0 log(pri\_disp) + \beta_1 log(pri\_disp_{-1}) + \\ & \beta_2 log(pri\_disp_{-2}) + \gamma_0 tbr\_r + \gamma_1 tbr\_r_{-1} + \\ & \gamma_2 tbr\_r_{-2} \end{aligned}$$

All three variables in the model proved to be I(1) and the Johansen cointegration test showed that they were cointegrated. We ended up with the following estimated equation:

$$log(pfce) = 0.43916 * log(pfce_{-1}) + 0.43786 * log(pri\_disp) + 1.00969$$

after carrying out a series of "variable elimination" tests.

Since this paper is concerned largely with the model's usefulness for forecasting key economic variables (and subsidiarily with the evaluation of fiscal and monetary policy), we chose to structure the equations in the form of equation (1) rather than equation (3). Estimation of (3) would have introduced some added complications that include loss of degrees of freedom, the determination of which EC terms to enter which equation etc. which might have caused some deterioration in the information content of the model. There is also no need to estimate (3) directly since it is related to (1) by a simple linear transformation. In the final analysis, the short-run – long-run dichotomy emphasized in any individual equation in (3) may count for little in guiding overall policy measures that will be based on the overall solution of the model. As we are reminded by Wallis and Whitley (1991), "the effect of incorporating a new equation in the model is often inadequately reflected in its single equation properties".

The model was evaluated to determine its closeness of fit to the actual data model. It was solved using the Gauss-Siedel routine of AREMOS ver 5.0. Goodness of fit of the model is judged on the basis of a series of statistics generated using the COMPARE command in AREMOS (which "COMPARE"s the actual and simulated values). These statistics include the Theil inequality coefficient, *U*, as well as the decomposition of the Theil *U* into proportions due to deviations attributable to the mean *(UM)*, the intercept *(UR)* and the residuals *(UD)* in a linear regression of the simulated on the actual values. All these terms are positive and by definition sum to unity. In the "ideal" case, $UM=UR=0$ and $UD=1$. These very popular "diagnostic" statistics must, however, be used with caution. They provide a measure of point by point accuracy that cannot on their own be used to judge goodness of fit. Chong and Hendry (1986) are very critical of the use of a model's dynamic simulation properties to judge its goodness-of-fit.

Table 8.1 below provides the diagnostic statistics for the 4 key variables based on the dynamic simulation of the model:

TABLE 8.1
DIAGNOSTIC STATISTICS FOR TARGET VARIABLES BASED ON MODEL SIMULATION

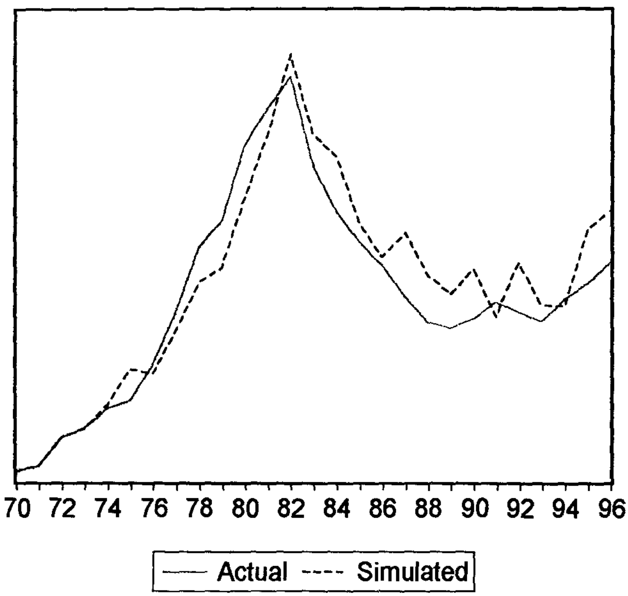
Variable	Theil U	UM	UR	UD
GDPMP	0.0518	0.1196	0.0455	0.8349
UNEMP_RATE	0.1494	0.1024	0.0177	0.8798
EXCHAVG	0.1697	0.0499	0.7480	0.2021
CPI85	0.0691	0.6627	0.1609	0.1764

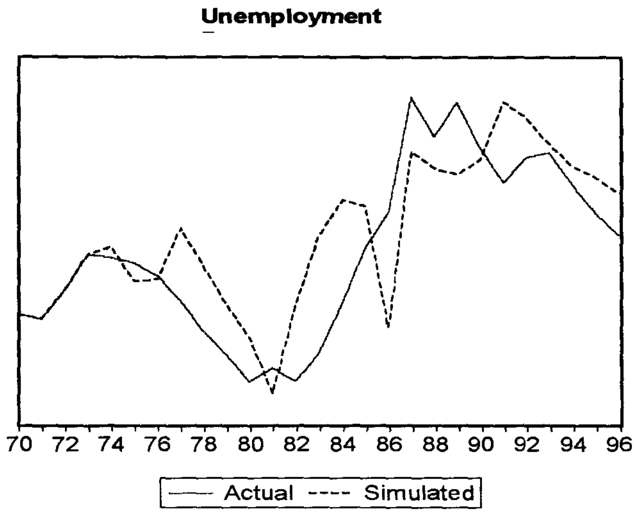
The Theil *U* statistic is very reasonable in the case of real GDP (GDPMP) and the Retail Price Index (CPI85) and is less than 0.2 for the unemployment and nominal exchange rates. The decomposition is very good in the first two cases, less so in the third and even less so in the fourth.

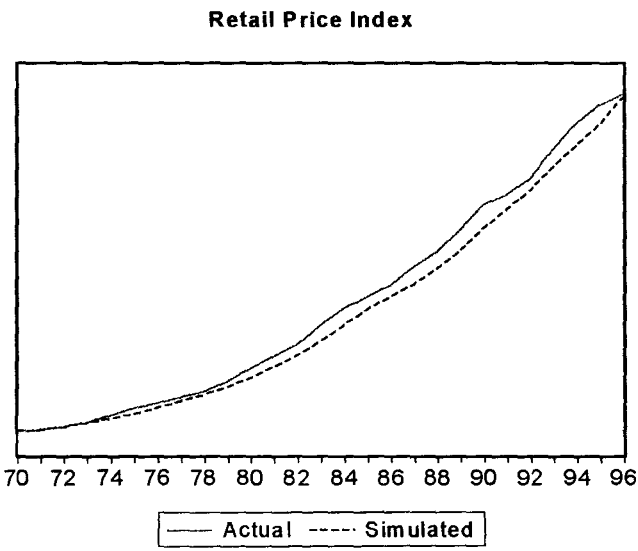
It is always useful to accompany the use of these summary statistics with an examination of the graphical plot of the paths of the observed and simulated values. This is considered in Figure 8.1 below:

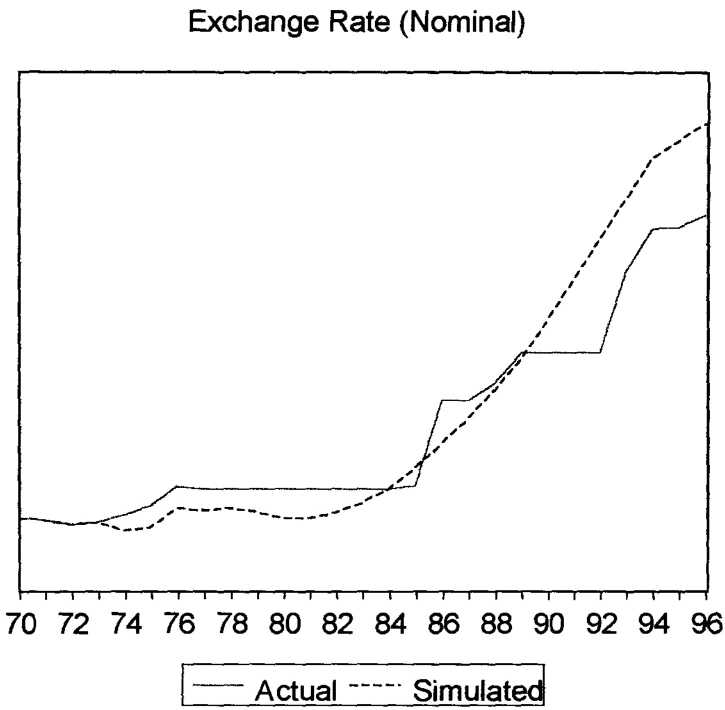
FIGURE 8.1
GRAPHICAL PLOTS OF ACTUAL AND SIMULATED VALUES FOR KEY TARGET VARIABLES

GDP




Unemployment
70
72
74
76
78
80
82
84
86
88
90
92
94
96
Actual
Simulated


Retail Price Index
70
72
74
76
78
80
82
84
86
88
90
92
94
96
Actual
Simulated



The above plots present a generally more appealing picture and give us greater confidence in the fitted model.

5. Policy Implications

The usefulness of the model for informing policy measures is determined within the framework of the dynamic response of the model (or "multiplier" analysis). Multipliers and elasticities are used to measure the dynamic response of endogenous variables in the system to unit changes in selected exogenous variables, in this case the policy variables. The size and direction of these responses indicate whether the model is responding to stimuli in a way that is economically meaningful and are also fairly reliable indicators of the impact of shocks on target endogenous variables. We have a greater interest in the resulting effects on rates of growth of the target variables, and not their levels. The elasticity concept does this and is measured as:

$$ELAST = [log(Y_s / Y_a)] \div [log(X_s / X_a)]$$

where Y_s is the simulated and Y_a the actual (observed) endogenous variable values and X_s and X_a the corresponding exogenous variable values. In Tables 8.2-8.7 below, elasticities are displayed for *GDPMP, UNEMP_RATE, EXCHAVG,* and *CPI85* with the relevant policies variables which are being evaluated.

TABLE 8.2
ELASTICITIES BASED ON SHOCKS TO OIL_CORP_RATE

YEAR	GDPMP	UNEMP_RATE	EXCHAVG	CPI85
1	-0.02885	0.00799	-0.00027	-0.00027
2	-0.07383	0.02888	-0.00192	-0.00193
3	-0.08149	0.04018	-0.00598	-0.00599
4	-0.08347	0.05428	-0.01066	-0.01077
5	-0.08744	0.06829	-0.01569	-0.01607
6	-0.09072	0.07133	-0.02073	-0.02163
7	-0.10549	0.10904	-0.02395	-0.02594
8	-0.11793	0.11282	-0.02753	-0.03117
9	-0.11431	0.11733	-0.03293	-0.03923
10	-0.09518	0.09809	-0.03776	-0.04850
11	-0.07752	0.06730	-0.04333	-0.06056
12	-0.06129	0.06982	-0.05039	-0.07554
13	-0.05063	0.08767	-0.06086	-0.08937
14	-0.04368	0.07113	-0.05850	-0.10116
15	-0.03630	0.07765	-0.06051	-0.11415
16	-0.02862	0.07533	-0.05258	-0.11954
17	-0.01962	0.07078	-0.03329	-0.12264
18	-0.01870	0.07370	-0.01664	-0.12660
19	-0.00711	0.06881	0.00610	-0.12595
20	-0.00558	0.06406	0.00472	-0.12072
21	0.00412	0.06226	0.02254	-0.11633
22	0.01141	0.04366	0.04189	-0.11167
23	0.01202	0.03311	0.04929	-0.10732

TABLE 8.3
ELASTICITIES BASED ON SHOCKS TO SALESTAX_RATE

YEAR	GDPMP	UNEMP_RATE	EXCHAVG	CPI85
1	-0.00158	0.00224	0.00008	0.00008
2	-0.00338	0.00426	0.00137	0.00136
3	-0.00376	0.00537	0.00128	0.00130
4	-0.00332	0.00904	-0.00282	-0.00276
5	-0.00409	0.01087	-0.00284	-0.00283
6	-0.00371	0.00895	-0.00240	-0.00247
7	-0.00305	0.00987	-0.00112	-0.00133
8	-0.00277	0.00885	-0.00163	-0.00194
9	-0.00352	0.00894	-0.00178	-0.00228
10	-0.00522	0.00742	0.00115	0.00038
11	-0.00700	0.00128	0.00868	0.00783
12	-0.00646	0.00132	0.00825	0.00819
13	-0.00897	0.00467	0.00636	0.00751
14	-0.01132	0.00403	0.00733	0.00991
15	-0.01219	0.00780	-0.00037	0.00356
16	-0.01177	0.00972	-0.00495	0.00014
17	-0.01610	-0.00661	0.03180	0.03800
18	-0.01418	-0.00841	0.02359	0.03393
19	-0.02061	0.00487	0.00377	0.01937
20	-0.03023	0.00900	0.00355	0.02012
21	-0.02842	0.00639	-0.00099	0.01942
22	-0.02831	0.00989	-0.01356	0.01088
23	-0.03062	0.01174	-0.01729	0.00834

TABLE 8.4
ELASTICITIES BASED ON SHOCKS TO TAX_INC_C_RATE

YEAR	GDPMP	UNEMP_RATE	EXCHAVG	CPI85
1	-0.00206	0.00038	-0.00002	-0.00002
2	-0.00527	0.00140	-0.00013	-0.00014
3	-0.00506	0.00192	-0.00039	-0.00040
4	-0.00991	0.00435	-0.00075	-0.00076
5	-0.01258	0.00761	-0.00135	-0.00138
6	-0.01303	0.00920	-0.00208	-0.00215
7	-0.01234	0.01304	-0.00262	-0.00280
8	-0.01402	0.01308	-0.00308	-0.00343
9	-0.01735	0.01502	-0.00379	-0.00443
10	-0.02017	0.01611	-0.00475	-0.00587
11	-0.01836	0.01288	-0.00623	-0.00810
12	-0.01508	0.01325	-0.00816	-0.01103
13	-0.01399	0.01662	-0.01053	-0.01399
14	-0.01197	0.01366	-0.01131	-0.01681
15	-0.01233	0.01564	-0.01266	-0.01994
16	-0.00997	0.01556	-0.01226	-0.02180
17	-0.00778	0.01491	-0.00972	-0.02308
18	-0.00675	0.01558	-0.00725	-0.02452
19	-0.00668	0.01537	-0.00349	-0.02514
20	-0.01044	0.01590	-0.00367	-0.02498
21	-0.00815	0.01657	-0.00077	-0.02520
22	-0.00697	0.01340	0.00238	-0.02539
23	-0.00752	0.01244	0.00321	-0.02593

TABLE 8.5
ELASTICITIES BASED ON SHOCKS TO TAX_INC_I_RATE

YEAR	GDPMP	UNEMP_RATE	EXCHAVG	CPI85
1	-0.01373	0.00052	0.00473	0.00474
2	-0.02145	0.00678	-0.00006	-0.00007
3	-0.02892	0.01612	-0.00632	-0.00610
4	-0.03118	0.03083	-0.01432	-0.01406
5	-0.03132	0.04538	-0.02315	-0.02313
6	-0.03668	0.04970	-0.02807	-0.02873
7	-0.03753	0.07417	-0.03109	-0.03345
8	-0.04247	0.07829	-0.03756	-0.04219
9	-0.05713	0.09101	-0.04331	-0.05169
10	-0.07139	0.09516	-0.04746	-0.06150
11	-0.07108	0.08603	-0.05824	-0.07984
12	-0.06784	0.10006	-0.07511	-0.10443
13	-0.06486	0.13125	-0.10293	-0.13312
14	-0.05475	0.11248	-0.11347	-0.15916
15	-0.05662	0.13017	-0.12485	-0.18476
16	-0.04157	0.13331	-0.12556	-0.20413
17	-0.02104	0.13266	-0.10745	-0.21966
18	-0.01312	0.13879	-0.08199	-0.22998
19	-0.01063	0.13247	-0.04036	-0.22822
20	-0.01753	0.12834	-0.03543	-0.22227
21	-0.00466	0.13195	-0.00782	-0.22126
22	0.01080	0.10429	0.01696	-0.22241
23	0.01790	0.09000	0.02240	-0.22414

TABLE 8.6
ELASTICITIES BASED ON SHOCKS TO TAX_TRADE_RATE

YEAR	GDPMP	UNEMP_RATE	EXCHAVG	CPI85
1	-0.00509	0.00746	-0.00061	-0.00062
2	-0.01352	0.01887	-0.00263	-0.00319
3	-0.01754	0.02781	-0.00509	-0.00737
4	-0.01916	0.04213	-0.00692	-0.01244
5	-0.02339	0.05701	-0.00776	-0.01835
6	-0.02371	0.05860	-0.00616	-0.02416
7	-0.02086	0.08316	-0.00004	-0.02848
8	-0.01820	0.07713	0.01086	-0.03219
9	-0.02082	0.07681	0.02647	-0.03687
10	-0.02155	0.06893	0.05276	-0.04205
11	-0.01295	0.04805	0.07950	-0.04917
12	-0.01124	0.05609	0.09918	-0.05841
13	-0.01609	0.07467	0.08513	-0.06964
14	-0.00372	0.05829	0.12228	-0.08058
15	0.00509	0.06087	0.13646	-0.09013
16	0.01440	0.05462	0.15890	-0.09166
17	0.02764	0.04563	0.20587	-0.08941
18	0.02460	0.04792	0.23319	-0.08702
19	0.03659	0.04152	0.26590	-0.08256
20	0.02836	0.03806	0.22792	-0.07625
21	0.03712	0.03416	0.24268	-0.07206
22	0.05432	0.01287	0.26960	-0.06437
23	0.05554	-0.00412	0.27351	-0.05217

TABLE 8.7
ELASTICITIES BASED ON SHOCKS TO TBR

YEAR	GDPMP	UNEMP_RATE	EXCHAVG	CPI85
1	-0.00000	0.00000	-0.00000	-0.00000
2	-0.01156	0.00334	-0.00018	-0.00019
3	-0.01718	0.00751	-0.00102	-0.00102
4	-0.02034	0.01253	-0.00219	-0.00222
5	-0.02230	0.01739	-0.00376	-0.00384
6	-0.02178	0.01853	-0.00528	-0.00548
7	-0.02001	0.02543	-0.00630	-0.00676
8	-0.02079	0.02414	-0.00709	-0.00798
9	-0.02113	0.02486	-0.00820	-0.00978
10	-0.02154	0.02261	-0.00916	-0.01185
11	-0.02225	0.01795	-0.01034	-0.01464
12	-0.02210	0.02013	-0.01228	-0.01851
13	-0.02345	0.02678	-0.01580	-0.02282
14	-0.02536	0.02367	-0.01711	-0.02766
15	-0.03062	0.02930	-0.02051	-0.03396
16	-0.03270	0.03212	-0.02168	-0.03887
17	-0.03495	0.03465	-0.01964	-0.04348
18	-0.03731	0.04035	-0.01865	-0.04951
19	-0.03962	0.04473	-0.01654	-0.05570
20	-0.05025	0.05111	-0.02143	-0.06092
21	-0.04871	0.05805	-0.02074	-0.06733
22	-0.04660	0.05241	-0.01923	-0.07373
23	-0.04062	0.05115	-0.02135	-0.08135

The responses shown in Tables 8.2-8.7 present no surprises from an economic point of view. Consider first the responses of income *(GDPMP)* to fiscal stimuli highlighted in Tables 8.2-8.6. In all cases, income will increase following a tax cut (the tables show that it will decrease following an increase in taxes). For a sustained 1% cut in the corporation tax rate in the oil sector, income rises by 0.087% after 5 years and 0.078% after 10 years. For a similar cut in personal income taxes, income rises by 0.031% and 0.071% after 10 years. For the other taxes, the response is smaller and, in some cases, it is quite small. Fiscal policy aiming to affect income should therefore be based largely on the first two instruments.

Does the evidence provided here support the theory that, in the long run, expansionary fiscal measures (tax cuts) will not achieve the goal of higher income and low unemployment? Technically, yes, since some 20 years of sustained tax cuts will eventually result in falling incomes *and* unemployment rates. The reason why a rising income level is not sustained in the long run is primarily due to the variations of the exchange rate. Consider Table 8.2: a steady depreciation[1] of the exchange rate accompanies rising incomes resulting from a tax cut. It is only when the rate begins to appreciate that income begins to fall. But the so-called long run is very far off (about 20 years) and is hardly likely to be of major concern to a policy maker. That the theory is proven to be correct is likely to be no impediment in practice to economic policy makers.

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1 The negative exchange rate elasticities indicate an *appreciation* of the currency since the exchange rate is expressed in TT dollars for US$1.00.

A government which seeks to alleviate the unemployment problem in a climate of expanding economic activity should therefore seek to lower (oil and personal income) taxes. It must, however, live with the undesirable consequences of rising prices and a deterioration in the exchange rate.

What about expansionary monetary policy measures, more specifically, variations in the Treasury Bill Rate (TBR)? Table 8.7 shows the effects of a sustained 1% rise (and so also a 1% fall) in the TBR on the key economic indicators. This will result in an immediate and sustained increase in incomes and employment, as well as a sustained depreciation in the exchange rates and rising prices. After 5 years, it will raise output by 0.031% (compared to 0.087% for a similar cut in oil taxes) and will achieve this objective with an increase in prices of 0.005% (compared to 0.016% for a similar cut in oil taxes). Both measures will result in a depreciation of the TT dollar: by 0.016% for the fiscal measure and by 0.005% for the monetary policy measure. A policy maker may well decide to forego more rapid growth resulting from the fiscal measure in order to have a more stable price level and exchange rate. This seems to support the view that monetary policy may provide a more stable climate for growing incomes and employment levels.

Fiscal measures, however, have a considerably more significant impact on employment levels in the short to medium term. After 5 years, a sustained 1% cut in income taxes will lower the unemployment rate by 0.045% and a similar cut in oil taxes lowers the unemployment rate by 0.068%. A 1% cut in the Treasury Bill rate, however, reduces the unemployment rate by only 0.017%. In a climate where unemployment can become an explosive issue, policy makers may wish to offer some palliative in this direction and lean in the direction of fiscal policy measures.

6. The Forecasting Process

This section deals principally with the "how" of making projections and the caveats to employ in basing policy recommendations on the results obtained. As is typical of econometric models in general, projections of future values of endogenous variables presuppose knowledge of, or assumptions about the exogenous variables in the system. This is not an easy problem to resolve, and is tantamount to carrying out a projection exercise within another one. Of course, some variables are easier to deal with than others. This is particularly the case of policy instruments that are under the direct control of the public authorities. Life would be very simple if these were the only variables that mattered, but this is simply not the case. The prediction of the price of oil, in particular, is an exercise fraught with danger and has been the undoing of many a professional economist.

There is another, though related, complication. Forecasting requires that the model be solved to obtain future values of the key endogenous variables. This requires in turn that values associated with the exogenous variables in the model be available in the future up to the point of the forecast horizon. But not only is information on future values not available, data on *current* values are unavailable. In fact, it was quite an exercise getting a coherent annual data set up to 1996 to estimate the coefficients of the model although the exercise is being conducted in 1998. To be of practical importance to policy makers, the model must provide forecasts for 1999 and beyond, but in order to do so it must generate forecasts first of the past and present (1997-8) then of the future (1999 and beyond). The forecasts being used by policy makers will be themselves based on forecasts.

The problem of projecting the exogenous variables does not, however, invalidate the forecasting exercise. Rather, it highlights the options and dilemmas of the policy maker. Using the model as part of the policy-making process forces one to be consistent and explicit in making assumptions about the future. Such analytical rigour is an advantage in itself. Moreover, to the extent that the outcome of a policy package is highly dependent on the behaviour of an uncontrollable exogenous variable, such as the price of oil, policy makers may wish to run simulations on the basis of different scenarios. This would thus permit some degree of "contingency" planning given the uncertainties of the economic environment.

The forecasting accuracy of models like the one developed in this paper is often the principal criterion used to determine their relative usefulness. It is often claimed that the better forecasting performance of the pure time series models, like ARIMA and VAR models, make the latter much more suitable to the task at hand. Moreover, the process of their construction and validation is much more straightforward and their data requirements considerably less. In particular, the problem of forecasting "exogenous" variables does not arise.

Is it worth the effort, then, to construct and use a SEM? Does it not appear that, even before we start, we would probably do better to forecast using alternative methods whose data requirements are not so stringent? One major advantage in retaining the use of the SEM is that the forecasting will be done in an internally consistent accounting framework. Knowledge of a forecast value, without knowing how it relates to another, can be a hazard in the proper preparation and implementation of policy packages.

This model, like any other, cannot give unconditional predictions about the future of the Trinidad and Tobago economy. The usefulness of its projections will be proportional to the time spent in careful preparation of exogenous assumptions. Even with well chosen exogenous assumptions, the predictions made by the model will not be perfect. Nevertheless, they can act as a guide to the general evolution of the economy under a set of policy assumptions. Different policy packages can be contrasted and evaluated. Such a procedure is a clear advance on direct experimentation on a real economy.

7. Conclusion

The model used in this paper appears to be well supported by the data. This lends some credence to the econometric methodology employed. There is no clear conclusion to the fiscal-monetary policy debate – the theory holds but only in a lengthy and unrealsitic time frame. The policy measures to be adopted are likely to depend a lot on the shorter run objectives set by the political directorate. Fiscal measures seem to do very well in attaining unemployment and income targets but tend to pay the price of more rapidly deteriorating exchange rates and rising prices. Monetary policy measures tend to find a happy medium: reasonably good income and employment levels accompanied by tolerable exchange and inflation rates. Of course, our study is limited by the fact that only one instrument at a time is used: a more coherent and realistic policy package would include a group of policy instruments acting in unison on the targets.

The forecasting exercise to be based on the solution of this model is not, however, without its own intrinsic complications. We are nevertheless assured that an internally coherent set of forecasts is generated and these go some way in assuring that contradictory policy measures will not be adopted.

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Appendix 8.1
Principal Identities and Equations of the Model

Aggregate Expenditure

Identities

GDPMP = PFCE + GFCE + GCF + XGNFS - MGNFS (1)

GDPMP$ = PFCE$ + GFCE$ + GCF$ + XGNFS$ - MGNFS$ (2)

FCE$ = PFCE$ + GFCE$ (3)

PFCE$ = PFCE * PFCEDEF (4)

GFCE$ = GFCE * GFCEDEF (5)

GCF$ = GCF * GCFDEF (6)

GCF$ = GCFIXED$ + STOCK_GOV$ + STOCK_PRI$ (7)

GCF_FIXED$ = GCFP_FIXED$ + GCFG_FIXED$ (8)

GCFP_FIXED$ = GCFP_FIXED * GCFDEF (9)

GDPFC$ = GDPMP$ - IT_PLUS_VAT$ + SUBS$ (10)

GDPFC=GDPFC$/GDPMPDEF (11)

GSAVD$ = GCF$ + XGNFS$ - MGNFS$ (12)

GDI$ = GDPMP$+ (XFY$ - MFY$) + (XUT$ - MUT$) (13)

GSAVN$ = GDI$ - FCE$ (14)

NDI$ = GDI$ - DEP$ (15)

Behavioural Equations

Private Consumption (16)

log(pfce)

= 0.43916 * log(pfce)[-1] + 0.43786 * log(pri_disp) + 1.00969

(3.85498) 4.71388) (1.72428)

Sum Sq	0.1121	Std Err	0.0684	LHS Mean	9.0728
R Sq	0.8970	R Bar Sq	0.8884	F 2, 24	104.459
D.W.(1)	1.8481	D.W.(2)	1.9114		
H	0.4175				

Private Fixed Investment (17)

log(gcfp_fixed)

= 0.68173 * log(gcfp_fixed)[-1] - 1.66740 * tbr_r[-1] + 2.26247
(5.84043) (1.83699) (2.74365)

Sum Sq	0.8693	Std Err	0.1944	LHS Mean	7.2951
R Sq	0.7598	R Bar Sq	0.7389	F 2, 23	36.3703
D.W.(1)	1.2480	D.W.(2)	2.0830		
H	2.3687				

BALANCE OF PAYMENTS (CURRENT ACCOUNT)

IDENTITIES

XG= XG3 + XGX3 (18)

XG3$= XG3 * XG3DEF (19)

XGX3$= XGX3 * XGX3DEF (20)

XG$= XG3$ + XGX3$ (21)

XGNFS$= XG$ + XNFS$ (22)

XNFS$= XNFS * XNFSDEF (23)

XT$ = XGNFS$ + XFY$ + XUT$ (24)

MG = MCONS_DUR + MCONS_NONDUR +
MCAPGOODS + MINTER + MOTHCOMM (25)

MCONS_DUR$ = MCONS_DUR * MCONS_DUR_DEF (26)

MCONS_NONDUR$ = MCONS_NONDUR *
MCONS_NDUR_DEF (27)

MCONS$ = MCONS_DUR$ + MCONS_NONDUR$ (28)

MCAPGOODS$ = MCAPGOODS * MCAP_DEF (29)

MINTER$ = MINTER * MINT_DEF (30)

MG$ = MG * MGDEF (31)

MGNFS$ = MG$ + MNFS$ (32)

MGNFS = MG + MNFS (33)

MT$ = MGNFS$ + MFY$ + MUT$ (34)

MFY$ = FDINT$ + MOTHFY$ (35)

CAB$ = XT$ - MT$ (36)

BEHAVIOURAL EQUATIONS

Non Oil Exports (37)

log(xgx3)

= 0.24831 * log(xgx3)[-1] + 1.14817 * log(us_gdp)[-1]
(1.28255) (2.90158)

- 0.66381 * log(xgx3def/(us_indp85*exchavg)) - 7.86523
(4.19709) (2.95885)

Sum Sq	0.5061	Std Err	0.1632	LHS Mean	6.8858
R Sq	0.9075	R Bar Sq	0.8929	F 3, 19	62.1444
D.W.(1)	2.4377	D.W.(2)	1.6108		
H	-3.0678				

Imports of Durable Consumer Goods (38)

log(mcons_dur)

= 0.40194 * log(mcons_dur)[-1] - 1.08759 * log(mcons_dur_def)
(2.41009) (4.40069)

+ 0.72161 * log(mcons_dur_def)[-1] + 0.61868 * log(per_disp)
(3.22858) 2.11037)

- 1.82603
(0.90914)

Sum Sq	0.8624	Std Err	0.2189	LHS Mean	5.9717
R Sq	0.8253	R Bar Sq	0.7865	F 4, 18	21.2628
D.W.(1)	2.6486	D.W.(2)	1.7171		
H	-2.8563				

Imports of Non Durable Consumer Goods (39)

log(mcons_nondur)

= 0.56186 * log(mcons_nondur)[-1] + 0.83819 * log(gdpmp)
(3.85902) (2.33724)

- 5.27608
(1.79327)

Sum Sq	0.4581	Std Err	0.1513	LHS Mean	6.5721
R Sq	0.7488	R Bar Sq	0.7237	F 2, 20	29.8068
D.W.(1)	1.5665	D.W.(2)	1.6917		
H	1.0743				

Imports of Capital Goods (40)

log(mcapgoods)

= 4.93651 * log(gdpmp)[-1] - 2.64471 * log(gdpmp)[-2] - 15.7214
(3.43144) (2.01110) (3.34285)

Sum Sq	2.2058	Std Err	0.3241	LHS Mean	6.6176
R Sq	0.5447	R Bar Sq	0.5014	F 2, 21	12.5635
D.W.(1)	1.5897	D.W.(2)	1.7536		

Imports of Raw Materials and International Goods (41)

log(minter)

= 0.54134 * log(minter)[-1] - 0.45329 * log(mint_def)
(3.78183) (1.85934)

+ 0.81601 * log(mint_def)[-1] + 3.00117
(3.28997) (3.27637)

Sum Sq	1.0583	Std Err	0.2360	LHS Mean	6.7238
R Sq	0.6915	R Bar Sq	0.6428	F 3, 19	14.1980
D.W.(1)	2.5186	D.W.(2)	1.8621		
H	-1.7105				

PUBLIC SECTOR

IDENTITIES

GCEXP$ = GFCE$ + SUBS$ + DINT$ + TRANS$ + OTHEXP_GOV$ (42)

GFCE$ = COMP_GOV$ + NGEG$ + GDEP$ (43)

DINT$ = MCGFINT$ + CGDINT$ (44)

FDINT$ = MCGFINT$ + MSEFINT$ (45)

CGDINT$ = CGINTRATE * AVINTDEBT$ (46)

MCGFINT$ = MCGFRATE * AVCGEXTDEBT$ (47)

MSEFINT$ = MSEFRATE * AVSEEXTDEBT$ (48)

GCREV$ = OILREV$ + NOILREV$ (49)

OILREV$ = OILTAX_CORP$ + OILTAX_ROY$ + OILREV_OTH$ (50)

OILTAX_CORP$ = OIL_CORP_RATE * (OS_G_OIL$ + OS_G_OIL$-1) / 2 (51)

OILTAX_ROY$ = (OS_G_OIL$ + OS_G_OIL$-1) / 2 *
OIL_ROY_RATE (52)

OILREV_OTH$ = (OS_G_OIL$ + OS_G_OIL$-1) / 2 *
O_OTH_TAX_RATE (53)

NOILREV$ = IT_PLUS_VAT$ + OCF$ +NOILTAX_INC$+
NOILTAX_PROP$ + NOIL_OTHREV$ (54)

IT_PLUS_VAT$ = SALESTAX$ + NOILTAX_TRADE$+
OTHIT$ (55)

SALESTAX$ = SALESTAX_RATE * (FCE$ +FCE$-1)/ 2 (56)

NOILTAX_TRADE$ = TAX_TRADE_RATE *
(MG$+MG$-1) / 2 (57)

NOILTAX_INC$ = NOILTAX_INC_C$ +NOILTAX_INC_I$ +
NOILTAX_OTHINC$ (58)

NOILTAX_INC_C$ = TAX_INC_C_RATE *
((OS_G$-OS_G_OIL$) + (OS_G$-1-OS_G_OIL$-1)) / 2 (59)

NOILTAX_INC_I$ = TAX_INC_I_RATE *
(COMP$ +COMP$-1) / 2 (60)

NOILTAX_OTHINC$ = ((GDPFC$ - GDPFC_OIL$) +
(GDPFC$-1 - GDPFC_OIL$-1)) / 2 *
OTHINC_TAX_RATE (61)

NOILTAX_PROP$ = ((GDPFC$ - GDPFC_OIL$) +
(GDPFC$-1 - GDPFC_OIL$-1)) / 2 *
PROP_TAX_RATE (62)

NOIL_OTHREV$ = ((GDPFC$ - GDPFC_OIL$) +
(GDPFC$-1 - GDPFC_OIL$-1)) / 2 *
N_OTH_TAX_RATE (63)

SAVG$ = GCREV$ - GCEXP$ (64)

CGBR$ = - SAVG$ - GCAPREV_CB$ + GCFGIXED$ +
STOCK_GOV$ + CAP_ADJ$ (65)

FINANCIAL SYSTEM

IDENTITIES

CGBR$ = DCGTOTDEBT$ (66)

CGTOTDEBT$ = CGINTDEBT$ + CGEXTDEBT$ (67)

DCGINTDEBT$ = DNONBCRED$ +DCOMCRED$
+DCBDEPOS$+DCBCRED$ (68)

DCGBDEBT$ = DCBCRED$ + DCOMCRED$ +DCBDEPOS$ (69)

DCGEXTDEBT$ = DCGBOPDEBT$ +DCGNBOPDEBT$ (70)

SETOTDEBT$ = SEDEBT$ + SEEXTDEBT$+
OPUBEXTASS$-CGNBOPDEBT$ (71)

SEBR$= DSETOTDEBT$ (72)

DEXTDEBT$ = DCGEXTDEBT$ + DSEEXTDEBT$ +
DCBEXTDEBT$ (73)

PRIBR$= PFCE$ + GCFPIXED$ + STOCK_PRI$ - PRI_DISP$ (74)

DPRIDEBT$ = PRIBR$ + DMON$ + DQMON$ +
DOTHLIAB$ + DNONBCRED$ - DFI$ -
DOPRIEXTASS$ - DOERR$ (75)

DTOTLIAB$ = DMON$ + DQMON$ + DOTHLIAB$ (76)

DOMFA$ = MON$ + QMON$ (77)

DDOMFA$=PDFA_PER * PER_DISP$ (78)

PMON = MON$ / DOMFA$ (79)

DDOMCRED$ = DCGBDEBT$ + DSEDEBT$ +DPRIDEBT$ (80)

DRES$ = CAB$ + DEXTDEBT$ + DOTHEXTASS$ +DEAO$ (81)

DOTHEXTASS$ = DFI$ + DOPRIEXTASS$ +
DOPUBEXTASS$ + DOADJEXT$ (82)

DEAO$ = - DNRES$ + DOERR$ (83)

DEXTASS$ = DRES$ + DNRES$ (84)

DTOTASS$ = DEXTASS$ + DDOMCRED$ (85)

TOTASS$ = TOTLIAB$ (86)

DOADJEXT$ = - DCBEXTDEBT$ - DCGNBOPDEBT$ (87)

DOPRIEXTASS$ = DEXTFA$ -DOERR$ (88)

DEXTFA$ = PEFA_PER * PER_DISP$ (89)

AVINTDEBT$ = ((CGINTDEBT$ - CBDEPOS$) +
(CGINTDEBT$-1 - CBDEPOS$-1)) / 2 (90)

AVCGEXTDEBT$ = (EXTDEBT$ +EXTDEBT$-1) / 2 (91)

AVSEEXTDEBT$ = (SEEXTDEBT$ +SEEXTDEBT$-1) / 2 (92)

IR_LR= (1 + IR_L/100) / (CPI85/CPI85-1) -1 (93)

TBR_R= (1 + TBR) / (CPI85/CPI85-1) -1 (94)

BEHAVIOURAL EQUATIONS

Proportion of Personal Disposable Income used for Acquisition of Financial Assets (95)

pdfa_per

= 0.24071 * (os_g$/(os_g$+comp$))
(1.61709)

\+ 0.43313 * (os_g$/(os_g$+comp$))[-1]
(2.82709)

\+ 0.62486 * (domfa$/(per_disp$))
(3.11296)

\- 0.75622 * (domfa$/(per_disp$))[-1] - 0.14885
(4.27717) (1.89837)

Sum Sq	0.0244	Std Err	0.0333	LHS Mean	0.0858
R Sq	0.7881	R Bar Sq	0.7495	F 4, 22	20.4527
D.W.(1)	2.1709	D.W.(2)	2.6338		

Proportion of Domestic Assets held as Money (M1) (96)

log(pmon)

= 0.58444 * log(pmon)[-1] + 0.68981 * Dlog(per_disp)
(5.33685) (3.89561)

- 0.27124 * tbr_r[-1] - 0.60970
(0.91615) (3.87926)

Sum Sq	0.1425	Std Err	0.0787	LHS Mean	-1.4090
R Sq	0.7463	R Bar Sq	0.7132	F 3, 23	22.5492
D.W.(1)	2.2509	D.W.(2)	1.7340		
H	-0.8164				

Other Liabilities of the Banking Sector (97)

(othliab$/cpi85)

= 0.63052 * (othliab$/cpi85)[-1] + 0.13190 * (domfa$/cpi85)
(4.71874) (2.00897)

- 221.483
(0.77570)

Sum Sq	3491553	Std Err	381.420	LHS Mean	1454.40
R Sq	0.8117	R Bar Sq	0.7960	F 2, 24	51.7318
D.W.(1)	1.7174	D.W.(2)	2.3612		
H	1.0097				

Direct Foreign Investment (98)

log(dfi$/mcap_def)

= 0.64682 * log(dfi$/mcap_def)[-1] + 1.05699 * log(reexch)
(3.93744) (1.40627)

+0.77730
(0.76816)

Sum Sq	4.9942	Std Err	0.4997	LHS Mean	5.7175
R Sq	0.5654	R Bar Sq	0.5219	F 2, 20	13.0078
D.W.(1)	1.7476	D.W.(2)	1.9906		
H	0.8070				

PRICES, INCOME, OUTPUT, EMPLOYMENT

IDENTITIES

GDPMPDEF = GDPMP$ / GDPMP (99)

XGNFSDEF = XGNFS$ / XGNFS (100)

XG3DEF = OILP_RAT * (OILP_EXT * EXCHAVG) (101)

XGDEF = XG$ / XG (102)

REEXCH = (USPPI * EXCHAVG) / CPI85 (103)

COMP$ = COMP_GOV$ + COMP_OIL$ +
COMP_MANUF$ + COMP_OTH$ (104)

COMP_GOV$ = AVWAG_GOV$ * EMP_GOV (105)

COMP_OIL$ = AVWAG_OIL$ * EMP_OIL (106)

COMP_MANUF$ = AVWAG_MANUF$ * EMP_MANUF (107)

COMP_OTH$ = AVWAG_OTH$ * EMP_OTH (108)

OS_G_OIL$ = GDPFC_OIL$ - COMP_OIL$ (109)

OS_G_MANUF$ = GDPFC_MANUF$ - COMP_MANUF$ (110)

OS_G_OTH$ = GDPFC_OTH$ - COMP_OTH$ (111)

OS_G$ = OS_G_OIL$ + OS_G_MANUF$ + OS_G_OTH$ (112)

PER_DISP$ = COMP$ +TRANS$ - OCF$ - NOILTAX_INC_I$ (113)

PER_DISP = PER_DISP$ / CPI85 (114)

OSDISP$ = OS_G$ - OILTAX_CORP$ - NOILTAX_INC_C$ (115)

PRI_DISP$ = PER_DISP$+PP_OS * OSDISP$ (116)

PRI_DISP = PRI_DISP$ / CPI85 (117)

GDPFC_OIL$ = GDPFC_OIL * GDPMP_OIL_DEF (118)

GDPFC_MANUF$ = GDPFC_MANUF * GDPMP_MAN_DEF (119)

GDPFC_OTH$ = GDPFC_OTH * GDPFC_OTH_DEF (120)

GDPFC$ = GDPFC_MANUF$ + GDPFC_OIL$ +
GDPFC_OTH$ + COMP_GOV$ + GDEP$ (121)

EMPTOT = EMP_GOV + EMP_OIL + EMP_MANUF +
EMP_OTH (122)

UNEMP_RATE = 1 - (EMPTOT / LABF) (123)

EXCHAVG = REEXCH*(CPI85/USPPI) (124)

BEHAVIOURAL EQUATIONS

Retail Price Index (125)

log(cpi85/(1+salestax_rate))

= 0.89778 * log(cpi85/(1+salestax_rate))[-1]
(32.1371)

+ 0.06910 * log(domfa_s$) - 0.52282
(2.88730) (2.46293)

Sum Sq	0.0245	Std Err	0.0327	LHS Mean	-0.3220
R Sq	0.9985	R Bar Sq	0.9984	F 2, 23	7775.34
D.W.(1)	1.1887	D.W.(2)	2.4441		
H	1.5534				

Private Final Consumption Expenditure Deflator (126)

log(pfcedef)

= 0.66283 * log(pfcedef)[-1] + 1.26558 * log(cpi85)
(4.18157) (3.28790)

- 0.93258 * log(cpi85)[-1] - 0.02518
(2.65420) (0.63474)

Sum Sq	0.1287	Std Err	0.0748	LHS Mean	-0.3464
R Sq	0.9932	R Bar Sq	0.9923	F 3, 23	1122.64
D.W.(1)	1.9446	D.W.(2)	2.2003		
H	0.0084				

General Government Final Consumption Expenditure Deflator (127)

log(gfcedef)

= 0.16994 * log(gfcedef)[-1] + 0.65184 * log(avwag_gov$)
(2.24751) (10.1982)

- 2.33660
(10.0057)

Sum Sq	0.0630	Std Err	0.0524	LHS Mean	-0.4443
R Sq	0.9936	R Bar Sq	0.9931	F 2, 23	1796.73
D.W.(1)	1.7783	D.W.(2)	2.4887		
H	0.4912				

Gross Capital Formation Deflator (128)

log(gcfdef)

= 0.47648 * log(gcfdef)[-1] + 0.57218 * log(mcap_def) - 0.08760
(4.01533) 4.30188) (1.95667)

Sum Sq	0.1492	Std Err	0.0843	LHS Mean	0.0892
R Sq	0.9852	R Bar Sq	0.9838	F 2, 21	699.410

D.W.(1)	2.0717	D.W.(2)	1.2285
H	-0.4925		

Imports of Consumer Non-Durable Goods Deflator (129)

log((mcons_ndur_def)/(1+tax_trade_rate))

= 0.41857 * log((mcons_ndur_def)/(1+tax_trade_rate))[-1]
(2.67917)

+ 0.23513 * log(usppi*exchavg) - 0.09103
(2.53419) (1.07554)

Sum Sq	0.4433	Std Err	0.1489	LHS Mean	0.2438
R Sq	0.7897	R Bar Sq	0.7687	F 2, 20	37.5593
D.W.(1)	1.4403	D.W.(2)	2.1505		
H	1.9495				

Imports of Consumer Durable Goods Deflator (130)

log(mcons_dur_def/(1+tax_trade_rate))

= 0.31053 * log(mcons_dur_def/(1+tax_trade_rate))[-1]
(1.93358)

+ 0.40029 * log(usppi*exchavg)[-1] -0.22811
(3.01580) (1.86867)

Sum Sq	0.7179	Std Err	0.1895	LHS Mean	0.2072
R Sq	0.8233	R Bar Sq	0.8056	F 2, 20	46.5879
D.W.(1)	1.8655	D.W.(2)	2.0850		
H	0.4775				

Imports of Raw Materials and International Goods Deflator (131)

log(mint_def/(1+tax_trade_rate))

= 0.43265 * log(mint_def/(1+tax_trade_rate))[-1]
(2.21450)

+ 0.29900 * log(usppi*exchavg) -0.07626
(2.61836) (0.79831)

Sum Sq	0.8078	Std Err	0.2010	LHS Mean	0.3850
R Sq	0.7240	R Bar Sq	0.6964	F 2, 20	26.2335
D.W.(1)	1.6387	D.W.(2)	1.8738		
H	2.1495				

Imports of Capital Goods Deflator (132)

log(mcap_def)

= 0.41450 * log(mcap_def)[-1] + 0.52364 * log(us_cap85*exchavg)
(2.58280) (3.65949)

-2.73866
(3.53690)

Sum Sq	0.2937	Std Err	0.1212	LHS Mean	0.3516
R Sq	0.9595	R Bar Sq	0.9555	F 2, 20	237.142
D.W.(1)	2.0793	D.W.(2)	1.9203		
H	-0.3156				

Imports of Goods Deflator (133)

log(mgdef/(1+tax_trade_rate))

= 0.20521 * log(mgdef/(1+tax_trade_rate))[-1]
(1.02371)

+ 0.49870 * log(usppi*exchavg)[-1] -0.26042
(3.60934) (2.48292)

Sum Sq	0.3730	Std Err	0.1366	LHS Mean	0.2759
R Sq	0.8989	R Bar Sq	0.8888	F 2, 20	88.9348
D.W.(1)	1.5071	D.W.(2)	2.0440		
H	3.7512				

Average Wage: Manufacturing Sector (134)

log(avwag_manuf$/cpi85)

= 0.78050 * log(avwag_manuf$/cpi85)[-1]
(10.0044)

+ 0.27801 * log(gdpfc_manut) - 1.38869
(3.01723) (2.30201)

Sum Sq	0.1661	Std Err	0.0850	LHS Mean	2.7438
R Sq	0.8769	R Bar Sq	0.8662	F 2, 23	81.9130
D.W.(1)	1.6446	D.W.(2)	1.9015		
H	0.7229				

Average Wage: non-oil non-government (135)

log(avwag_oth$/avwag_oil$)

= 0.51466 * log(avwag_oth$/avwag_oil$)[-1]
(3.85857)

- 1.91960 * unemp_rate - 0.18461
(3.40936) (2.07911)

Sum Sq	0.1114	Std Err	0.0696	LHS Mean	-0.9948
R Sq	0.8239	R Bar Sq	0.8086	F 2, 23	53.8155
D.W.(1)	1.9105	D.W.(2)	2.4681		
H	0.2684				

Persons Employed in Manufacturing Sector (136)

log(emp_manuf)

= 0.65254 * log(emp_manuf)[-1] + 0.33795 * log(gdpfc_manuf)
(5.13456) (4.87432)

- 0.55086 * log(avwag_manuf$/cpi85)
(4.41852)

+ 0.34923 * log(avwag_manuf$/cpi85)[-1] - 0.56028
(3.12651) (1.26420)

Sum Sq	0.0466	Std Err	0.0471	LHS Mean	3.7712
R Sq	0.8311	R Bar Sq	0.7990	F 4, 21	25.8387
D.W.(1)	1.8928	D.W.(2)	2.4787		
H	0.0466				

Total Employment in Sectors other than Oil, Manufacturing and Government (137)

log(emp_oth/emptot)

= 0.33873 * log(emp_oth/emptot)[-1]
(1.95204)

- 0.08282 * log(avwag_oth$/pfcedef) - 0.06782
(3.79874) (1.29756)

Sum Sq	0.0057	Std Err	0.0158	LHS Mean	-0.4676
R Sq	0.7584	R Bar Sq	0.7374	F 2, 23	36.0982
D.W.(1)	2.0412	D.W.(2)	1.7268		
H	-0.4232				

Exchange Rate (138)

reexch

= 0.86884 * reexch[-1] -0.00004 * res_s$[-1] + 0.50364
(11.9711) (1.99500) (1.89150)

Sum Sq	1.1644	Std Err	0.2203	LHS Mean	3.4870
R Sq	0.8646	R Bar Sq	0.8533	F 2, 24	76.6177
D.W.(1)	2.2543	D.W.(2)	2.1224		
H	-0.7925				

APPENDIX 8.2
LIST OF EXOGENOUS VARIABLES

AVWAG_GOV$	Average wage: government $TT million
AVWAG_OIL$	Average wage: oil industry $TT million
BOPADJ$	Balance of Payments Adjustment $TT million
CAP_ADJ$	Adjustment on Govt Fiscal Account $TT million
CBEXTDEBT$	Central Bank External Debt $TT million
CBOPDEBT$	Central government External Debt (BOP) $TT million
CGINTRATE	Average Interest Rate on Central Govt internal Debt
CGNBOPDEBT$	Central government External Debt (Non-BOP) $TT million
COMCRED$	Commercial Bank Credit $TT million $TT million
DEP$	Consumption of fixed capital (depreciation) $TT million
DEPRATE	Nominal bank deposit interest rate
EMP_GOV	Employment:Government
EMP_OIL	Employment:Oil Sector
EXCH_ADJ	Adjustment for dual exchange rate in 1986
GCAPREV_CB$	Central Government Capital Revenue $TT million
GCFG_FIXED$	Fixed Public Sector Investment $TT million
GDEP$	General Government Fixed Capital Consumption $TT million
IR_L	Median Commercial Bank Lending Rate
LABF	Labour Force (000's)
MCGFRATE	Average interest rate on Central Govt External Debt
MNFS	Imports of non-factor services 1985 prices
MNFSDEF	Deflator, imports of non-factor services
MOTHCOMM$	Imports of Other Commodities $TT million
MOTHFY$	Fact.inc. pd. abroad (exc. foreign debt interest) $TT million
MSEFRATE	Av Interest rate on State Enterprise External Debt
MUT$	Unrequited Transfers to the Rest of the World $TT million
NGEG$	Govt.net purchases of goods & services $TT million
NONBCRED$	Non-Bank Credit to Government $TT million
NRES$	Non-Reserves: banking system $TT million
N_OTH_TAX_RATE	Tax Rate on "other" revenue of non-oil sector
OCF$	Other Compulsory Fees Paid to Govt. $TT million
OERR$	Non-Bank Errors And Omissions $TT million
OILP_EXT	chained oil price-sa/ukbrent
OILP_RAT	Ratio of oil export deflator to Brent
OIL_CORP_RATE	Rate of Taxation of Oil Companies
OIL_ROY_RATE	Rate on royalty revenue of oil sector
OPUBEXTASS$	Other Public External Liabilities $TT million

OTHEXP_GOV$	Other Government Expenditure $TT million
OTHINC_TAX_RATE	Tax Rate,"other" income of non-oil sector
OTHIT$	Other Indirect Taxes $TT million
O_OTH_TAX_RATE	Tax Rate,"other" revenue of oil sector
PEFA_PER	Proportion of personal income used to purchase ext assets
PP_OS	Proportion of operating surplus appropriated by private sector
PROP_TAX_RATE	Property Tax Rate, non-oil sector
REQ_LIQ	Required Liquidity
SALESTAX_RATE	Tax Rate on Goods & Services (inc VAT).
STOCK_GOV$	Public Sector Investment in Stocks $TT million
STOCK_PRI$	Private sector investment in stocks $TT million
SUBS$	Central Government Subsidies, $TT million
TAX_INC_C_RATE	Tax Rate on Companies (income)
TAX_INC_I_RATE	Tax Rate on Individuals (income)
TAX_TRADE_RATE	Tax Rate on International Trade
TBR	Treasury Bill rate
TRANS$	Other Current Govt Transfers $TT million
USPPI	US. Producer Price Index, 1985 = 1.00
US_CAP85	US capital equipment index
US_GDP	US Gross National Product, 1985 prices.
US_INDP85	US industrial goods index
XFY$	Factor (investment) inc.from abroad $TT million
XG3	Exports of goods sitc3, 1985 prices
XGX3DEF	Exports of non-SITC 3 goods, deflator 1985=1
XNFS	Exports of non-factor services, constant 1985 prices
XNFSDEF	Exports of non-factor services, deflator 1985=1
XUT$	Exports of unrequited transfers $TT million

APPENDIX 8.3
LIST OF ENDOGENOUS VARIABLES

AVCGEXTDEBT$	Average Central Govt External Debt $TT million
AVINTDEBT$	Average Central Govt Internal Debt $TT million
AVSEEXTDEBT$	Average State Enterprises External Debt $TT million
AVWAG_MANUF$	Average wage: Manufacturing Sector $TT million
AVWAG_OTH$	Average wage: non-oil non-government $TT million
CAB$	Surplus of the Nation on Current Account $TT million
CBCRED$	Central Bank Credit $TT million
CBDEPOS$	Central Bank Deposits $TT million
CGBDEBT$	Central Government Credit $TT million
CGBR$	Total Debt:central government $TT million
CGDINT$	Central Govt Interest Payments on Internal Loans $TT million
CGEXTDEBT$	External Debt:central government $TT million
CGINTDEBT$	Internal Debt $TT million
CGTOTDEBT$	Total Debt:central government $TT million
COMP$	Compensation of employees $TT million
COMP_GOV$	General Government Compensation of Employees $TT million
COMP_MANUF$	Compensation of Employees, Manufac.Sector $TT million
COMP_OIL$	Compensation of Employees, Petrol.Sector prices $TT million
COMP_OTH$	Compensation paid to workers in non-oil and non-government industries $TT million
CPI85	Retail Price Index, 1985 = 1.00
DEPRATE_R	Real Deposit Rate of Interest
DFI$	Direct Foreign Investment Flows $TT million
DINT$	General Government Interest Paid on Loans $TT million
DOMCRED$	Domestic Credit $TT million
DOMFA$	Domestic financial assets (stock) $TT million
EAO$	Errors and omissions $TT million
EMPTOT	Total Employment (all industries)
EMP_MANUF	Persons Employed in Manufacturing Sector
EMP_OTH	Total Employment in sectors other than oil, manuf and Government
EXCHAVG	Average Exchange rate for 1 U.S.$.
EXP_INF	Expected Rate of Inflation
EXTASS$	External assets: banking system $TT million
EXTDEBT$	Total External Debt $TT million
FCE$	Final Consumption Expenditure $TT million
FDINT$	Interest Paid on Public Sector External Debt $TT million
GCEXP$	Central Government Current Expenditure $TT million
GCF	Gross Capital Formation , 1985 prices

GCF$	Gross Capital Formation $TT million
GCFDEF	Gross Capital Formation Deflator
GCFP_FIXED	Private Fixed Investment
GCFP_FIXED$	Fixed Private Investment $TT million
GCF_FIXED$	Total Fixed Investment $TT million
GCREV$	Central Government Current Revenue $TT million
GDI$	Gross Disposable Income $TT million
GDPFC	GDP at Factor cost, 1985 prices
GDPFC$	GDP at Factor Cost $TT million
GDPFC_MANUF	GDPFC of Manuf Sector, 1985 prices
GDPFC_MANUF$	GDP at Factor Cost, manuf. Sector $TT million
GDPFC_OIL	GDP at FC, oil Sector, 1985 prices
GDPFC_OIL$	GDP at Factor Cost, Petrol sector $TT million
GDPFC_OTH	Real GDPFC of Sectors exc oil and manuf, 1985 prices
GDPFC_OTH$	GDP at Factor Cost (exc oil and manuf) $TT million
GDPFC_OTH_DEF	Implicit GDP deflator, sectors exc oil and manuf
GDPMP$	Gross Domestic Product at market prices $TT million
GDPMPDEF	GDP(MP) deflator
GDPMP_MAN_DEF	Implicit GDPMP manufacturing deflator
GDPMP_OIL_DEF	Implicit GDPMP Petroleum deflator
GFCE	Government Final Consumption Expenditure, 1985 prices
GFCE$	Government Final Consumption Expenditure $TT million
GFCEDEF	General Government Final Consumption Exp. Deflator
GSAVD$	Gross Domestic Savings (Resource Balance) $TT million
GSAVG$	Gross Govt Savings $TT million
GSAVN$	Gross National Savings $TT million
IR_LR	Real Lending Rate
IT_PLUS_VAT$	Indirect Taxes inc VAT $TT million
MCAPGOODS	Imports of Capital Goods, 1985 prices
MCAPGOODS$	Imports of Capital Goods $TT million
MCAP_DEF	Imports of Capital Goods Deflator
MCGFINT$	Central Govt. Interest paid on Ext. Loans Payments $TT million
MCONS$	Imports of Consumer Goods $TT million
MCONS_DUR$	Imports of Durable Consumer Goods $TT million
MCONS_DUR_DEF	Imports of Cons Durable Goods Deflator
MCONS_NDUR_DEF	Imports of Consumer Non-Durable Goods Deflator
MCONS_NONDUR$	Imports of non-durable consumer goods $TT million
MCONS_NONDUR	Imports of Cons non-durable goods, 1985 prices
MFY$	Factor Income to the Rest of the World $TT million
MG	Imports of goods (adjusted),1985 prices
MG$	Imports of Goods (adjusted) $TT million
MGDEF	Deflator, imports of goods
MGNFS	Imports Of Goods And Non-Factor Services, 1985 prices

MGNFS$	Imports of Goods & Non-Factor Services $TT million
MINTER$	Imports of Raw Mat & Inter Goods (adjusted) $TT million
MINTER	Imports of Raw Mat & Inter Goods, 1985 prices
MINT_DEF	Deflator (MINTER)
MNFS$	Imports of non-factor services $TT million
MON$	Money (M1) $TT million
MS$	Imports of Services $TT million
MSEFINT$	Interest Payment on State Enterprises' Foreign Debt $TT million
MT$	Imports of Goods,Services and Unreq.Trans $TT million
NDI$	National Disposable Income $TT million
NOILREV$	Govt.Revenue from Non-Oil Sector $TT million
NOILTAX_INC$	Govt.Revenue from Non-Oil Income $TT million
NOILTAX_INC_C$	Corporation Tax, non-oil sector companies $TT million
NOILTAX_INC_I$	Income Taxes Paid by Individuals $TT million
NOILTAX_OTHINC$	"Other" Inc. Tax from non-oil sector $TT million
NOILTAX_PROP$	Govt.Revenue from Non-Oil Taxes on Property $TT million
NOILTAX_TRADE$	Taxes on International Trade $TT million
NOIL_OTHREV$	"Other" revenue from the non-oil sector $TT million
OADJEXT$	Other External Adjustments $TT million
OILREV$	Government Current Revenue from the Oil Sector prices $TT million
OILREV_OTH$	Govt Rev from oil other than Corp Tax and Royalties $TT million
OILTAX_CORP$	Corporation Tax (Oil Sector) $TT million
OILTAX_ROY$	Oil Royalties $TT million
OSDISP$	Disposable Operating Surplus $TT million
OS_G$	Gross Operating Surplus $TT million
OS_G_MANUF$	Gross Operating Surplus, Manufacturing Sector $TT million
OS_G_OIL$	Gross Operating Surplus, Petroleum Sector $TT million
OS_G_OTH$	Gross Operating Surplus, Sectors Exc.Oil And Manuf $TT million
OTHEXTASS$	Other Assets and External Liabilities $TT million
OTHLIAB$	Other Liabilities of Banking Sector $TT million
PDFA_PER	Proportion of personal income used for acquistion of domestic financial assets
PER_DISP	Real personal disposable income, 1985 prices
PER_DISP$	Personal disposable income $TT million
PFCE	Private Final Consumption Expenditure, constant 1985 prices
PFCE$	Private Final Consumption Expenditure $TT million
PFCEDEF	Private Final Consumption Exp. Deflator
PMON	Proportion of domestic assets held as money (M1)
PRIBR$	Private sector borrowing requirement $TT million
PRIDEBT$	Private Sector Credit $TT million
PRI_DISP	Private Disposable Income
PRI_DISP$	Private disposable income $TT million

QMON$	Quasi_Money $TT million
REEXCH	Real Exchange Rate
RES$	Foreign Reserves held by banking system $TT million
SALESTAX$	Govt Revenue from sales of goods and services $TT million
SAVF$	Net Lending Abroad (Net Foreign Savings) $TT million
SAVG$	Govt. Surplus on current a/c using CB Data $TT million
SEBR$	Change in Total Debt:state enterprises $TT million
SEDEBT$	State Enterprises Credit $TT million
SEXTDEBT$	External Debt:State enterprises $TT million
TBR_R	Real Treasury Bill rate
TOTASS$	Total assets: banking system $TT million
TOTLIAB$	Total Liabilities, banking system $TT million
UNEMP_RATE	Unemployment Rate
XG	Exports of goods, 1985 prices
XG$	Total exports of Goods
XG3$	Exports SITC 3 - Minerals, Fuels,Lubricants & rel mat
XG3DEF	Exports of SITC 3 goods, deflator
XGDEF	Exports of goods, deflator
XGNFS	Exports of Goods & Non Fact.Services, 1985 prices
XGNFS$	Exports Of Goods And Non Factor Services
XGNFSDEF	Exports of Goods & Non Factor Services Deflator
XGX3	Exports of goods excluding sitc3, 1985 prices
XGX3$	Exports of goods excluding SITC 3 $TT million
XNFS$	Exports of Non Factor Services $TT million
XT$	Exports of Goods, Services and Unreq.Transfers $TT million