Business Cycles and the Optimum Exchange Rate of a Small Open Economy: The Case of Bahrain

being a Thesis submitted for the Degree of

Doctoral of Philosophy

in the University of Hull

by

Ahmed Hashim Alyousha
BA (Michigan State University), M.Phil (University of Glasgow)

August 1995

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This work is dedicated to my wife Hanan

Abstract

This thesis utilizes time series techniques to investigate Bahraini business cycles and the optimality of Bahrain's exchange rate arrangements. To do so it is necessary to disaggregate the annual series of GDP, non-oil GDP, government expenditure, GDP deflator and non-oil GDP deflator into quarterly observations. The results on the business cycles show that the series of GDP, non-oil GDP and oil GDP have little persistence. Additionally, the results show that government expenditure is the only macro variable Granger causing non-oil business cycles and that the existing exchange rate regime does not Granger cause non-oil GDP. The survey on the optimum exchange rate literature shows that several of the theoretical exchange rate models are based on very strong assumptions that deter us from using them. The optimality of the Bahrain Dinar (BD) exchange rate regime is tested using an extended Horne-Martin approach. Further tests are carried out to examine the effects of the post-Bretton Woods exchange rate arrangements for the BD on the conduct of interest rate policy and domestic inflation. The results reveal that domestic interest rate policy is divorced from domestic fundamentals and that the post-Bretton Woods exchange rate arrangements did not inhibit domestic inflation from converging to the world average inflation rate. These results, plus those of chapter three, cast serious doubt on the optimality of the BD exchange rate arrangements. Indeed, the optimality test rejects the existing regime and

shows that Bahrain cannot have an optimum peg regime. Thus the authorities have the option of floating the BD. However, the authorities may opt for a second best peg arrangement, but at the expense of obtaining counter intuitive results.

Acknowledgment

I would like to express my deep gratitude to my supervisor, Professor Terence Mills, for many valuable discussions and guidance throughout the course of this work. I am also grateful to Dr. M. Nolan for his help with computing.

I would like to thank the Bahrain Center for Studies and Research for financial support and to thank Dr. Abdulla Al Sadik and M. Al Manai for supplying me with some of the data.

Finally, I am grateful to my wife for her patience and love during the course of my study.

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Chapter One

Introduction

In the past three decades there has been increasing disillusionment with economics as an adequate means of interpreting and predicting economic changes.[1] The disillusionment touched economic theory as well as the quantitative techniques that were used to ratify the theoretical postulates. At the theoretical level, the dissatisfaction with economic theory gave rise to new strands of macroeconomic theories that are aimed at

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[1]A clear example of this can be found in the debate over the stability of pre and postwar output and the ability of economic theory to explain the stability postulate. The confusion is explicitly stated by John Taylor (1986, p. 640):

> "I examine changes in wage and price rigidities and in macroeconomic performance by concentrating on two episodes in United States history: the quarter-century before World War I, from 1891 through 1914, and the slightly longer period after World War II, from 1955 through 1983. Each period includes eight economic fluctuations. By ending the earlier period before World War I, we exclude economic turbulence of both world wars as well as the Great Depression of the 1930s. Even with these exclusions, economic fluctuations in the earlier period were larger than those in the postwar period. The data also indicate that wages and prices were more flexible in the earlier period. This latter finding, which has also been noted by other researchers, presents a puzzle. Less flexibility of wages and prices should lead to deterioration in economic performance. The comparison suggests the opposite has occurred. Either other factors-such as those mentioned by Burns- were strong enough to offset the reduced wage/price flexibility, or macrotheory needs some revision if it is to provide a satisfactory explanation for economic fluctuations in both these periods of the United States history."

Using improved data sets, Watson (1994) has rejected Taylor's views of increased stability in the postwar data. Watson finding poses a serious challenge to the adequacy of the macroeconomic policies pursued in the postwar period.

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identifying causes of macroeconomic fluctuations that existing theories fail to grasp.

While economists were busy debating policy (in)effectiveness due to rational expectations, Robert Lucas, a main initiator of this debate, had published a paper in 1977 titled "Understanding Business Cycles". In this paper, Lucas has again provided a new impetus to macroeconomics in which the focus this time is directed at the sources of macroeconomics fluctuations, i.e. at the causes of business cycles. Lucas (1977), as in Friedman (1968), proposes decomposing output into its trend and cyclical components in order to evaluate policy effectiveness within the business cycle context. In his paper the trend component is deterministic and is assumed to be exogenously determined, thus implying that it is independent from macroeconomic policies. On the other hand, the cyclical or stochastic component is assumed to be stationary, so that any shock to its level is expected to have only transitory effects. Hence, if macroeconomic policy is effective, it will only have short-run effects on output. Even though one may not agree with Lucas' assumption on the trend integration property of output, one can see that Lucas's paper has brought economics to the heart of the matter: that of decomposing output into trend (long-run) and cyclical (short-run) components and testing for the variables driving each component.

In the 1980s and 1990s, the debate among macroeconomists culminated in the emergence of two contradictory theories

explaining the causes of economic changes (see Kydland and Prescott, 1982; Romer, 1986, 1990). These theories reflect the two conventional views of macroeconomic fluctuations, i.e. the intervention and laissez faire schools of economic thought.

The first (intervention) school resulted in two separate responses. The first response is known in the literature as endogenous growth theory and is concerned with the sources of economic growth, focusing on the determination of the trend component (see Romer, 1986, 1990; Barro, 1990). Unlike the neoclassical/real business cycle theory of growth, endogenous growth theory does not see growth as a result of exogenous technological shocks. This theory is described in Romer (1994) as follows:

"This work distinguishes itself from neoclassical growth by emphasizing that economic growth is an endogenous outcome of an economic system, not the result of forces that impinge from outside."

Hence, endogenous growth theory addresses the issue of what determines growth over the long-run? For the short-run, the Keynesian response manifested itself in asserting the Keynesian view on the importance of macroeconomic policy in output stabilization (see Blanchard,

1989; Blanchard and Quah, 1989).[2]

On the other hand, the laissez faire school have built upon the new classical policy ineffectiveness hypothesis, which has resulted in the emergence of real business cycle theory (RBC) (see Kydland and Prescott, 1982; Long and Plosser, 1983). As in Lucas, RBC theory decomposes output into trend and cyclical components. However, in the RBC theories the trend is an integrated process whose stochastic properties characterize the exogenous shocks that are emanating from technological changes.[3] If output is viewed in such a way, then the trend is stochastic and exogenously determined, so that technological shocks will have permanent effects on the level of output.

For the cyclical component, the RBC theories advance the policy ineffectiveness hypothesis by propagating the views that macroeconomic fluctuations can only be explained by real variables, thus rendering macroeconomic policy ineffective.

Since then, macroeconomic theory has taken on a new phase, characterized by resorting to the basics of macroeconomic theory, that of analyzing macroeconomic fluctuations within the context of the business cycle. In

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[2]In fact, both papers investigate the issue of the determinants of short and long-run growth rates. However, these studies pay specific attention to the determinants of short-run growth.

[3]Lucas (1988) and Romer (1990) challenged the view of the exogeneity of technological changes by providing an alternative specification in which technical progress is modelled as a function of human capital.

effect, the extension of the policy neutrality proposition to the business cycle has inspired a new round of debate among economists of the two schools, i.e. on whether or not macroeconomic policies are neutral.

At the quantitative level, developments in econometric theory has resulted in the discarding of standard methods. These developments emphasize the role of time series techniques in modelling macroeconomic relations. Davidson et al. (1978) and Sims (1980b) are important contributions to econometric theory.[4] Even though these articles advocate different methods of modelling macroeconomic relations, subsequent developments have integrated the two approaches. This approach is known as the structural vector autoregression (SVAR) and was pioneered by Blanchard and Quah (1989). Nevertheless, when the model is built for forecasting purposes, the Bayesian approach to VAR modelling has produced better results than either the atheoretical or structural VAR (see Doan et al. 1984; Todd, 1984; Litterman, 1986a; McNees, 1986; Raynauld and Simonato, 1993).[5]

Having noted these developments, plus the fact that studies on Bahrain have been carried out using aggregated annual series, this thesis incorporates these developments

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[4]For discussion of the various econometric methodologies see Pagan (1987), Gilbert (1986), and Hylleberg and Paldam (1991, Introduction chapter).

[5]The Bayesian approach is considered to be another econometric methodology (see Pagan, 1987). This approach is identified with the works of Edward Leamer and Arnold Zellner.

while studying the Bahraini economy. To be able to do so, the sample size of the series we are going to analyse must be long enough to allow us to use time series techniques.[6] With fifteen annual observations it will not be possible to accomplish this task. Given that the data is in annual form, a logical alternative would be to use quarterly observations. It is important to acknowledge that increasing the number of observations by disaggregating the series will not increase the information content of the data; however, it will allow us to employ the time series techniques that will enhance our understanding of the Bahraini economy.

The second chapter undertakes the task of estimating the quarterly missing observations in some of Bahrain's national accounts data. Since none of the series is observed quarterly, the disaggregation procedure uses the related variable method: we use the Harvey-Kalman filter approach discussed in Harvey (1984), Harvey and Pierce (1984) and

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[6]Using panel and cross-section data have several disadvantages that deter us from using them. These disadvantages are: (i) cross-section econometrics is confined to estimating correlations between variables but not causal relationships; (ii) almost all economic hypotheses have time content to them, e.g. convergence, short and long-run effects. Panel and cross-section data cannot be used to test such hypotheses; and (iii) it will not be clear whether or not to difference the data. In either way the results can be very misleading. Additionally, it is not possible to difference cross-sectional data and in panel data, differencing leads to the removal of all time-invariant variables, including the heterogeneity variable (see Hausman and Taylor, 1981). Thus, panel data analyses will not capture sector-specific responses to exogenous shocks.

Harvey (1992). The missing quarterly observations of gross domestic product, non-oil gross domestic product, government expenditure, the GDP deflator and the non-oil GDP deflator are estimated using this method. Compared to other approaches, the Harvey-Kalman filter approach has three important advantages. First, it requires a powerful statistical prerequisite: the aggregate series have to be cointegrated. Second, cointegration allow us to overcome simultaneity problems. This is a major disadvantage that is associated with other approaches. Third, estimation is carried out recursively using the Kalman filter. Setting the models in a state space framework implies that, over time, the model builder can observe changes in the state vector. As a result, the disaggregation process can be conditioned on the state vector. Such a disaggregation process avoids the "residuals problem" common to other approaches, which need to find a way to disaggregate the residual series.

Given the limited size of our samples, it was not possible to use the Johansen cointegration procedure. Instead, the cointegration test is carried out using the less powerful Engle and Granger (1987) two-step procedure. In effect, irrespective of the type of test, the small sample size will reduce the test's power. For this reason, the autoregressive root of each cointegrating regression residual is calculated so as to ensure the robustness of the results. For all models, the two-step test fails to reject the null hypothesis of no cointegration even when the roots

in all models are numerically much less than one. There is strong evidence emerging from the literature pointing to the weakness of the two-step cointegration test (see Kremers et al. 1992; Hooker, 1993). As a result, inference on cointegration is based on the numerical value of the largest autoregressive root in the cointegrating regression residuals.

To estimate the models using the Kalman filter, each model needs to have a state space representation. Since the estimations are carried out for both flow and stock variables, the state space is set up to distinguish between them. The state space is set up so that the measurement equation of each model can be used to check the robustness of the disaggregation results. The robustness of the disaggregation process is further investigated by testing for the equivalence between the integration properties of the temporally aggregated and disaggregated series as suggested by Granger (1988a). The results show that the Harvey-Kalman filter procedure is a very useful method for estimating missing observations.

The estimated quarterly observations are utilized in chapter three to study Bahrain's business cycle. This aims at establishing stylized facts for Bahrain, and is done by investigating two major properties of Bahrain's business cycle. The first concentrates on measuring persistence within the data, while the second uses the VAR methodology to identify the macroeconomic variables causing the non-oil business cycle.

The first empirical part of chapter three uses the univariate parametric approach developed by Campbell and Mankiw (1987a,b) and the non-parametric approach developed by Cochrane (1988) to measure persistence in GDP, non-oil GDP and oil GDP. Since persistence is an asymptotic property of the data, series of sixty observations are considered to be fairly short samples. For the parametric approach, this is expected to imply that the results will be sensitive to model specification. Indeed, the parametric persistence results point to such an outcome. For this reason, Cochrane's non-parametric approach is subsequently used to verify the Campbell-Mankiw results. Both measures show that there is very little persistence in the GDP, non-oil GDP and oil GDP series. Thus an innovation to the level of these series will have only transitory effects. These results are confirmed by unit root tests in which GDP and non-oil GDP are found to be trend-stationary series, while oil GDP is found to be a stationary process. The persistence measures and unit root tests on GDP and non-oil GDP are in conformity with the conventional views on output decomposition. Such a view decomposes output into secular and transitory components. The first is a deterministic exogenously determined component while the second is a stochastic stationary component which can be explained using macroeconomic theory. These views are persuasively discussed in Friedman (1968).

Given that Bahrain is a very small oil producer and that the oil sector is independent of domestic macroeconomic

policies, the second part of chapter three addresses the question of which macroeconomic variables are driving non-oil GDP. Earlier in the chapter a section was devoted to explaining the major macroeconomic characteristics of Bahrain. The discussion pointed to the following: (i) since the government is the domestic owner of the oil joint venture, the oil sector can influence other sectors indirectly, i.e. through government expenditure; (ii) government is large in the goods market; and (iii) government is also large in the money market; it is a net lender to the private sector. Thus it is anticipated that government expenditure will have an important role in explaining non-oil macroeconomic fluctuations.

Acknowledging the importance of government expenditure, and the fact that chapter three is the first attempt to investigate the Bahraini business cycle, leads us to test for the effect of monetary policy by estimating several VAR models using different monetary aggregates. The results from Granger causality tests point to the presence of unidirectional causation running from government expenditure to non-oil GDP. Additionally, the results point to the absence of a causal relationship between monetary policy and non-oil GDP.

The robustness of these results is checked using McCallum's (1983, 1992) method. For Bahrain, McCallum's approach implies using the exchange rate as a measure of monetary policy effectiveness. In all VARs, the exchange rate variable failed to cause non-oil GDP, thus rendering

monetary policy ineffective.

The lack of influence of the exchange rate is very surprising in the sense that the authorities have pursued a monetary policy that is neutral with respect to their economic aim, i.e. targeting non-oil GDP. The results of chapter three invalidate the adequacy of the existing exchange rate regime and call for further investigation of the optimality of the Bahrain Dinar (BD) exchange rate arrangement. To address this issue, the remaining chapters of the thesis are devoted to studying the optimality of the BD exchange rate arrangements.

In chapter four a survey of the literature on optimum exchange rate regimes is carried out. Since developing countries are known to have different structural relationships, the last section of chapter four is devoted to surveying the literature on the optimum exchange rate for a developing economy. The Horne-Martin approach, which will be utilized in the thesis to investigate the optimum regime, is only briefly discussed in this chapter so as to avoid having too long a literature survey.

One draws the conclusion from the literature that there is little consensus, if at all, on what constitutes an optimum exchange rate regime. This holds even for models drawn from the same schools of thought. From an empirical point of view, the results of these models cannot be robust, for a small change in model specification leads to entirely different results (compare Fischer (1977) with Enders and Lapan (1979)). Hence, we doubt the adequacy of these

theoretical models.

On the other hand, the theoretical literature on the optimum exchange rate for developing economies converges to the conclusion that a peg regime is the best regime available to a developing economy. Again, this literature does not precisely define this peg regime, i.e. is it a single or multicurrency peg? Commenting on this issue, Williamson (1982, p. 39) stated:

> "In a world where the major currencies are all floating against one another, however, the question of exchange rate policy is not resolved by resolving to peg rather than to float; it is also necessary to decide what to peg."

Thus addressing the question of the optimality of the exchange rate regime requires using a flexible approach that is capable of modelling the various alternative regimes, i.e. both peg and floating regimes. The Horne-Martin approach is found to be the most appropriate one and is further discussed in chapter six. However, one can conclude from the surveyed literature that the optimum regime is dependent upon the economic structure of the country under consideration and that, in order to decide on the optimum regime, one needs to define a target variable and to set a selection criterion by which the optimum regime can be identified. For this reason it was necessary to establish stylized facts about the Bahraini economy prior to testing for the optimum exchange rate regime.

Chapter five discusses BD exchange rate policies and the consequences of these policies for the conduct of interest rate policy and domestic inflation. Chapter five starts with a brief review of the policies adopted. It is emphasized in this section that, since December 1980, the BD had followed a dual exchange rate arrangement of having a pegged rate to the special drawing rights (SDR) and a fixed rate to the US dollar. In practice, the new arrangement resulted in pegging the BD to the US dollar. In the next section, the BD exchange rate indices are discussed and it is shown that the BD-dollar fixed arrangement has led to higher fluctuations in the BD rate vis-à-vis its main trading partners exchange rates.

Since the collapse of the Bretton Woods system, Bahrain had consistently followed pegged exchange rate arrangements. The last two sections of chapter five test the implications of these arrangements for the conduct of interest rate policy and for domestic inflation. Section 5.4 tests the hypothesis on the divorce of interest rate policy from domestic fundamentals using Geweke's (1982, 1984) canonical form for testing causal relationships. The canonical form is used because it allows for the existence of all forms of causal relationship, i.e. linear causal feedback, linear contemporaneous feedback and linear dependence.

The results from section 5.4 show that the post-Bretton Woods exchange rate arrangements of the BD have resulted in the divorce of Bahrain's interest rate policy from domestic fundamentals. This implies that post-Bretton Woods exchange

rate arrangements have reduced the ability of the Bahraini monetary authorities to influence the domestic economy.

The next section uses data from the post-Bretton Woods era to test one of the major drawbacks of the Bretton Woods system: namely, that the fixed exchange rate regimes under the Bretton Woods system promoted inflation transfer among participating countries. Hence, in the long-run, the domestic inflation of a small and open economy like Bahrain is anticipated to converge to the world average inflation rate. The inflation transfer drawback was one of the disadvantages that resulted in the collapse of the Bretton Woods system. Thus, the post-Bretton Woods exchange rate arrangements are expected to inhibit the convergence of the domestic inflation rate to the world average inflation rate. Section 5.5 tests the above hypothesis using Johansen's (1988, 1991) test of cointegration.

The results of the cointegration test rejected the null hypothesis of no cointegration, thus asserting the convergence of the Bahraini inflation rate to the world average inflation rate. This result provides additional evidence for doubting the optimality of the BD exchange rate arrangement.

The findings of this chapter and that of chapter three seriously question the optimality of Bahrain's post-Bretton Woods exchange rate arrangements. Additionally, these findings demand the testing of the optimality of the existing regime and to the suggestion of an alternative arrangement once the optimality tests reject the present

regime.

Chapter six discusses the Horne-Martin approach and certain extensions that enhance its ability to identify the appropriate regime. These extensions are:

(i) Setting criteria identifying the appropriate regime. The optimality of a regime is conditioned on its ability to minimize the root mean square error of the target variable forecast error as well as having a meaningful pattern of Granger causality.

(ii) Investigating the integration properties of the series.

(iii) Using our prior knowledge provided by chapter three to estimate a restricted VAR model in which the restriction takes a Bayesian form.

Unlike other studies, we set clear criteria for identifying the optimal regime. Additionally, we differ from existing studies by testing for, rather than assuming, stationarity. The optimality tests are thus calculated from restricted VARs that are estimated using stationary variables. Furthermore, the thesis differs from the existing literature by employing restrictions stemming from our prior knowledge of the link between exchange rates and the target variable. For such reasons it is not possible to compare the results of this thesis with those from existing studies.

The extensions added to the Horne-Martin approach point to the flexibility of this approach. Compared to other methods, the Horne-Martin approach possesses the following advantages:

(i) Unlike other methods, this approach uses the VAR technique to estimate the relationships between the variables. In the Horne-Martin approach the exchange rates are endogenous, thus allowing each of them to interact with other variables in the model.

(ii) Its ability to precisely identify the optimum regime; if none of the exchange rates can improve the forecasting ability of the target variable and none of them Granger cause the target variable, the method implies that there is no optimum peg. If this is true, then the authorities have the option of floating the exchange rate. This advantage of the extended Horne-Martin approach makes it a very useful way of determining the optimum exchange rate arrangement.

(iii) Having been developed within a VAR framework, the Horne-Martin approach implicitly uses prior knowledge when solving for the optimum exchange rate regime. Such an advantage is not provided by other approaches. It is well known that the Bayesian approach to VAR modelling increases forecasting accuracy (see Doan et al. 1984; Todd, 1984; Litterman, 1986a; McNees, 1986;

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Raynauld and Simonato, 1993).

(iv) It allows for structural changes and hence for varying basket weights.

Chapter seven solves for the optimum exchange rate regime using the extended Horne-Martin approach. Estimation is carried out using a BVAR, with a prior based on chapter three's results: namely, that the overall tightness and relative tightness of the government expenditure coefficient in the target variable equation is relaxed such that government expenditure Granger causes non-oil GDP. On the other hand, less relaxed priors are imposed on the coefficients of all exchange rates in the target variable equation. With respect to other equations, the priors are set so that each variable is an autoregression on the first difference.

The results of chapter seven reveal the absence of any optimum peg. This result is consistent with recent empirical studies in which exchange rates are found to be unimportant for determining macroeconomic aggregates (see Baxter and Stockman, 1989; Mills and Wood, 1993).

The Bahraini authorities are left with the floating option. They may peg the BD rate, however, at the expense of achieving their economic goal. This finding contradicts the theoretical literature on the choice of an exchange rate regime by a developing economy. This literature postulates that the economic structures of developing economies inhibit them from adopting floating regimes. Such postulates lack

empirical support and, in the case of Bahrain, the results point to the opposite policy. Consequently, it is concluded that the choice of exchange rate cannot be based solely on theoretical arguments; instead, inference must be conditioned on the economic target identified by decision makers.

The main findings of the thesis are drawn together in a concluding chapter. Additionally, this chapter lists recommendations drawn from the thesis and provides suggestions for future research.

Chapter Two

Estimating Quarterly Missing Observations of Some of Bahrain's National Accounts Data: Harvey-Kalman Filter Approach

2.1 Introduction

Studies on the effects of using temporally aggregated data in model estimation have warned against the use of such data and called upon their users to interpret their regression results with extreme caution. The literature point to several problems arising from using temporally aggregated data. Among the problems associated with temporal aggregation are that: (i) it may give rise to distorted lag distributions (Griliches, 1967); (ii) it causes bias in the coefficients and increases forecast errors, thus lowering the precision of prediction (Zellner and Montmarquette, 1971; Mills, 1991b); (iii) it may produce contemporaneous relationships which result in bidirectional causality being observed rather than the true unidirectional causality (Christiano and Eichenbaum, 1987) ; and (iv) for stationary series temporal aggregation tends to dampen the relationships between the dependent variable and the explanatory variable(s) (Granger, 1992).

For Bahrain, as well as for many other developing countries, the national accounts data are only available on an annual basis and for a very short period: in the Bahraini case, only since 1975. Thus estimating quarterly observations of national accounts data can be helpful because it: (i) reduces the exposure of the series we will be using in this thesis to the above criticisms; (ii) increases the number of observations, which will make it possible to use powerful estimation procedures such as vector autoregression; and (iii) having quarterly series

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will not deter us from differencing whenever it is
necessary. To avoid the difficulties associated with
temporally aggregated data we will seek an appropriate way
to estimate the missing quarterly observations of some of
Bahrain's national accounts data which will be used in this
thesis. The approach that we will use is the related
variable(s) method discussed in Harvey (1984), Harvey and
Pierse (1984), and Harvey (1992). Since Andrew Harvey is
the main contributor to this approach and the estimation is
conducted by means of the Kalman filter, the approach will
be referred to as the Harvey-Kalman filter approach.

The remainder of this chapter is organized as follows.
Section 2.2 provides a brief review of the main methods of
estimating missing observations. In section 2.3 the
quarterly missing observations of the annual series of
nominal gross domestic product (GDP), nominal non-oil gross
domestic product (NGDP), government expenditure (G), the GDP
deflator (GDPD), and the non-oil GDP deflator (NGDPD) are
estimated for the period 1975-89. In the same section two
robustness checks are carried out to test the reliability of
the disaggregation results.

2.2 Missing Observations Estimation Methods

2.2.1 Univariate Model Approach

This approach assumes that the data generation process
(DGP) of the series is appropriately approximated by a

univariate model (see Harvey and Pierse, 1984; Nijman and Palm, 1986; Al-Osh, 1989). Thus given the integration properties of the series, the data is fitted either to an autoregressive moving average (ARMA) or to an autoregressive integrated moving average (ARIMA) model. Whether the DGP is ARMA or ARIMA, Harvey and Pierse (1984) demonstrate that the issues of interpolation and distribution in the univariate model can be solved optimally by means of the Kalman filter.[1]

The applicability of the univariate model is restricted to the situation in which parts of the disaggregated series are missing. Since none of the series under consideration are available in disaggregated quarterly form, the univariate approach will not serve the disaggregation purposes of this chapter.

2.2.2 Related Variables Approach

This approach was pioneered by Chow and Lin (1971) and later developed by Chow and Lin (1976), Fernandez (1981), Litterman (1983), and Wilcox (1983). The Chow and Lin (1971, 1976) articles addressed Friedman's (1962) views on the question of disaggregation by related variables by providing a unified treatment for the distribution,

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[1] The terms interpolation and distribution refer, respectively, to the disaggregation process of a stock and flow or time average of a stock variable (see Litterman, 1983; Harvey, 1992).

interpolation and extrapolation problems.[2]

Of course, the appropriateness of this approach is conditional upon the correct model specification. To overcome the possibility of misspecification, Wilcox (1983) suggested treating the error term as a first-order Markov process. This approach decomposes the disaggregation process into two components; the first is a linear function of the movements of the disaggregated explanatory variables, while the second is a distribution of the aggregated residual series so the disaggregated values sum/average to the aggregated series. Disaggregating the residuals in such a way can cause discontinuity between the last observation of one year and the first observation of the next, thus questioning the autocorrelation assumption (Fernandez, 1981).

The assumption of residual serial correlation will encounter a more serious challenge if it arises from non-stationary residuals. Granger and Newbold (1974) and Phillips (1986) have demonstrated that a regression between the levels of time series may result in an entirely spurious relationship which will then provide very misleading inferences. In fact, positive serial correlation manifested by a low Durbin-Watson statistic is suggested to be an indicator of non-stationary residuals (see Granger and Newbold, 1974). Consequently, a residual autocorrelation test will be very useful as a test for model

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[2]Friedman (1962) concentrated on the interpolation problem and ignored the issues of distribution and extrapolation.

misspecification, since other standard (single and joint significance) test statistics may support spurious relationships (Phillips, 1986; Banerjee et al. 1993).[3]

Furthermore, the Chow-Lin approach suffers from an additional drawback related to model specification. In Chow-Lin's approach, inference on disaggregation is drawn from the results of a single equation model. In general, this may not be plausible. There could be no behavioural relationship between the dependent and the explanatory variable. What may cause both variables to exhibit similar behaviour may be a consequence of both being generated in the same environment. Under such conditions, the error components of both series will not be orthogonal and hence a single equation model is a misspecification of how the data is generated.

To overcome this problem Harvey (1992) pointed to the following prerequisites when carrying the disaggregation process within the Kalman filter:

(i) The need for a homogeneous system.

(ii) Weakly exogenous explanatory variables.

(iii) However, if the series' have a common trend (i.e. are cointegrated), then a single equation estimate is consistent and asymptotically efficient even if the explanatory variables and

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[3]Based on Monte Carlo simulations, Banerjee et al. (1993) show that the spuriousness of t-statistics increases with sample size. Thus in large sample regressions they reported that the null hypothesis of no relationship will be rejected 75.5 per cent of the time even when the null is true.
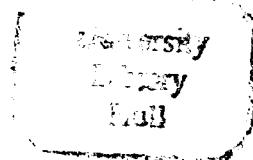
the error term are correlated.

Clearly, Harvey's last point represents an argument for estimating missing observations in a single equation framework. However, this does not imply using the cointegration relation to estimate the missing observations. Instead, the cointegration relation must be interpreted as the essential prerequisite for basing the disaggregation process on the estimate from a single equation model. Hence, once the null of no cointegration is rejected, the single equation model is estimated using the smoothing algorithm of the Kalman filter.

The following are important advantages of using the Harvey-Kalman filter approach:

(i) Inference on disaggregation is based on a single equation model, thus avoiding the complexity that may arise from using system of equations.

(ii) The Harvey-Kalman approach is assumption-free, hence it eliminates some of the uncertainties associated with the Chow-Lin approach.

(iii) It gives a precise prerequisite for the estimation process, i.e. the presence of a common trend. For variables to possess such a statistical characteristic they must be cointegrated. In contrast, the Chow-Lin approach does not consider cointegrability of the variables, thus it can be argued that

disaggregation based on this approach is less justified.[4]

(iv) The Harvey-Kalman filter approach addresses the simultaneity problem in a single equation model. As a result the Kalman filter estimators are consistent and asymptotically efficient, and hence allow us to carry out the estimation without resorting to instrumental variables methods.

(v) Since the estimation is carried out in Kalman filter each model is estimated recursively. By setting the models in state space framework, model builder will be able to observe, over time, changes in the state vector. In the Harvey-Kalman filter approach the disaggregation process is conditioned on the state vector. Consequently, this disaggregation approach avoids the "residual problem" common to other approaches, which need to fined a way to disaggregate the residual series.

(vi) The Kalman filter is a powerful method of estimation and will deliver the optimal estimators of the state vector and the error covariance matrix (see Harvey, 1992, 1993).

These are important advantages that characterize the Harvey-Kalman filter approach which render it a better approach to disaggregating temporally aggregated series.

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[4]It should be noted that cointegration techniques were not invented when the Chow and Lin work was published.

2.3 Estimating Missing Observations By the Related Variables Method: Harvey-Kalman Filter Approach

Assume that

$$Y_t = \alpha_1 x_{1t} + \alpha_2 x_{2t} + \ldots + \alpha_n x_{nt} + \varepsilon_t \qquad (1)$$

is the model we wish to estimate and that Y_t is the temporally aggregated series while $x_{1t}, \ldots, x_{nt}$ are the observed quarterly series of the independent variables, and $\alpha_1, \ldots, \alpha_n$ are the model coefficients. Harvey (1992) states that if $(Y_t - \alpha' X_t) \sim I(0)$, so that Y and X are cointegrated, and where $\alpha' = (\alpha_1, \ldots, \alpha_n)$ and $X_t' = (x_{1t}, \ldots, x_{nt})$, then it is possible to estimate the quarterly missing observations of Y using the Kalman filter.

Estimating (1) by means of the Kalman filter implies that it has a state space representation. Equation (1) can be set in the following state space framework:

$$Y_t = B' Z_t + \varepsilon_t \qquad (2)$$

where

$$
B_{N+1 \times 1} = \begin{bmatrix} 1 \\ 0 \\ \cdot \\ \cdot \\ \cdot \\ 0 \end{bmatrix}, \qquad
Z_{N+1 \times 1} = \begin{bmatrix} Y_t \\ x_{1t} \\ \cdot \\ \cdot \\ \cdot \\ x_{nt} \end{bmatrix}
$$

In the state space framework, equation (2) is known as the measurement equation, B is the coefficient vector, Z_t is the unobserved state vector and y_t is the sum of the quarterly missing observations, $(y_{1t}+y_{2t}+y_{3t}+y_{4t})$ for a flow variable and $1/4y_t$ for an average stock variable.[5] ε_t is a null vector. Specifying the measurement equation in this way enables it to be used to evaluate the robustness of the results (see section 2.3.2). The transition equation will be

$$Z_t = \Theta Z_{t-1} + W_t \qquad (3)$$

where

$$\Theta_{N+1 \times N+1} = \begin{bmatrix} 0 & \alpha_1 L^{-1} & \alpha_2 L^{-1} & \cdots & \alpha_n L^{-1} \\ 0 & L^{-1} & 0 & \cdots & 0 \\ . & 0 & L^{-1} & & . \\ . & & & . & . \\ . & & & . & . \\ 0 & . & . & 0 & L^{-1} \end{bmatrix},$$

---

[5]The latter definition of y_t is applicable to variables such as price indices.

$$
W_{N+1 \times 1} = \begin{bmatrix} \omega_t \\ 0 \\ \cdot \\ \cdot \\ \cdot \\ 0 \end{bmatrix}
$$

L is the lag operator. ω_t is a white noise disturbance assumed to be orthogonal to ε_t.[6]

The role of the measurement and transition equations in the estimation process can be explained as follows:

(i) The measurement equation specifies the relationship between the temporally aggregated series and its own unobserved quarterly observations.

(ii) The transition equation is used to overcome the unobservability problem associated with the measurement equation. This is done by respecifying (2) in terms of the related quarterly observed series.

Thus the transition equation will serve to transfer the state from temporally aggregated (annual) to the disaggregated state (quarterly), while the measurement equation will serve as a

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[6]For detailed discussion of state space modelling see Lütkepohl (1991, chapter 13).

robustness check on the results of the disaggregation process.

The transition equation will be estimated for five models: nominal GDP on total exports, nominal non-oil GDP on non-oil visible foreign trade, government expenditure on oil exports, the GDP deflator on the oil price index and the consumer price index, and the non-oil GDP deflator on the consumer price index.[7] This implies that, for the bivariate models, Z_t is a (2×1) vector of the temporally aggregated series and the disaggregated series, i.e. that equation (3) is composed of two equations. The first is the bivariate model while the second is the explanatory variable set equal to itself. The same arrangement holds for the trivariate model except that Z_t is a (3×1) vector and the transition equation is composed of three equations. For obvious reasons, the second equation in the bivariate model and the second and third equations of the trivariate model are ignored.

To apply the Harvey-Kalman filter approach we need to show that (i) each element of the state vector is a process integrated of order one, I(1); and (ii) the elements of the state vector are cointegrated. Both properties are tested in the next subsection.

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[7]See Appendix 2A for discussion of the regressor selection.

2.3.1 Determining the Univariate and Multivariate Integration Properties of the State Vector Elements

The univariate integration property of the state vector elements is investigated by testing for the presence of a unit root in the levels of each series. We use the Dickey-Fuller test discussed in Said and Dickey (1984), as well as utilizing the Phillips-Perron test developed by Phillips (1987) and Phillips and Perron (1988). For both tests the extent of the autoregressive correction is determined by testing for the whiteness of the residuals. Given that each of the aggregated series contains only fifteen observations, the models are estimated with a maximum of five lags.

Applying the above tests show that the levels of each series listed in Table 2.1 contain unit roots and that they are stationary in first differences.

A disadvantage of the above tests arises when changes occur to the series structure. Perron (1989) demonstrated that when there are changes in the structure of a stationary series, the full-sample unit root tests can bias the statistics toward the non-rejection of the false null hypothesis of first-order integration. To accommodate such changes, Perron (1989) proposed an alternative unit root procedure that distinguishes a process with a unit root from a process that is stationary around a breaking trend function. He does so by extending the model specification so that the "outlier event" is removed from the noise function and introduced into the deterministic component of

the model.

Of the series listed in Table 2.1, the levels of GDP, the GDP deflator and the non-oil GDP deflator have fallen substantially in the 1985-87 period for the first and third series and in 1983-88 for the second series (see Figures 2.1-2.3). Between 1984 and 1987, the levels of the GDP and non-oil GDP deflator fell by 18.8% and 17.3% respectively. For the GDP deflator the fall in its level commenced in 1983 and continued until 1988. Between 1982 and 1988 the level of the GDP deflator fell by 28.6%. The fall in the levels of the series are caused by two consecutive shocks. The first emerged from a measurement error induced by revision of the national accounts data. The second shock was a consequence of the fall in oil prices in 1986. As can be seen from Figures 2.1-2.3, these falls in the levels of the three series are the largest over the sample period, thus requiring further investigation of the effects of such changes on the results of our previous unit root tests. Given that the fall in the levels of the series lasted for more than a single period, the unit root test is reestimated using the innovational-outlier framework of Perron's model C.

This model has the advantage of accounting for the effects of both a crash and a break in the trend of the series. The first and second changes are defined, respectively, as a one time change in the intercept and in the slope of the trend function. These changes are not a realization of the data generating mechanism, rather they

are an outcome of exogenous events that influence the series. To capture their effects on the unit root test, Perron suggested adding a set of dummy variables to the Dicky-Fuller regression, i.e.

$$Y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \delta D(TB)_t + \alpha Y_{t-1} + \Phi(L)(1-L)Y_{t-1} + \varepsilon_t \quad (4)$$

where

$DU_t = 1$ if $t > T_B$, 0 otherwise;

$DT_t = t$ if $t > T_B + 1$, 0 otherwise; and

$D(TB)_t = 1$ if $t = T_B + 1$, 0 otherwise.

μ, θ, β, γ, δ and α are scalar parameters to be estimated. $\Phi(L)$ is a polynomial in the lag operator L.

The results of Table 2.2 reveal that the trend functions of these series are stochastic, i.e. the two shocks discussed above did not cause a break in the GDP, GDP deflator and non-oil GDP deflator trend functions.

Hence, using the 5% significance level, it is possible to state that the data clearly accept the first-order integration null hypothesis for all series listed in Table 2.1.

Table 2.1
Unit Root Tests

Series		ADF	Phillips-Perron
GDP	[2]	-1.038	-1.413
NGDP	[1]	-1.899	-1.579
G	[1]	-1.952	-1.227
GDPD	[1]	-1.740	-1.668
NGDPD	[1]	-2.016	-1.526
E	[2]	-1.579	-1.758
NTR	[1]	-2.019	-2.513
OE	[2]	-1.423	-1.663
OPI	[1]	-1.744	-2.702
CPI	[1]	-1.684	-1.605

Notes:Figures in square brackets are the required lag length to whiten the residual series. ADF is the augmented Dickey-Fuller statistic. The Phillips-Perron statistics are estimated using a Parzen lag window. Using different lag windows (Bartlett and Tukey) does not alter the above results.

Table 2.2
Augmented Dickey-Fuller Test With Changing Trend
(Innovational-Outlier Model)

Series		TB	λ = TB / T	ADF
GDP	[1]	1984	0.67	-2.417
GDPD	[1]	1983	0.60	-2.525
NGDPD	[3]	1984	0.67	-1.717

Notes: TB denotes time period at which the break took place. Figures in square brackets are lag lengths required to whiten the residuals. The ADF statistics are compared with the 5% critical values given in Perron (1989, Table VI.B).

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Given that we have sample sizes of fifteen, our choice of cointegration tests is restricted to those which will allow the highest degrees of freedom. With fifteen observations, it will not be unreasonable to anticipate a very low test power, and this will probably be true irrespective of the cointegration test we select. Nevertheless, in this section we will report the results of Engle and Granger's (1987) two-step test, as it leaves the highest degrees of freedom.[8]

Table 2.3 lists the results of the two-step test. It shows that it is not possible to reject the null hypothesis of no cointegration. This result is obtained despite the fact that the roots of all cointegrating regression residuals are numerically much less than one. These small values suggest that the residuals from the bivariate and trivariate models may be stationary, i.e. by the Engle-Granger definition, the series in each model are cointegrated. The conflicting results of Table 2.3 point to the weak power of the two-step cointegration test. It has the tendency to accept the null hypothesis of no cointegration even when the null is false (see Kremers et al. 1992). Indeed, based on Monte Carlo experiments, Hooker (1993) has found that, for an annual sample of thirty three (2.2 times Table 2.3 samples), the power of the two-step

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[8]Johansen (1988, 1991) has developed an alternative cointegration test that avoids the difficulties associated with the two-step test. However, as the Johansen test is conducted using vector autoregressions, it will not be possible to carry out cointegration tests of the above models using this procedure.

test is extremely low (see Hooker, 1993 Table 2 part B and C). For example, at a 5% significance level the test fails approximately 50% of the time to reject the null hypothesis of no cointegration even when the null is false.

Hence, our decisions about cointegration will be based on the roots of the cointegrating regression residuals rather than on the test itself. As a result, the null hypothesis of no cointegration is rejected for all models.

Table 2.3
Two-Step Cointegration Test and the Roots of
the Cointegrating Regression Residuals

Two-Step Test	Root of the Cointegrating Regression Residuals
(i) Nominal GDP on Total Exports	
-1.578 [1]	0.789
(ii) Nominal Non-Oil GDP on Non-Oil Visible trade	
-1.844 [1]	0.607
(iii) Government Expenditure on Oil Exports	
-1.435 [1]	0.810
(iv) GDP Deflator on Oil Price Index and CPI	
-1.973 [1]	0.561
(v) Non-Oil GDP Deflator on CPI	
-2.619 [1]	0.170

Notes: Figures in square brackets are the lag size required to whiten the residuals. The t-statistics are compared with critical values provided in Charemza and Deadman (1992, Table 2)

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FIGURE 2.1: GDP
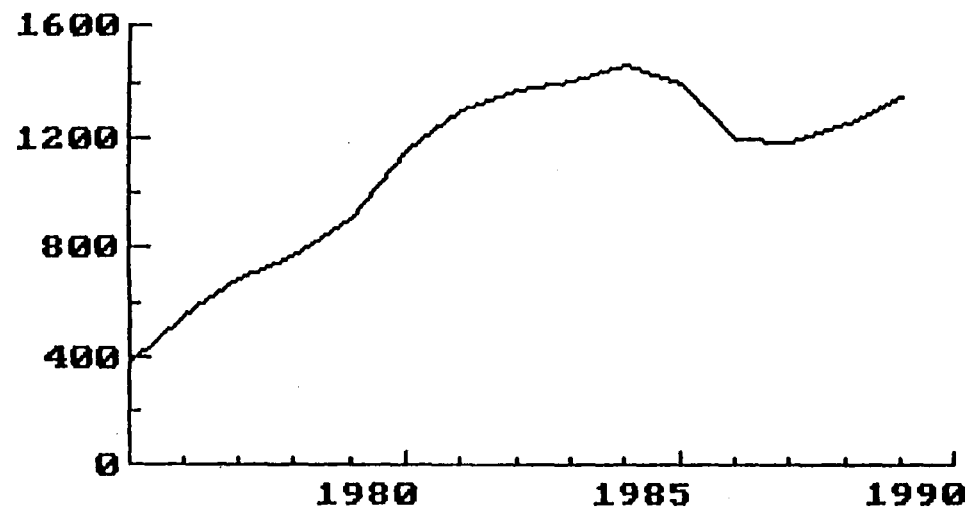
FIGURE 2.2: GDP DEFLATOR
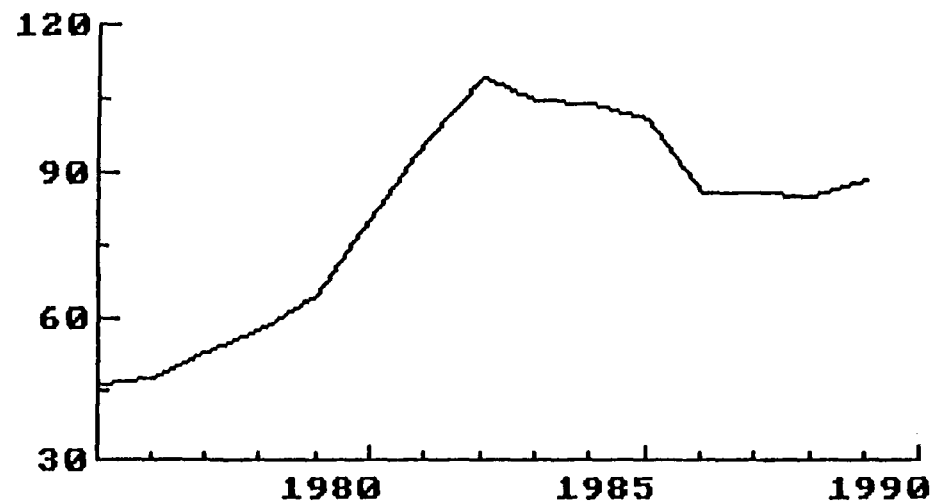
FIGURE 2.3: NON-OIL GDP DEFLATOR
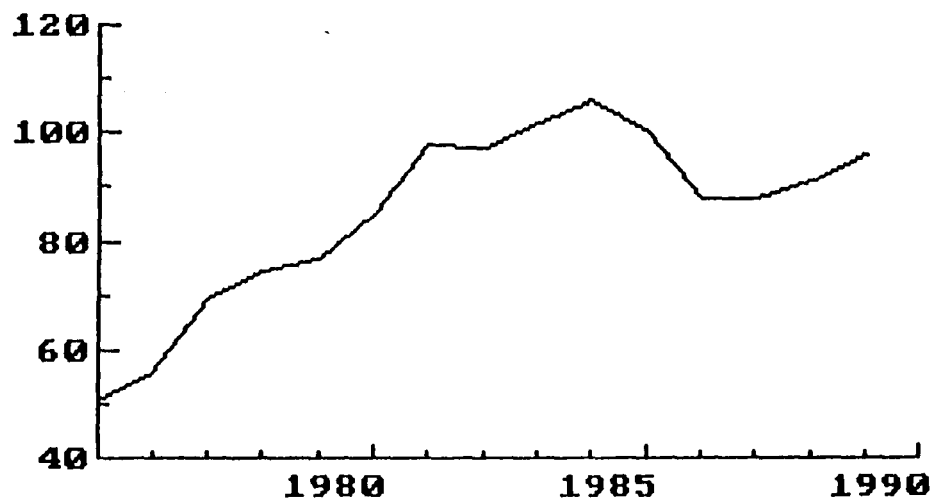
2.3.2 Estimating the Missing Observations and Testing the Robustness of the Results

The estimates of the missing observations are obtained by smoothing each transition equation within the Kalman filter. Unlike the filter itself, the smoothing algorithm uses all the information in the sample. As a result the smoother error will have a covariance matrix that is smaller than the filter's covariance matrix. The latter will exceed the smoother's matrix by a positive semidefinite matrix (Harvey, 1992).

Figures 2.4-2.8 display the results using the smoothing algorithm for seasonally unadjusted series.[9] The annually estimated series of GDP, non-oil GDP and government expenditure are obtained by summing the estimated quarterly observations. The estimated GDP deflator and non-oil GDP deflator series are the averages of the corresponding quarterly observations.

The robustness of the results are checked by two means. The first utilizes the fact that the measurement equation is deterministic and hence can be used to check the robustness of the disaggregated series, i.e. for a flow variable, by summing the quarterly observations of the right hand side and comparing it with the actual aggregated series on the left hand side. In the second, we will follow Granger's (1988a) recommendation by testing for the similarity between

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[9]Smoothing seasonally adjusted series show insignificant changes from the results of seasonally unadjusted series. In Appendix 2B lists of the seasonally unadjusted quarterly observations are provided.

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the integration properties of the aggregated and disaggregated series. Granger demonstrated that whatever is the level of aggregation, the same series must have the same integration property.

The results of both checks can be summarized in the following:

(i) Of the five smoothed series, noticeable deviations from the actual series occurred in 1976 and 1977 to the GDP deflator and the non-oil GDP deflator. The smoothed series of the GDP deflator deviated from the actual series by 1.9% and 2.7% for the years 1976 and 1977 respectively. For the non-oil GDP deflator the size of the deviations were, respectively, 6.4% and 10.8%. The next largest deviation occurred to the non-oil GDP deflator series in 1988. However, this time the deviation was only 0.6% of the actual series.

(ii) Table 2.4 shows that the quarterly series possess similar integration properties to their corresponding aggregated series.

Thus, the results given in Figure 2.4-2.8 and Table 2.4 show that the Harvey-Kalman filter approach to estimating missing observations have produced quarterly observations series that exhibit similar properties to those of the temporally aggregated series. More important, they show that these results are robust.

Table 2.4
Testing the Integration Order of the
Quarterly Series

Series		ADF	Phillips-Perron
GDP	[1]	-2.413	-2.666
NGDP	[2]	-2.568	-3.041
G	[3]	-2.666	-3.451
GDPD	[1]	-1.412	-1.431
NGDPD	[1]	-1.254	-1.143

Notes: Figure   in   brackets   are   the   lag   length
required to whiten the residuals.

2.4 Conclusion

In the above section we have demonstrated that the Harvey-Kalman filter is a very useful technique for estimating missing observations. It demands the acceptance of a strong statistical prerequisite (cointegration) and, once blended with economic theory, produces a very good approximation to the missing data. Consequently, the estimated observations will be utilized in subsequent chapters to carry out analyses of the Bahraini economy using time series techniques which are not possible to employ with aggregated series.

FIGURE 2.4: GDP AND ESTIMATED GDP
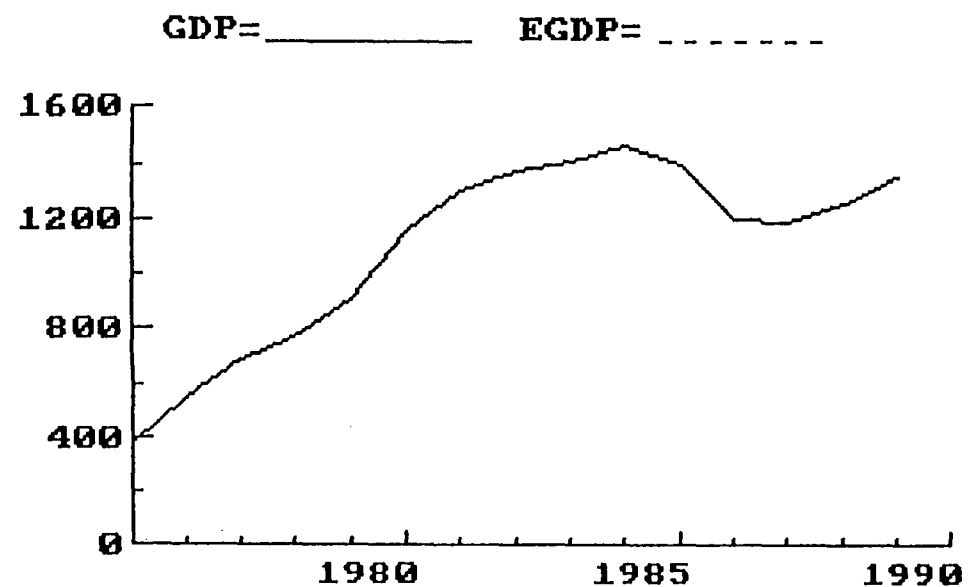
FIGURE 2.5: NGDP AND ESTIMATED NGDP
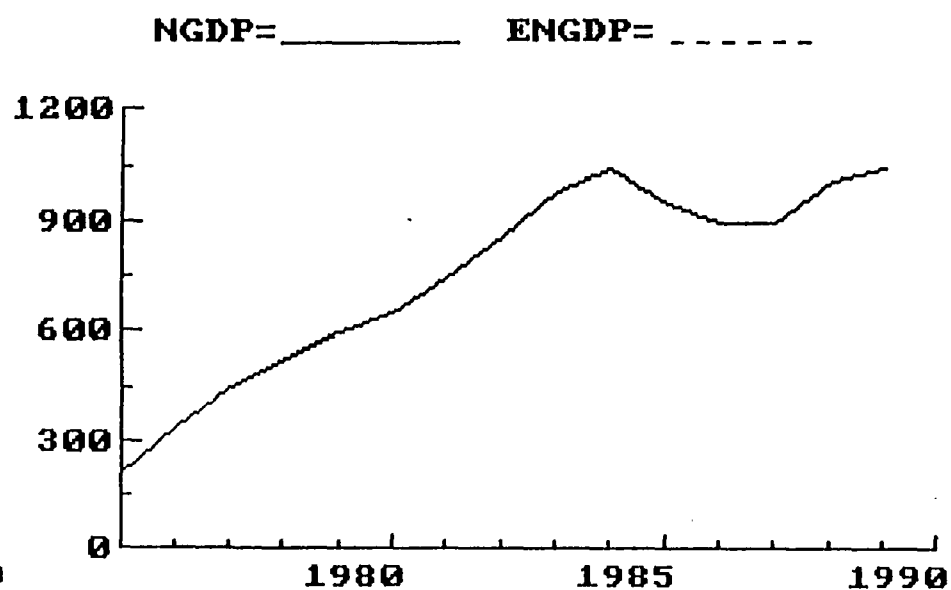
GDP=_____ EGDP= _ _ _ _ _ _

NGDP=_____ ENGDP= _ _ _ _ _ _

FIGURE 2.6: G AND ESTIMATED G
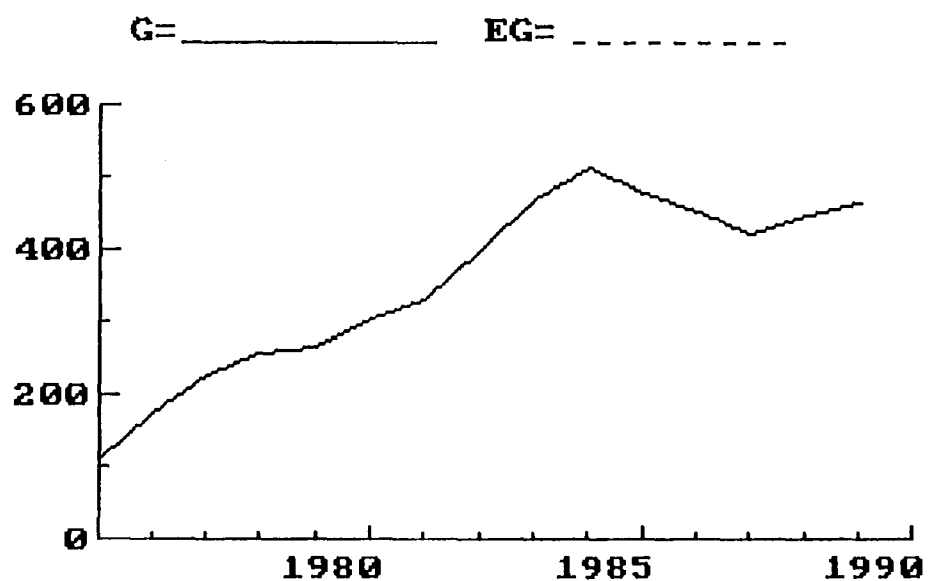
FIGURE 2.7: GDPD AND ESTIMATED GDPD

G=_____ EG= _ _ _ _ _ _ _ _
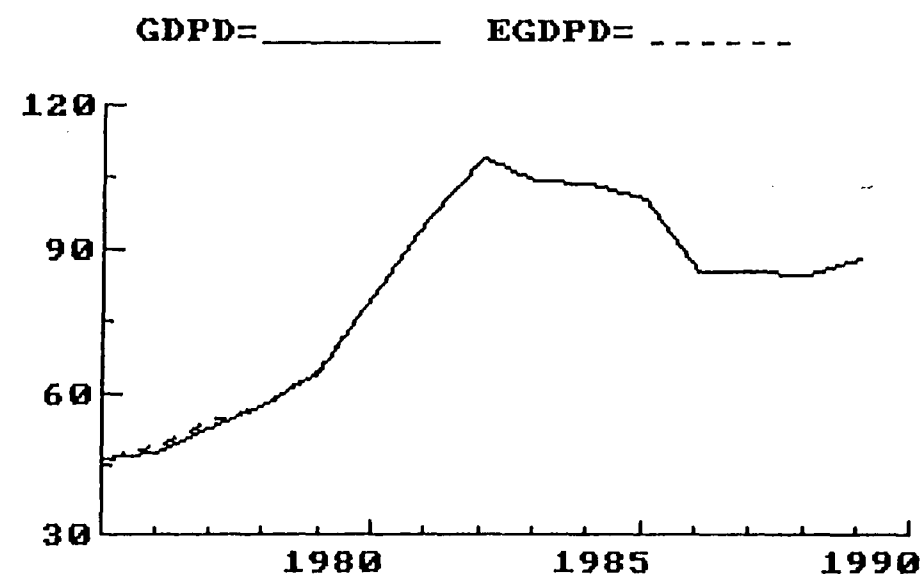
GDPD=_____ EGDPD= _ _ _ _ _ _

NOTES: EGDP: ESTIMATED GDP; ENGDP: ESTIMATED NON-OIL GDP; EG:ESTIMATED G; AND
EGDPD: ESTIMATED GDP DEFLATOR

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FIGURE 2.8: NGDPD AND ESTIMATED NGDPD
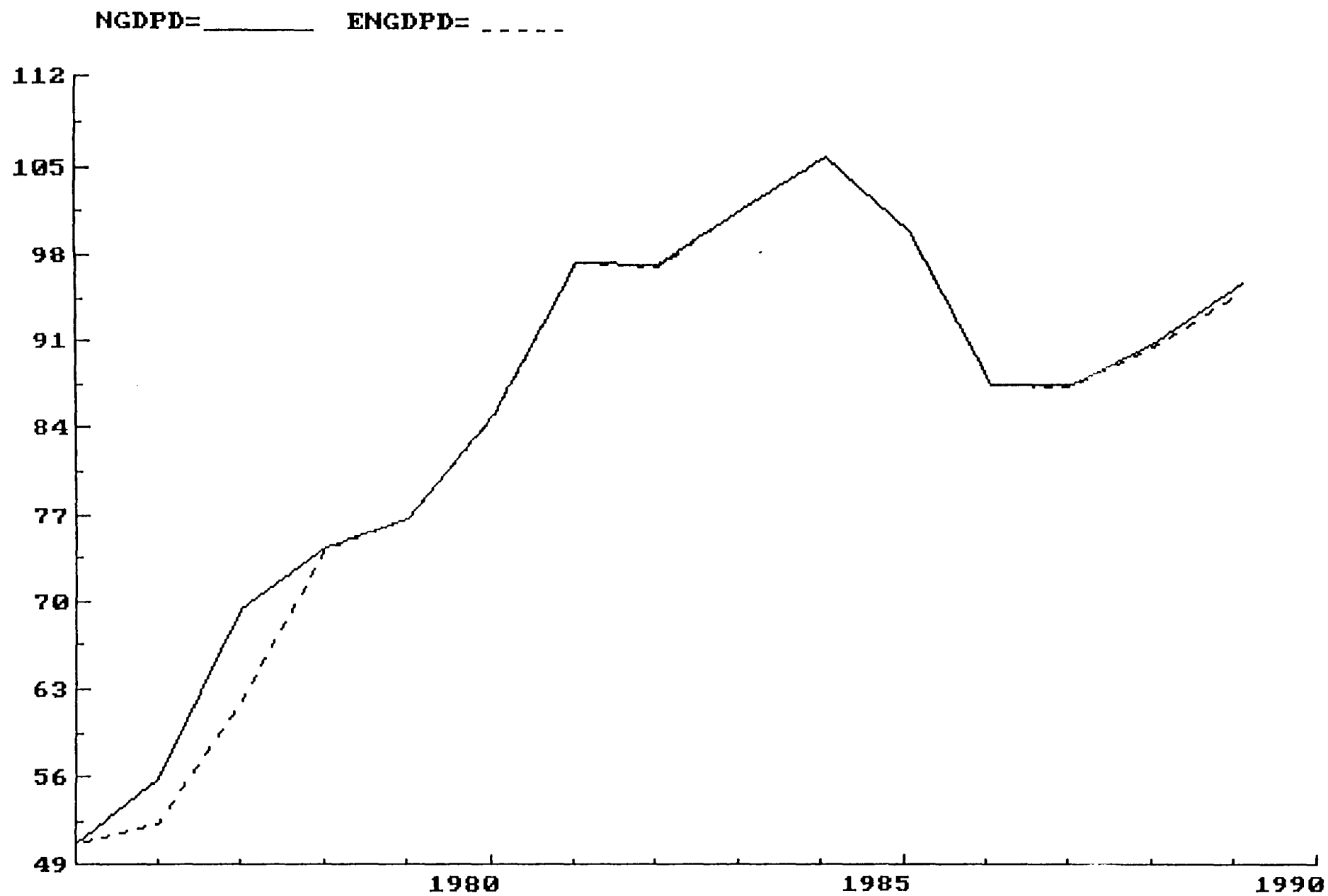
NGDPD=_____   ENGDPD= _ _ _ _ _

NOTE: ENGDPD: ESTIMATED NON-OIL GDP DEFLATOR

Chapter Three

Business Cycles in an Oil Based Economy: Establishing Stylized Facts for Bahrain

3.1 Introduction

Following the seminal paper of Nelson and Plosser (1982), a new field in macroeconomics emerged aimed at measuring persistence in output (see Campbell and Mankiw, 1987a,b; Cochrane, 1988, 1994; Durlauf, 1989, 1991, 1993; Pesaran et al. 1993). In general, these studies estimated persistence using data from developed countries and produced conflicting results. For developing countries, and Bahrain in particular, the issue of persistence has not been addressed, thus encouraging us to investigate, and consequently establish, a stylized fact about the extent of innovations persistence in Bahrain GDP, non-oil GDP and oil GDP. Another key stylized fact observed over the business cycle is the positive comovement of money and output (see Friedman and Schwartz, 1963; Sims, 1972; Moosa, 1986; Stock and Watson, 1989). A third stylized fact that is more appealing for developing economies, and for the rentier economies in particular, is the role of government expenditure in explaining macroeconomic fluctuations (see Moosa, 1986; Chishti et al. 1992).

In this chapter we will investigate the relevance of these stylized facts to the Bahraini economy for the period 1975I-1989IV.

The stylized facts that are established in this chapter can be summarized in the following: (i) real GDP and its two components have very little persistence; (ii) from a macroeconomic and hence policy perspective, monetary policy stands neutral with respect to real non-oil GDP; and (iii)

by contrast, fiscal policy seems to be the only macro instrument that can influence real GDP. This result supports Blanchard and Quah's (1989) findings on the importance of demand policies in explaining macroeconomic fluctuations. Nonetheless, the results of this chapter differ from Blanchard and Quah (1989) in two ways. First, shocks can have only transitory effects on the level of GDP. Second, even though shocks are of the demand type, they are confined to fiscal policy shocks. Additionally, the results of this chapter produce other important findings. These are: (i) inside money Granger causes non-oil prices; (ii) government expenditure is an important determinant of the monetary aggregates; and (iii) the existing exchange rate regime is not optimal, given the authorities aim of stabilizing non-oil GDP.

The above findings can be attributed to the following factors:

(i) The presence of a very large government sector. It is not possible to attribute the presence of large government to market failure per se. The post 1973 oil shock period reveals that the non-oil sector was nurtured by the government, as might be thought natural when viewed from the perspective of the economic history of Bahrain. In other words, in the case of Bahrain the presence of large government cannot be reconciled with market failure.

(ii) The dependence of the private sector on government expenditure. The dependency was found in two markets, the goods and money markets. The second dependency arises from indirect government financing of private sector activities. These are important structural constraints encountered by the Bahraini economy.

(iii) The adoption of a pegged exchange rate regime. It is well known that such a regime tends to hamper the efficiency of monetary policy and, in the Bahraini case, it seems to have contributed to the divorce of domestic monetary policy from domestic fundamentals.[1]

The rest of this chapter is organized as follows. Section 3.2 provides a brief discussion on the characteristics of the Bahraini economy. In section 3.3 persistence in GDP and its components is measured. Section 3.4 uses the VAR approach to model non-oil GDP fluctuations. Section 3.5 gives a summary of the findings and concludes the chapter.

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[1]See chapter 5 for further tests on the divorce of monetary policy from domestic fundamentals.

3.2 A Background to the Bahraini Economy: A Brief Review

3.2.1 Output

In a rentier economy the behaviour of the macroeconomy is better understood when output is decomposed into rent and non-rent sectors. For the Bahraini economy this is equivalent to the oil and non-oil sectors. This decomposition allow us to distinguish between the exogenous and domestically influenced sectors and hence to evaluate domestic economic policies.

The characteristics as well as the functioning of the Bahraini economy can be summarized as follows:

(i) Bahrain is a very small oil producer and a non-member of the organization of petroleum exporting countries (OPEC); consequently Bahrain behaves as a price taker in the world oil market. Like other commodities, the demand for oil is strongly influenced by its price and since oil is an international commodity, its price is eventually determined in the international markets. What this implies for a small oil producer like Bahrain is that the demand for its oil output is internationally determined, i.e. output is exogenous to domestic economic policies. Thus domestic fiscal and monetary policies are not expected to have any influence on the oil sector.

To have approximately one third of domestic output determined by decisions taken overseas must have potentially serious implications for any stabilization programme (see Table 3.1 for shares of oil output in GDP). The first implication is related to the high volatility of the oil sector, which exacerbates GDP fluctuations. The second implication follows from the fact that, in spite of the ultimate goal of the Bahraini decision makers being a continuously growing GDP, targeting GDP is a gross misunderstanding of the characteristics of the Bahraini economy. For this reason, the 1986 and 1990 stabilization programmes have explicitly identified diversification of economic activities away from the oil sector as the aim of the policy makers, i.e. targeting non-oil GDP.

(ii) In terms of input/output analyses the oil and non-oil sectors are weakly linked (see Table 3.2). The proportion of oil sold in the domestic economy is mainly consumed for personal and commercial purposes at a set of unified and fixed prices. These prices were set in April 1983 and have remained fixed since then. Hence a shock to the level of oil prices affects Bahraini oil export prices but not domestic oil prices, thus concealing any direct transmission of oil shocks to the non-oil sector.

The link between the two components of output is indirect and is channelled through government expenditure. In the literature on natural resource based economies, this transmission is known as the "expenditure effect" (see Kremers, 1985; Neary and Wijnbergen, 1985). By being the domestic owner of the oil joint venture, the government is capable of cushioning the non-oil sector from oil shocks.

To understand the reasons that gave rise to the government/non-oil sector relationship, we need to take a short detour through the history of the Bahraini economy. It is possible to begin the review with the discovery of oil in 1929; however, starting from the first oil shock will provide enough background. Before commencing we need to acknowledge four facts that were in existence prior to 1973. First, Bahrain had a high rate of unemployment, arising from a stagnating economy. Second, non-oil sectors were underdeveloped and some sectors were not in existence: for instance, there was no tourism sector. Third, the infrastructure was extremely underdeveloped. Fourth, government and not the private sector was the domestic partner in the oil joint venture. Between the first oil shock and a year prior to the 1986 oil shock, the government's average annual revenue from the oil sector increased by 31.8% per annum. This amounted to a 27.6 fold increase in government oil receipts. As a result, the

government pursued a highly expansionary fiscal policy, manifested by the adoption of a vast number of development projects. This led to the restructuring of the Bahraini economy and to the emergence of the existing non-oil sector.

For further understanding of the relationship between government expenditure and output, a review of the role of fiscal policy will help us to grasp the background to this relationship. To review the role of macroeconomic policies, the discussion will not be complete without reviewing the role of monetary policy. Consequently, the effectiveness of monetary policy in Bahrain is briefly discussed in subsection 3.2.3.

3.2.2 The Conduct of Fiscal Policy

There are two major points to note when analyzing the role of fiscal policy in the Bahrain economy. The first is related to the size of the government sector in the economy. As can be seen from Table 3.3, the government sector is indeed very large. However, as the oil companies maintain their finance independence from the government, the ratio of government expenditure to non-oil GDP is more appropriate as a measure of government size. A meaningful stabilization programme must incorporate this fact. Second, we need to know the source of the government intakes and outlays. Usually, income and corporate taxes are the main source of government revenues and these are dominated by domestic sources. Under such a regime government revenues are

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directly linked to the performance of the domestic economy. Conventional economic policies are then pursued given this structural relationship between government revenues and macroeconomic performance. In Bahrain, however, there are neither income nor corporate tax, so revenues are mainly obtained through oil exports.

The dependence of government revenues on oil exports is a fundamental structural characteristic of Bahrain's rentier economy. Tables 3.4 and 3.5 provide evidence on this. Additionally, both tables point to the following:

(i) Government revenues are very undiversified. During 1975-89 oil revenues constituted two-thirds of total government revenues.

(ii) Over this period, the domestic sources of revenues were approximately one-third of total revenues and were mainly comprised of indirect taxes and fees.

(iii) Knowing that Bahrain is a price taker in world oil markets reveals that Bahrain's government has very little or no influence over a major source of its income. This points to the extreme exposure of government revenues to oil price shocks. For instance, government revenues increased by 62.7% following the 1979/80 oil shock but fell by 20.2% after the collapse of the oil price in 1986.

(iv) Oil revenues are the main source of fluctuation in government revenues (see Table

3.5).

(v) Given that there is no income tax, fiscal policy will need to resort to indirect means to influence income and output distributions.

Because government revenues are independent of private income, the conventional view on the distribution of resources between the government and private sectors cannot be reconciled with the Bahraini case; an increase in government revenues does not imply that resources are extracted from private income. In reality, private income tends to depend on government expenditure: non-oil GDP on government expenditure (see section 3.4.2).

(vi) It is highly unlikely that with the available fiscal instruments a resource reallocation can be smoothly achieved and hence the diversification goal met. In such a fiscal environment, the scope for using supply side policies is limited. Thus fiscal policy is anticipated to be more effective through the demand side, i.e. government expenditure.

Table 3.1
The Proportion of the Non-oil and Oil Sectors in GDP
(Percentage)

Period	Non-oil	Oil
1975-79	64.1	35.9
1980-84	63.7	36.3
1985-89	74.7	25.3
1975-89	68.1	31.9

Table 3.2
Correlation Matrix Between GDP and Its Components

	GDP	Non-oil GDP	Oil GDP
GDP		0.670	0.478
Non-oil GDP			0.027
Oil GDP			

Notes: The   correlations   are   estimated   taking
the   integration   properties   of   the   series   into
consideration.

Table 3.3
Percentage of Government Expenditure in GDP and
Non-oil GDP

Period	In GDP	In Non-oil GDP
1975-79	31.6	49.3
1980-84	30.3	47.5
1985-89	36.7	47.7
1975-89	32.6	47.9

Table 3.4
Percentage Share of Oil and Non-oil Receipts in Government Revenues

Period	Oil	Non-oil
1975-79	72.6	27.4
1980-84	71.2	28.8
1985-89	59.6	40.4
1975-89	67.1	32.9

Table 3.5
Variation in Government Revenues by Sector
(Percentage)

Oil Revenues	Non-oil Revenues
63.3	36.7

Notes: Variation in government revenues (GR) is calculated as follows: Var(GR)=Var(OR)+ Var(NOR)-2Cov(OR,NOR), where OR and NOR stand for oil and non-oil revenues respectively. Since OR and NOR are assumed to be orthogonal, Cov(OR,NOR)=0.

3.2.3 The Effectiveness of Monetary Policy

When attempting to understand the role of monetary policy in Bahrain, we need to take into account two fundamental factors that exert important influences over Bahrain's monetary policy. The first factor is given by the exchange rate regime(s) that is/are adopted during the sample period. In an open economy with capital mobility, such as Bahrain's, the exchange rate regimes are crucial to

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understanding the role of monetary policy. Under a pegged regime, such as Bahrain's Dinar (BD), monetary policy is considered to be strongly influenced by the peg currency's monetary policy.[2] In fact, once the authorities have decided to peg their exchange rate they implicitly have taken the decision of surrendering their monetary policy (see Friedman, 1953). Thus, unless the domestic and peg currency fundamentals are in perfect harmony, the peg may result in the divorce of domestic monetary policy from domestic fundamentals.

The second factor arises from the presence of a large government in the financial sector, which is a net lender to the Bahrain Monetary Agency (BMA) and the domestic banks (see Table 3.6). The relationship between the government's position in the banking sector and the money supply can be summarized in the following:

(i) The government owns a large proportion, approximately 57.9%, of foreign assets. This stems from the fact that the government and not the private sector is the owner of the main foreign exchange earners: oil, aluminium and petrochemicals.

(ii) The government is a net lender in the domestic credit market. This policy reflects the authorities concern with the stability of the domestic banking sector. Being a net lender to

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[2]See chapter 5 for discussion of BD exchange rate policy.

the banking sector, the government is indirectly financing the private sector borrowing requirement (see the fourth column of Table 3.6).

(iii) As a result, the government's policies are expected to be an important determinant of the money supply (see section 3.4.2 for further discussion). Additionally, given that the government borrowing requirement is exogenous to monetary policy, fiscal policy may contribute to diminishing the effectiveness of monetary policy.

The above two subsections have highlighted the role of fiscal and monetary policies and have hypothesized that the effects of a large government spills over into the goods and money markets. This hypothesis will be tested in section 3.4. Prior to testing the above hypothesis, section 3.3 will estimate the level of persistence in GDP, non-oil GDP and oil GDP innovations. This is done to establish the stylized facts on persistence in the three series, i.e. the effects of a shock to the level of these series.

Table 3.6
Domestic Liquidity and Its Components
Millions BD

Year	Foreign Assets		Domestic Assets		Domestic Liquidity
	Monetary Authority	Deposit Money Banks	Claim On Gove.*	Claim On Private Sector	
1975	110.22	30.85	-106.39	160.76	195.44
1976	126.38	35.61	-109.77	267.90	320.12
1977	140.36	26.30	-91.01	310.76	386.41
1978	157.63	51.99	-95.65	325.44	439.41
1979	232.76	0.88	-135.83	375.84	473.65
1980	361.33	83.95	-278.54	434.89	601.63
1981	582.84	220.28	-465.54	487.48	825.06
1982	581.17	232.86	-389.50	544.64	969.17
1983	539.85	320.16	-398.30	606.88	1068.59
1984	535.66	330.83	-493.07	640.20	1013.62
1985	639.46	459.14	-540.27	598.43	1156.76
1986	590.64	543.00	-479.92	566.09	1219.81
1987	470.47	547.61	-240.02	498.02	1276.08
1988	501.53	695.75	-469.18	491.64	1219.74
1989	504.07	844.28	-566.94	482.37	1263.78

Notes: Gove stands for government.
Source: International Monetary Fund (1991), International Financial Statistics.

3.3 Measuring Persistence

3.3.1 A Brief Literature Review

Persistence is a statistical property of a series in which its data generating mechanism is not a trend or mean reverting process. Persistence has important implications

for economic, as well as, econometric theory. For economic theory, persistence reflects an approach to analyzing macroeconomic fluctuations in which output is viewed to be driven over the long-run by real shocks, e.g. technological or taste. If this is true then macroeconomic policies have no effect on output over the long-run, i.e. macroeconomic policies are neutral. Friedman (1968) has persuasively presented this view. According to Friedman, the supply schedule is vertical over the long-run to reflect its independence from macroeconomic policies and that aggregate demand shocks can influence output only over the short-run. However, real shocks emanating from technological or taste changes will affect output permanently. Along this line, the real business cycle (RBC) theories utilize the stochastic trend property of output to go one step further. The RBC theories attribute fluctuations in output only to technological shocks and the stochastic property of output stands as evidence supporting this proposition. For this reason the RBC theories render stabilization policies ineffective.[3] To conventional economic theory this poses a

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[3]For critical reviews of the real business cycle theories see Summer (1986) and Mankiw (1989). Campbell and Mankiw (1989) have tested the technological shock hypothesis on various countries and concluded by rejecting it. Their proposed test can be explained as follows: if technological shocks are the sole determinant of long-run fluctuations, then a technological innovation in one country is expected to be transferred to other countries after some period. If so, then the outputs of various countries have to be cointegrated. But a test of cointegration fails to reject the null of no cointegration, thus rejecting the RBC hypothesis. This leads them to conclude that domestic policies and institutions are an important determinant of domestic output over the long-run.

serious challenge.

For econometrics, persistence can be interpreted as a good indicator of the series integration properties: for a first difference stationary series, the value of the persistence measure is expected to be very close to one. Hence such series must be modelled only after differencing.

In the literature, persistence is either measured parametrically using such approaches as those suggested by Campbell and Mankiw (1987a,b), Cochrane (1994) and Pesaran et al. (1993), or by non-parametric methods, such as the Cochrane (1988) and Durlauf (1989, 1991, 1993) approaches. The Campbell-Mankiw measure and the Cochrane non-parametric measure are the simplest and most popular measures. The Pesaran et al. approach is a multivariate measure and, in spite of incorporating more information, it is nonetheless a generalization of the Campbell-Mankiw measure to the multivariate context. Durlauf's measure is calculated in the frequency domain and inference is conducted by comparing the properties of the normalized spectral distribution of the series under consideration with that of white noise. Since the normalized spectral distribution of white noise does not exhibit any form of concentration, the plot of its

normalized spectra in the $[0,\pi]$ domain is a diagonal line.[4]

Hence the further is the normalized spectrum from this diagonal line, the larger is the persistence in the series under consideration.

Generally, persistence is measured at the zero frequency; thus, if we assume that y is a first difference stationary series, then it can be modelled as an ARIMA (p,1,q) process of the following form:

$$\Phi(L)(1-L)y_t = \Theta(L)\varepsilon_t \tag{1}$$

where $\Phi(L)$ and $\Theta(L)$ are finite polynomials in the lag operator L of order p and q respectively. ε is a white noise process. Campbell and Mankiw (1987a, b) have suggested a measure of persistence based on the Wold decomposition of (1). To see this premultiply (1) by $\Phi(L)^{-1}$

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[4]The diagonal line property can be derived using the spectrum of a white noise process. Assume that σ^2 is the variance of the white noise, then its spectrum is

$$f(\lambda) = \sigma^2/2\pi = f(0)$$

This is true since $\text{cov}(x_t, x_s) = 0$, $\forall$ s≠t. Since the spectrum is symmetric around the zero frequency, the normalized spectral density function of white noise can be calculated as

$$R(\lambda) = \frac{2\int_0^\pi f(0)\,d\lambda}{2\pi f(0)}$$

$$= \lambda/\pi \quad \Big|_0^\pi$$

Thus the normalized spectrum will be a diagonal line in the $[0,\pi]$ domain.

to yield

$$(1-L)y_t = \Psi(L)\varepsilon_t \qquad (2)$$

where $\Psi(L) = \Phi(L)^{-1}\Theta(L)$.   Campbell and Mankiw measure persistence as:

$$\Psi(1) = \Theta(1)/\Phi(1) \qquad (3)$$

If y is a stationary series, $\Psi(1)$ converges to zero, i.e. its long-run value is independent of any innovation. Thus a shock to the level of y has only transitory effects. But if y is a random walk, $\Psi(1)$ will converge to $\Theta(1)/\Phi(1)=1$, since (1) can be modelled as:

$$(1-L)y_t = \varepsilon_t \qquad (4)$$

where $\Phi(1) = \Theta(1)$ and hence $\Psi(1) = 1$.

The convergence of $\Psi(1)$ to one both highlights the presence of high persistence in the data and indicates that a unit innovation to the level of y affects it permanently.[5] In other words, $\Psi(1)$ can be interpreted as the coefficient that measures the long-run effect of a unit shock on the level of y and is usually referred to as the coefficient of persistence.

An alternative measure due to Cochrane (1988) uses the series second moment to derive a non-parametric measure of persistence. Because the measure is non-parametric it is not as liable to model misspecification as is

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[5] In practice, $\Psi(1)$ may have a value greater than one reflecting the presence of high persistence.

Campbell-Mankiw's measure, as we will see later. Cochrane's method is based on the notion that a non-stationary series can be represented as the sum of a stationary and a random walk component. Thus it aims at measuring the size of the random walk component. To see this assume that y is a random walk. If this is true then the variance of y grows linearly with time so the variance of the k-difference is: $\text{var}(y_t - y_{t-k}) = k\sigma_\varepsilon^2$. σ_ε^2 is the variance of the residuals. Letting σ_k^2 denote the division of the variance of the k-difference by k then, for a random walk, the division of σ_k^2 by σ_1^2 must be one: $V_k = \sigma_k^2/\sigma_1^2 = 1$. V_k is known as the variance ratio. However, if y is stationary then we expect $\sigma_k^2 \to 0$ as $k \to \infty$ and hence $V_k \to 0$.

In the limit the Cochrane and Campbell-Mankiw approaches are related through the following formula:

$$\Psi(1) = (V/(1-R^2))^{1/2} \qquad (5)$$

where V is the limiting value of V_k and R^2 is the fraction of the variance of $(1-L)y_t$ that is explained by past information, i.e. $R^2 = (1 - \sigma_\varepsilon^2/\sigma_{(1-L)y}^2)$.

In the next two subsections the univariate techniques suggested by Campbell and Mankiw and Cochrane will be used to measure persistence in the time series of real GDP, real non-oil GDP and real oil GDP.[6]

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[6]Unit root tests for the three series are carried out in the next section and the results are given in Table 3.12. The tests show that real GDP and real non-oil GDP are trend stationary while oil GDP is a stationary series (integrated of order zero).

3.3.2 Parametric Estimates of Output Persistence

The growth rate of each of the three series is fitted by an ARMA(p,q) process for $p=(0,1,2,3,4)$ and $q=(1,2,3,4)$. Additionally, the Bayes information criterion (BIC) and the Akaike information criterion (AIC) are calculated to decide on the model.[7] However, knowing that the parametric measure of persistence is not independent of the model specification, the persistence measures from the various models will be displayed. Thus, if the series under consideration is stationary and its MA component does not have a unit root, its persistence measure should always point to that fact irrespective of the model specification.

Tables 3.8-3.10 reveal that the three series do not have high persistence: a 1 per cent surprise innovation to the level of output or to any of its two components will change the forecasts of the long-run level by less than 1 per cent. If the choice of the model rests on using either of the information criteria, the BIC and AIC select ARMA$(1,1)$ and $(2,2)$ for real output, ARMA$(4,2)$ for non-oil GDP and ARMA$(3,1)$ for oil GDP. The measures of persistence from using these models show that a 1 per cent innovation will increase the long-run forecast of real GDP, real non-oil GDP and real oil GDP by 0.62% or 0.52%, 0.45% and 0.07% respectively. However, the same tables show wide

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[7]The selection of the criteria is conditional on the absence of unit root(s) in the MA components. If the model selected by either criterion contains a unit root in its MA part, the model is discarded in favour of the next best model.

fluctuations in persistence across different model specifications. For instance, persistence in GDP fluctuated between 0.103 for ARMA(3,2) and 0.705 for ARMA(4,3). These fluctuations are a clear indication of the reliance in the parametric approach on model specification and hence encourages us to see the results from using a non-parametric measure.[8]

3.3.3 Non-Parametric Estimates of Output Persistence

Using Cochrane's approach to estimating persistence requires determining the span of the differences. Using the results from a Monte Carlo simulation, Campbell and Mankiw (1987a) warned against using large k. Their results show that a large k tends to bias the persistence results downwards, i.e. toward stationarity. To be consistent with the empirical studies, A(1) is calculated with k set to one quarter of the observed series (see Balke, 1991; Mills, 1991a). Table 3.11 lists the results of the non-parametric measures and shows that both measures, V_k and A(1), point to low persistence in GDP and its components.

The results of the non-parametric measures are consistent with the results of the parametric results. Thus it is possible to state that GDP, non-oil GDP and oil GDP all have little persistence and hence support the results of

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[8]Fluctuations in the values of the parametric measures are exacerbated by the shortness of the sample size. Such samples cannot fit high order ARIMAs accurately. Thus, they induce large fluctuations with changes in model specification.

the unit root tests given in Table 3.12 and discussed in the
next section.

Table 3.7
Model Selection Criteria
ARMA(p,q)

(p,q)	GDP		Non-Oil GDP		Oil GDP	
	BIC	AIC	BIC	AIC	BIC	AIC
(0,1)	-4.208	-4.278	-4.002	-4.105	-2.308	-2.411
(0,2)	-4.164	-4.269	-3.987	-4.092	-2.243	-2.348
(0,3)	-4.115	-4.255	-4.019	-4.159	-2.189	-2.395
(0,4)	-4.081	-4.255	-4.018	-4.158	-2.199	-2.457
(1,1)	-4.229	-4.299	-4.006	-4.076	-2.132	-2.235
(1,2)	-4.163	-4.268	-3.943	-4.047	-2.091	-2.196
(1,3)	-4.117	-4.257	-3.927	-4.067	-2.183	-2.323
(1,4)	-4.087	-4.193	-3.851	-4.026	-2.079	-2.253
(2,1)	-4.145	-4.250	-3.947	-4.052	-2.111	-2.216
(2,2)	-4.165	-4.305	-3.420	-3.560	-2.101	-2.241
(2,3)	-4.148	-4.323	-3.418	-3.593	-2.106	-2.281
(2,4)	-4.146	-4.355	-3.370	-3.579	-1.833	-2.042
(3,1)	-4.158	-4.298	-3.941	-4.081	-2.251	-2.390
(3,2)	-4.097	-4.271	-3.818	-3.992	-2.168	-2.343
(3,3)	-4.080	-4.259	-3.774	-3.983	-1.983	-2.192
(3,4)	-3.626	-3.870	-3.675	-3.920	-2.026	-2.270
(4,1)	-4.062	-4.236	-4.119	-4.293	-1.970	-2.144
(4,2)	-3.979	-4.186	-4.181	-4.390	-2.048	-2.258
(4,3)	-3.898	-4.143	-4.022	-4.267	-1.898	-2.143
(4,4)	-4.138	-4.418	-3.911	-4.190	-1.899	-2.179

Table 3.8
Parametric Estimates of Persistence of Real GDP
ARMA (p,q)

p	q			
	1	2	3	4
0	0.567	0.468	0.388	0.492
1	0.618	0.592	0.464	0.592
2	0.612	0.516	1.054*	0.712*
3	0.621	0.103	0.630*	0.247
4	0.648	0.683	0.705	1.094**

Notes: An asterisk indicates that the MA process contains 2 complex roots on the unit circle. A double asterisk denotes the MA component contains 4 complex roots.

Table 3.9
Parametric Estimates of Persistence of Real
Non-oil GDP
ARMA (p,q)

p	q			
	1	2	3	4
0	0.523	0.332	0.000*	0.000*
1	0.602	0.580	0.509	0.617
2	0.643	0.992*	0.867*	0.845*
3	0.619	0.825*	0.934*	0.952*
4	0.325	0.445	0.660	0.396

Notes: An asterisk denotes that the MA component has 2 complex roots on the unit circle.

Table 3.10
Parametric Estimates of Persistence of Real Oil GDP
ARMA (p,q)

p	q			
	1	2	3	4
0	0.000*	0.000*	0.000*	0.000*
1	0.037	0.040	0.013	0.047
2	0.047	0.021	0.029	0.119
3	0.068	0.073	0.093	0.114
4	0.067	0.064	0.076	0.104

Notes: An asterisk indicates that the MA component contains a unit root on the unit circle.

Table 3.11
Non-Parametric Estimates of Output Persistence

Series	k				A(1)	
	1	3	9	15	BIC	AIC
GDP						
V_k	1.000	0.462	0.154	0.231	0.501	0.559
NGDP						
V_k	1.000	0.333	0.133	0.133	0.457	0.457
OGDP						
V_k	1.000	0.505	0.102	0.043	0.289	0.289

Notes: A(1) is estimated for k=15.

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3.4 Testing for Causal Relationships: VAR Approach

The theoretical analyses provided in section 3.2 are utilized in this section to investigate macroeconomic causal relationships for the Bahraini economy. The tests are carried out to show the relevance of fiscal and monetary policies for the conduct of stabilization policies. As stated earlier, the authorities aim at stabilizing non-oil GDP, and this target variable will be used to examine the relevance of macroeconomic policies. Given that there are different views on the direction of causation between money and output, the estimation is carried out using vector autoregression (VAR), thus allowing us to estimate and simultaneously test for direction of causation.[9] There are views, such as the RBC theories, which use the notion of inside and outside money to argue for the endogeneity of the money supply (see King and Plosser, 1984). In fact, some of the RBC models reject the views that fiscal and monetary policies can contribute to output stabilization (see Long and Plosser, 1983; Fiorito and Kollintzas, 1994). In contrast, the new-Keynesians have consistently advocated the importance of macroeconomic policies for stabilization (see Blanchard and Watson, 1986; Blanchard, 1989; Blanchard and Quah, 1989). The VAR used in this section is designed to test the relevance of these conflicting views for the Bahraini economy.

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[9]For a literature review on VAR modelling, see section 6.3.

To test the various views, the VAR model is estimated using various definitions of the monetary aggregates. These are Cash, high powered money (HPM), defined as the sum of reserves and cash, inside money (IM), defined as private deposits, M1, which is currency outside banks plus private demand deposits, and M2, defined as the sum of M1 and private time and saving deposits.

The model used in this section is a modified version of the simple closed model used in Sims (1980a).[10] The model in this chapter differs from Sims' model by including a fiscal policy variable. Additionally, we differ with Sims in using Granger's causality test rather than variance decompositions to test for causation. The model is specified as follows:

$$
\begin{bmatrix}
\Omega_1(L) & \Omega_2(L) & \Omega_3(L) & \Omega_4(L) \\
\Upsilon_1(L) & \Upsilon_2(L) & \Upsilon_3(L) & \Upsilon_4(L) \\
\Gamma_1(L) & \Gamma_2(L) & \Gamma_3(L) & \Gamma_4(L) \\
\Xi_1(L) & \Xi_2(L) & \Xi_3(L) & \Xi_4(L)
\end{bmatrix}
\begin{bmatrix}
G_t \\
M_t \\
P_t \\
Y_t
\end{bmatrix}
=
\begin{bmatrix}
e_{gt} \\
e_{mt} \\
e_{pt} \\
e_{yt}
\end{bmatrix}
$$

where G, M, P and Y stand for government expenditure, the monetary aggregate, the price level (non-oil GDP deflator) and real non-oil GDP respectively. $\Omega_1(L)\ldots\Xi_4(L)$ are polynomials in the lag operator L, defined as $L^k Y_t = Y_{t-k}$. e_g, e_m, e_p and e_y are white noise innovations to the government expenditure, monetary aggregate, price and

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[10]For a discussion on Sims VAR model, see Todd (1990).

non-oil GDP series respectively. The innovations are assumed to be contemporaneously uncorrelated.

In discussing Sims' (1980a) results on the absence of a significant relationship between money and output, McCallum (1983, 1992) pointed out that these results are robust only when the model includes the monetary policy target. Monetary policy could thus be targeting another variable, which leads to an insignificant relationship between money and output, but not between the monetary target and output. For the United States, McCallum suggested the interest rate, which seems to have a large share in explaining output variations (see Sims, 1980a Table 2; Bernanke and Blinder, 1992; Balke and Emery, 1994).[11] For Bahrain this will be equivalent to including an exchange rate variable in the model. This is done for the reason that, during the sample period, Bahrain maintained pegged regimes. It is well known that, under such a regime, monetary policy is geared towards maintaining the peg relation. Fortunately, the inclusion of an exchange rate variable will not only serve to test the robustness of the results, but it will also simultaneously test for the relevance of the pursued exchange rate policy to the authorities aim of stabilizing non-oil GDP.

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[11]In a six variable VAR, Sims (1992) found nominal interest rate shocks to have an important role in explaining output variations for all G5 countries. However, the same cannot be said about money. Sims found that the response of output to money supply innovations was either very small or predominantly negative. Germany was the only exception.

3.4.1 Determining the Series Integration Properties

In order to detrend the data, we need to determine the integration properties of each series.[12] This is done using the Dickey-Fuller test.[13] From the plot of the series, the unit root tests of real GDP, real non-oil GDP, government expenditure, non-oil deflator and all monetary aggregates are carried out for the alternative hypothesis of trend stationarity. The rest of the series are tested for the alternative of integration of order zero, $I(0)$.[14]

In addition to reporting the results on Dickey-Fuller tests, the Stock (1991) confidence intervals for the largest autoregressive root are calculated to provide additional information concerning the presence of unit roots. This is done in response to the increasing concern about the low power of unit root tests (see Christiano and Eichenbaum, 1990; De Jong et al. 1992a,b).

Table 3.12 shows that it is possible to reject the first difference stationary ($I(1)$) null hypothesis for GDP, non-oil GDP and oil GDP. On the other hand, the unit root

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[12]Generally, studies carried out within the RBC framework use the Hodrick-Prescott filter to detrend the data (see Prescott, 1986; Kydland and Prescott, 1990; Christiano and Eichenbaum, 1992; Kim et al. 1994). Harvey and Jaeger (1993) have demonstrated that detrending data by the Hodrick-Prescott filter can produce spurious cyclical behaviour.

[13]For a literature review on unit root tests, see section 5.5.2.

[14]The exchange rate variable, NEERT, is a total trade weighted exchange rate index. It is a basket composed of the US dollar, Japanese Yen, Deutschmark, Pound Sterling, French Franc, Italian Lira and Australian dollar.

tests show that the null of I(1) cannot be rejected for the rest of the series. These results are further supported by the calculated confidence intervals for the largest unit root. Even though it is not possible to calculate the confidence intervals for the output series using Stock (1991, Table A.1), the ADF-statistics on the series are very low, thus rejecting the null at very low marginal significance levels.

The results of Table 3.12 can be interpreted in the following way:

(i) The integration properties of real GDP and non-oil GDP reveal that each series has a deterministic long-run path that is linear in time and that both series have cyclical components that have a strong tendency to revert to this long-run path (see Figures 3.12 and 3.13). The reversion process has been highlighted in the previous section by the absence of persistence in the stochastic components of both series. From an RBC perspective, the absence of stochastic trends is reconciled with the situation in which each series has a constant rate of technological shocks (see Kydland and Prescott, 1990). However, this rejects the very basic idea of the RBC, that of a stochastic productivity trend.

Nevertheless, the integration property of non-oil GDP does not allow us to reject Friedman's (1968) proposition on the neutrality of macroeconomic

(fiscal and monetary) policies over the long-run.
(ii) Given the property of the trend component of
real non-oil GDP, it will not be possible to use
modelling methods such the stochastic equilibrium
models associated with the RBC (see King et al.
1991) or error correction models. In fact,
having found that the series contains a
deterministic secular component, this prohibits
us from subjecting this series to models based on
stochastic trend. As a result the econometric
estimation will be confined to explaining
short-run fluctuations. In this section these
relations are estimated after detrending the
non-oil GDP series and applying the first
difference operator to the rest of the series.
By modelling the cyclical component of the non-oil
series, the model will be looking for the
macroeconomic variables that drive the business
cycle in the Bahraini economy. As a consequence,
the model addresses one of the most controversial
issues in the new-Keynesian and real business
cycle debate: is there a role for fiscal and
monetary policies in output stabilization?

Table 3.12
Unit Root Tests and Confidence Intervals of the Largest Root

Series		ADF	95% Confidence Intervals
GDP	[4]	-5.745*	(cc, 0.412)
NGDP	[4]	-6.195*	cc
OGDP	[2]	-5.387*	(cc, 0.469)
G	[3]	-2.666	(0.646, 1.064)
P	[1]	-1.254	(0.915, 1.084)
M1	[1]	-2.520	(0.680, 1.066)
M2	[2]	-2.878	(0.596, 1.057)
IM	[2]	-2.799	(0.616, 1.060)
HPM	[1]	-1.659	(0.850, 1.082)
CASH	[4]	-2.678	(0.652, 1.063)
NEERT	[1]	-1.660	(0.820, 1.079)

Notes: An asterisk denotes significant at 5% level. Figures in brackets are the lag length required to whiten the residuals. cc stands for cannot calculate from the tables provided in Stock (1991). All confidence intervals are calculated using Stock's Table A.1 part A and B.

FIGURE 3.1: REAL GDP
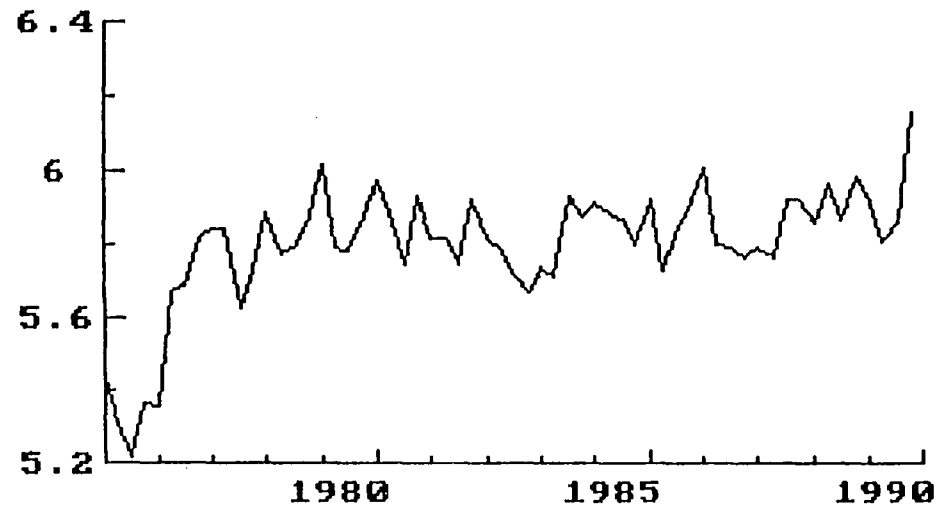
FIGURE 3.2: REAL NON-OIL GDP
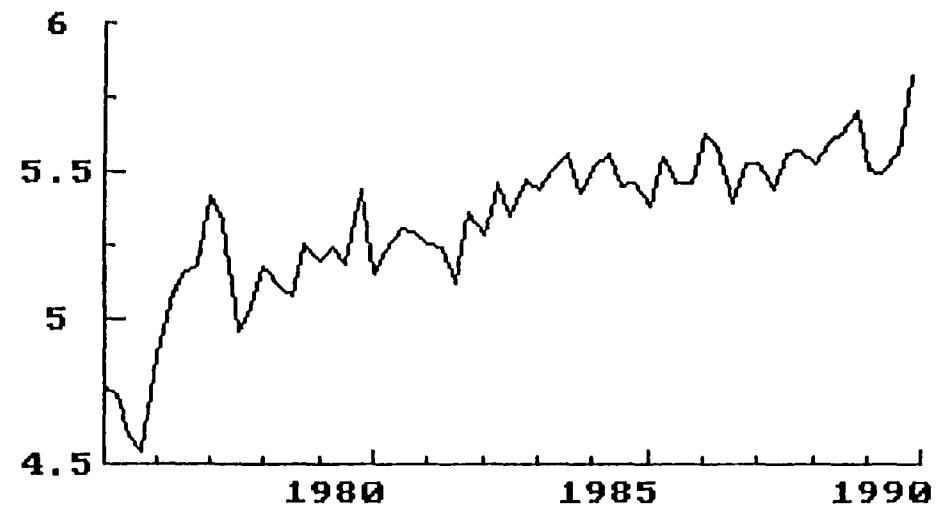
FIGURE 3.3: REAL OIL GDP
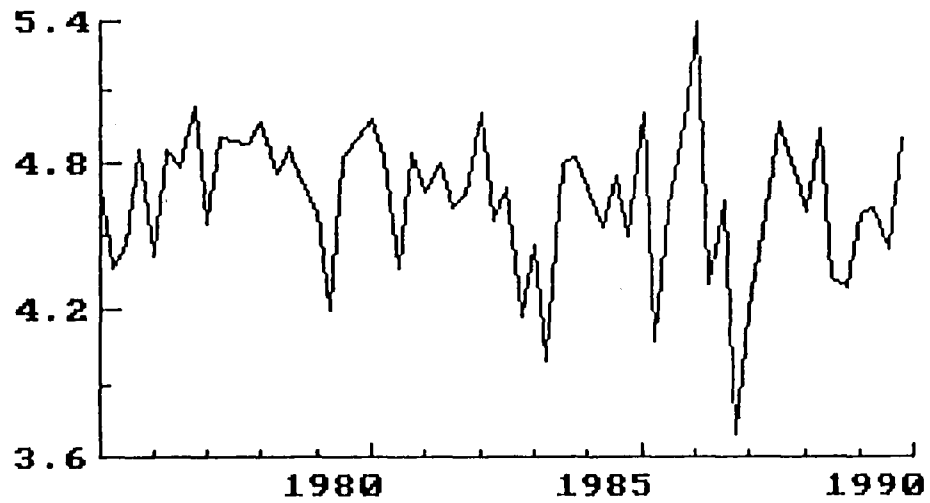
FIGURE 3.4: GOVERNMENT EXPENDITURE
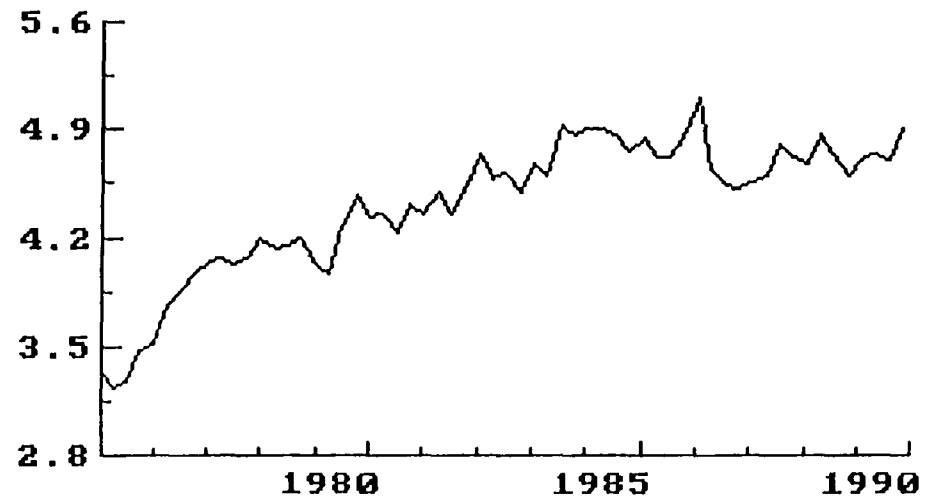
NOTE: ALL PLOT ARE IN LOGARITHMS.

FIGURE 3.5: NON-OIL GDP DEFLATOR   FIGURE 3.6: CASH
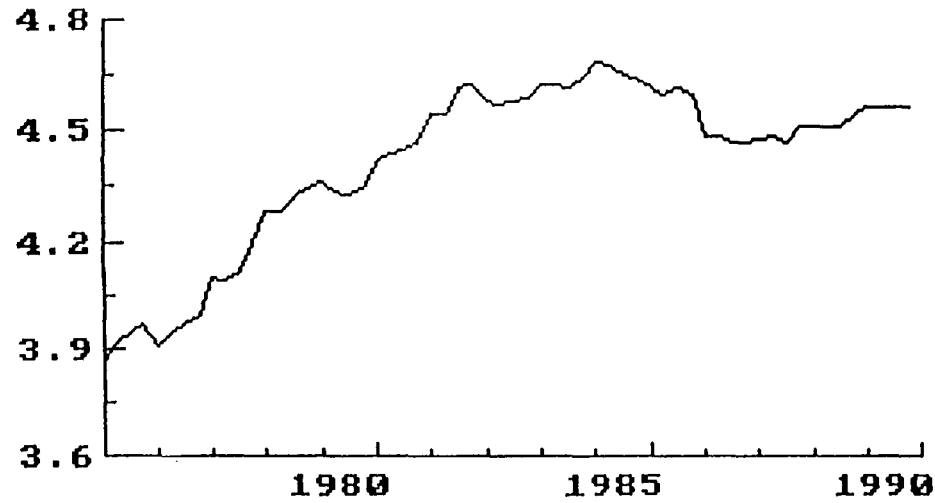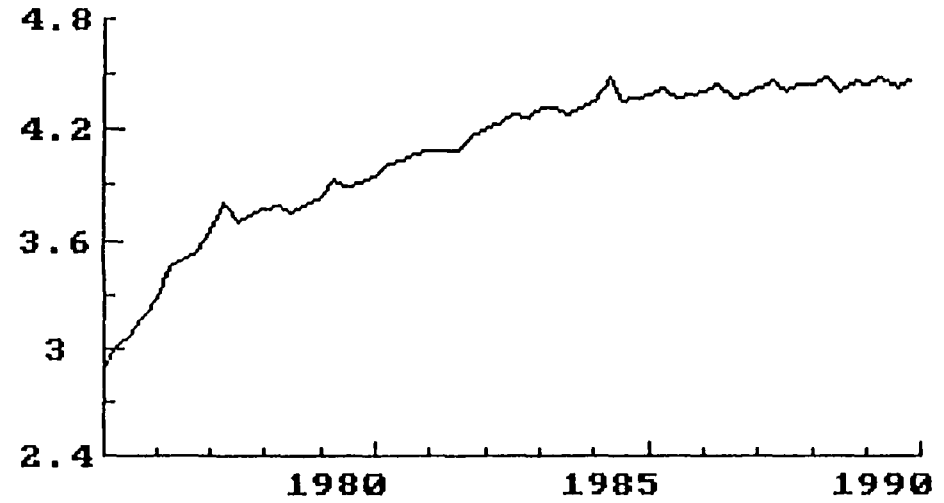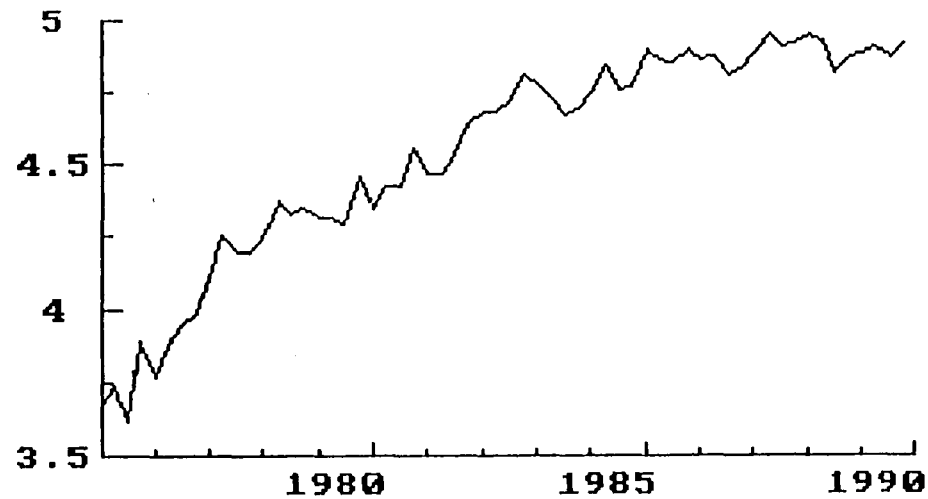
FIGURE 3.7: HPM   FIGURE 3.8: IM
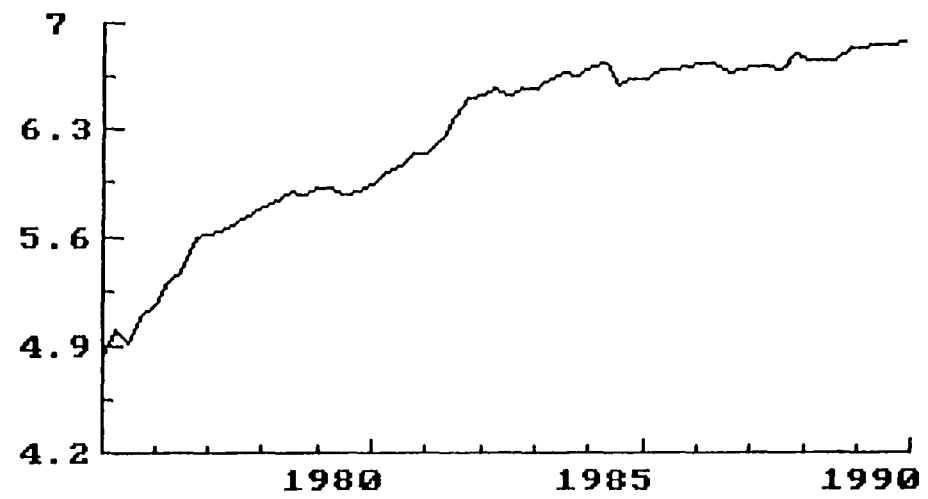
NOTE: ALL PLOTS ARE IN LOGARITHMS.

FIGURE 3.9: M1
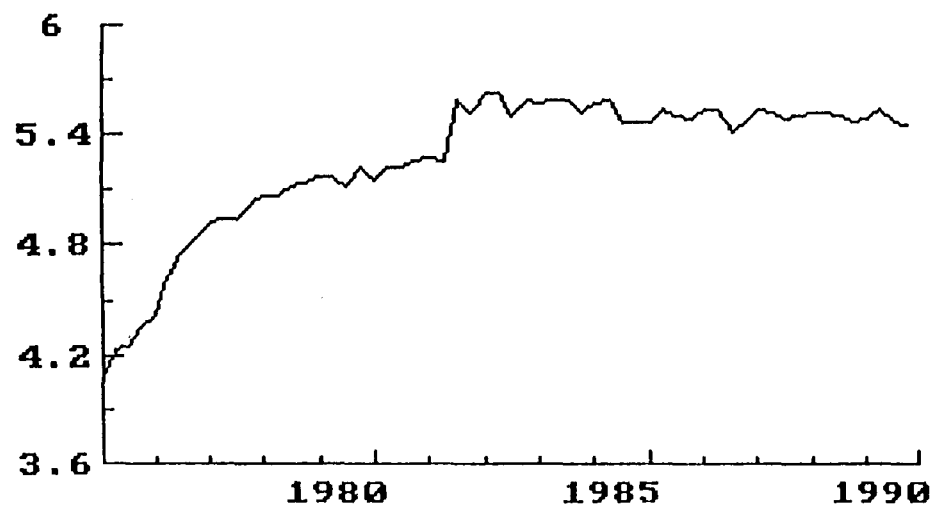
FIGURE 3.10: M2
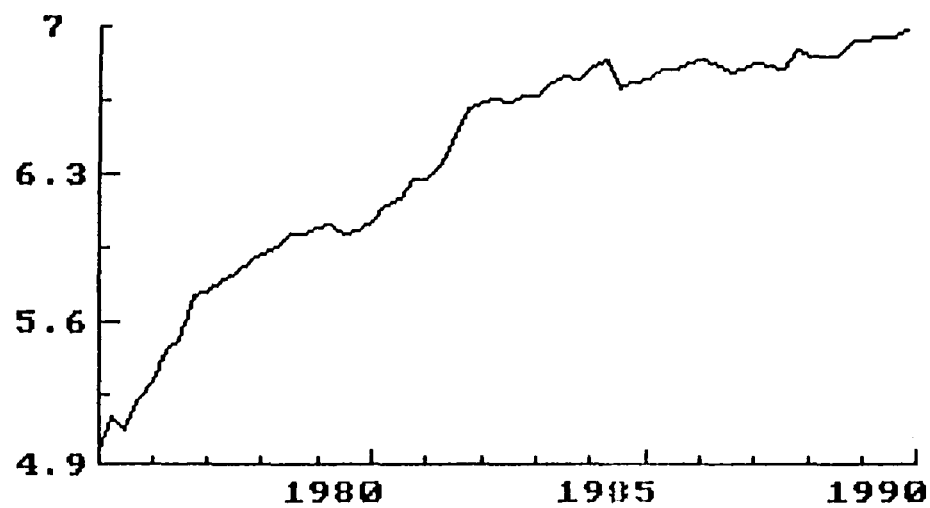
FIGURE 3.11: NEERT
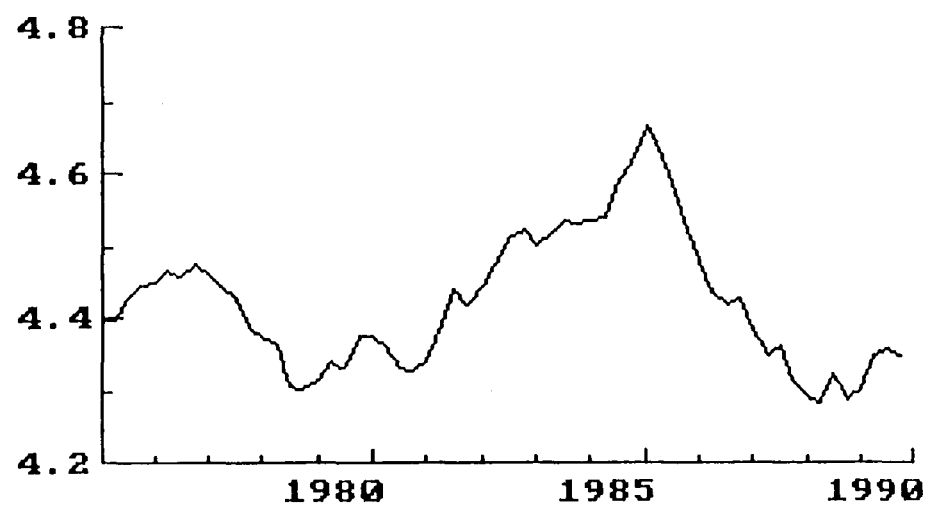
NOTE: ALL PLOTS ARE IN LOGARITHMS.

FIGURE 3.12: BAHRAIN BUSINESS CYCLES
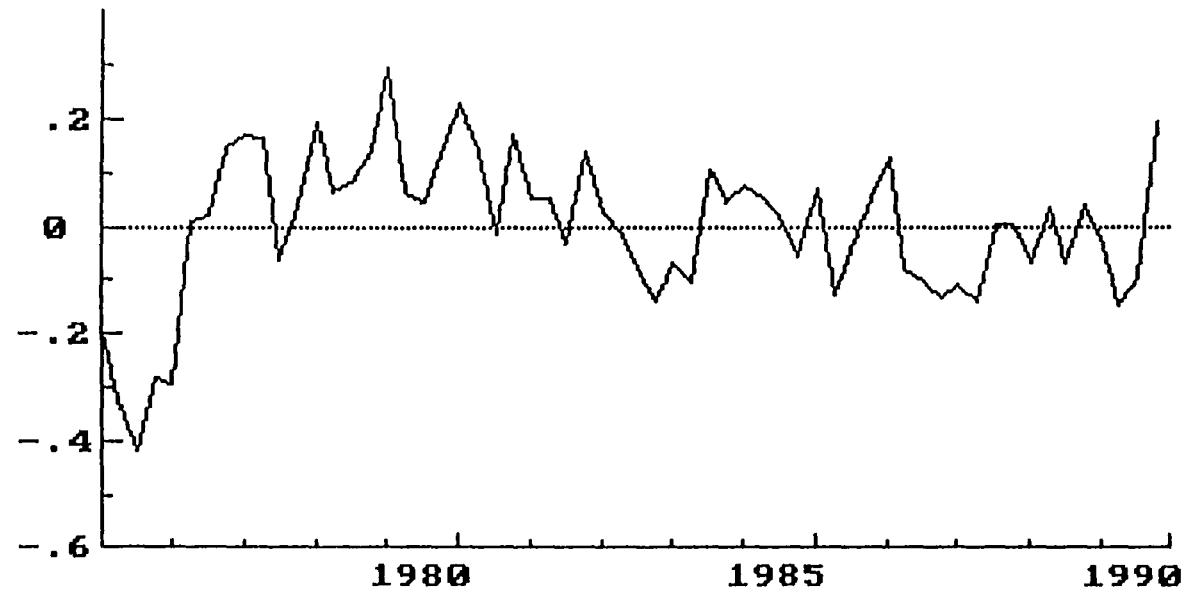
FIGURE 3.13: BAHRAIN NON-OIL BUSINESS CYCLES
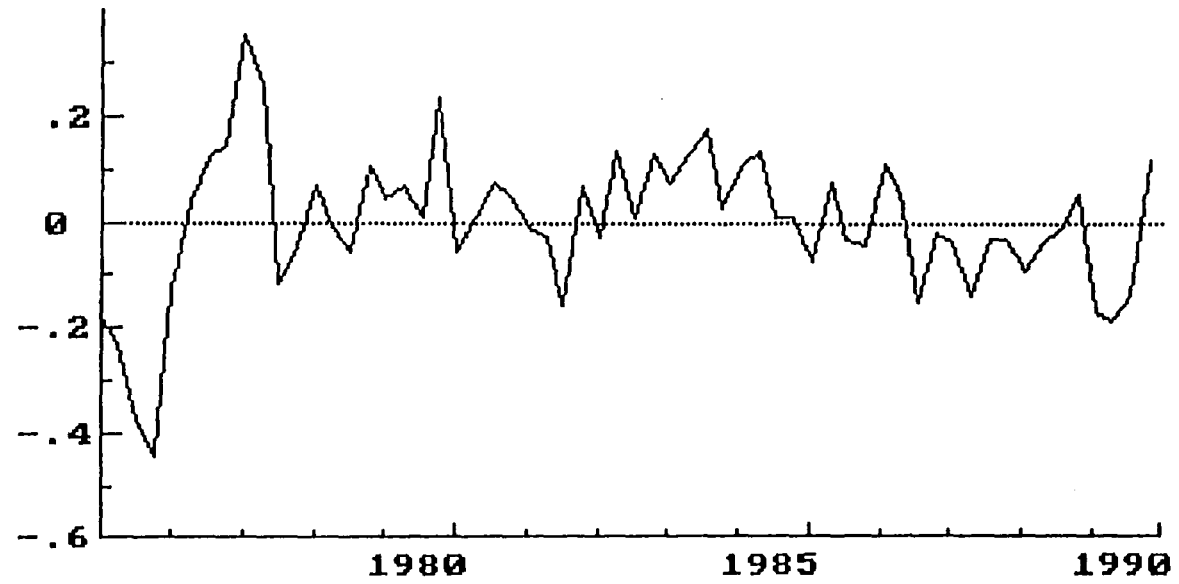
3.4.2 Determining the Macroeconomic Variables Driving Bahrain's Non-Oil Business Cycles

To test for the significance of the macroeconomic variables in explaining Bahrain's non-oil output within the VAR framework will require determining the order of the polynomials in the above model. These are selected using the BIC. This is done so as to avoid the over parameterization that is usually associated with the AIC.[15] The results obtained from the above model can be summarized as follows:

(i) Money is neutral with respect to non-oil GDP (see Tables 3.13 and 3.14), i.e. none of the monetary aggregates influence the non-oil business cycle (y). For money to effect business cycle the domestic interest rate needs to be responsive to changes in domestic money supply so changes in money supply induce changes in the interest rate in turn affecting investment and consumption demand which will induce changes in output. This causal ordering cannot be observed given Bahrain Dinar peg exchange rate arrangements. It is well known that under such regimes, the domestic interest rate is determined by the pegged currency monetary policy thus divorcing domestic monetary policy from domestic fundamentals.

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[15]For a comprehensive review of information criteria see Lütkepohl (1991) and Mills (1991b).

The presence of a significant relationship between Cash and output is rejected on the bases that: (a) they have negative relationship, thus an innovation to Cash reduces non-oil GDP (see Figure 3.14); and (b) this significant relationship is caused by presence of multicollinearity between government expenditure and Cash. Thus, once the government variable is removed, Cash does not Granger cause non-oil GDP.

(ii) The real business cycle proposition on the endogeneity of inside money cannot be accepted in the Bahraini case (see Tables 3.13 and 3.14).

(iii) Government expenditure is the only macro variable Granger causing non-oil GDP (see Tables 3.13 and 3.14). An unanticipated fiscal policy shock causes non-oil GDP to deviate for seven quarters from it long-run path (see Figure 3.15). This finding supports the discussion provided in section 3.2 and points to the importance of fiscal policy in explaining the cyclical component of non-oil GDP. Indeed, using data on industrialized countries, Ahmed and Park (1994) and Gali (1994) were able to reject the hypothesis that government purchases have no role in stabilizing output. Gali obtained these results using a real business cycle model. As a result, Gali concluded that the relationship between fiscal policy and output is far stronger than what standard real business

cycle models predict.

The results given in Tables 3.13 and 3.14 show the absence of a feedback from non-oil GDP to the fiscal policy variable. Hence, by Engle et al's (1983) definition, government expenditure is weakly exogenous with respect to non-oil GDP. This further supports the views presented in section 3.2.

(iv) Government expenditure has an important role in explaining the monetary aggregates (see Tables 3.13 and 3.14). This supports the views presented in section 3.2 on the influence of fiscal policy on the money supply. For the private sector, the unidirectional causation suggests that private financial transactions are in part a hedge on government expenditure. Non-oil GDP does Granger cause M1; however, the y coefficient has the wrong sign (see Figure 3.16). Such a result is counter intuitive and cannot be explained.

(v) IM is the only monetary aggregate that Granger causes price (see Tables 3.13 and 3.14). However, changes in price seems to have repercussions on M2, HPM and Cash.

(vi) The exchange rate does not Granger cause non-oil GDP, thus questioning the validity of the existing regime. This finding holds even if the exchange rate variable is an imports or exports

weighted index.[16]

If we are seeking a parsimonious model for non-oil GDP, Tables 3.13 and 3.14 provide the necessary conditions to marginalize all variables in the VAR except the fiscal policy variable.

Thus it can be stated that the results of this section is robust and establish the stylized facts on the importance of fiscal policy in stabilizing Bahrain non-oil business cycle and in determining money supply. Additionally, the results reveal that monetary policy in Bahrain is neutral and this fact holds even when the VARs are reestimated using McCallum robustness test on monetary policy neutrality. The application of McCallum test give raise to an additional stylized fact, namely that Bahrain have pursued an exchange rate policy that is independent of its target variable.

3.5 Conclusion

It was demonstrated in this chapter that output and its components have low persistence, reflecting their integration properties. The VAR results show that government expenditure is the only macro variable that influences the non-oil business cycle and that government expenditure is an important determinant of the private

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[16]For brevity the results using the imports and exports indices are not given here, but they can be obtained from the author on request.

monetary aggregates. Since non-oil GDP is mainly generated in the private sector, the VAR results point to the dependence of the private sector on government expenditure. The dependence is found in the goods and money markets. Additionally, the VAR results reveal that monetary policy does not influence non-oil GDP, a finding that remains even when the McCallum recommendation to test for the robustness of the impotency of monetary policy is incorporated. Consequently, this leads us to suggest that the impotency of monetary policy in Bahrain cannot be entirely ascribed to the private sector dependency on government expenditure. Instead, the exchange rate regimes adopted may have contributed to it. The private sector-government expenditure relationship constitutes a fundamental structural constraint that characterizes the economic development of Bahrain and correcting it cannot be achieved over the short-run. Furthermore, removing this obstacle may have serious political implications that are not the subject of this thesis. However, altering the exchange rate policy can be achieved immediately once the authorities have decided to do so. In the subsequent chapters, the thesis will concentrate on further investigating the BD exchange rate regimes and their implications for the Bahraini economy and to testing for an alternative optimum regime.

Table 3.13
Granger Causality Tests of the Estimated VAR Variables

Dependent Variable	G	CASH	HPM	IM	M1	M2	P	y
				Monetary Aggregate				
				(a) CASH				
G	0.999	0.469	NI	NI	NI	NI	3.061‡	0.209
CASH	3.642‡	0.118	NI	NI	NI	NI	6.800*	1.569
P	1.253	0.584	NI	NI	NI	NI	5.981*	1.528
y	5.413*	3.128‡	NI	NI	NI	NI	0.561	22.539*
				(b) HPM				
G	0.737	NI	0.004	NI	NI	NI	3.845‡	2.138
HPM	2.645	NI	11.868*	NI	NI	NI	9.717*	0.009
P	1.641	NI	1.469	NI	NI	NI	6.634*	1.656
y	4.503*	NI	0.739	NI	NI	NI	0.186	20.476*
				(c) IM				
G	1.177	NI	NI	1.074	NI	NI	2.027	2.102
IM	3.075‡	NI	NI	0.516	NI	NI	2.598	1.668
P	0.380	NI	NI	2.822‡	NI	NI	2.021	1.472
y	3.111‡	NI	NI	0.471	NI	NI	0.010	19.905*
				(d) M1				
G	0.784	NI	NI	NI	0.021	NI	3.408‡	2.129
M1	10.499*	NI	NI	NI	0.858	NI	1.607	3.664‡
P	0.666	NI	NI	NI	0.931	NI	3.257‡	1.392
y	3.579‡	NI	NI	NI	0.040	NI	0.016	19.632*

Table 3.13 continued

De-pendent Variable	G	CASH	HPM	IM	M1	M2	P	y
				(e) M2				
G	1.225	NI	NI	NI	NI	1.187	1.921	2.158
M2	3.295‡	NI	NI	NI	NI	0.825	2.962‡	1.952
P	0.403	NI	NI	NI	NI	2.202	2.170	1.384
y	3.258‡	NI	NI	NI	NI	0.183	0.000	19.684*

Notes: An asterisk stands for significant at 5%. ‡ stands for significant at 10%. NI implies not included in the VAR model.

Table 3.14

Granger Causality Tests of the Estimated VAR Models: Robustness of the Results

Dependent Variable	NT	G	CASH	HPM	IM	M1	M2	P	y

Monetary Aggregate

(a) CASH

	NT	G	CASH	HPM	IM	M1	M2	P	y
NT	8.108*	0.060	1.506	NI	NI	NI	NI	0.007	0.043
G	0.948	0.842	0.425	NI	NI	NI	NI	2.889‡	2.699
CASH	0.855	3.332‡	0.139	NI	NI	NI	NI	7.001*	1.315
P	2.498	1.008	0.521	NI	NI	NI	NI	6.517*	1.996
y	0.004	5.254*	3.060‡	NI	NI	NI	NI	0.555	21.943*

(b) HPM

	NT	G	CASH	HPM	IM	M1	M2	P	y
NT	7.792*	0.534	NI	0.835	NI	NI	NI	0.483	0.004
G	0.984	0.615	NI	0.004	NI	NI	NI	3.604‡	2.441
HPM	0.614	2.432	NI	11.785*	NI	NI	NI	9.903*	0.033
P	2.626	1.392	NI	1.514	NI	NI	NI	7.319*	2.181
y	0.904	4.361*	NI	0.725	NI	NI	NI	0.188	19.978*

(c) IM

	NT	G	CASH	HPM	IM	M1	M2	P	y
NT	7.564*	0.482	NI	NI	0.835	NI	NI	0.671	0.006
G	0.918	1.002	NI	NI	0.988	NI	NI	1.920	2.393
IM	2.974‡	2.680	NI	NI	0.645	NI	NI	2.904‡	1.240
P	2.951‡	0.234	NI	NI	3.172‡	NI	NI	2.280	2.016
y	0.022	2.991‡	NI	NI	0.470	NI	NI	0.009	19.447*

(continued)

Table 3.14 continued

De-pendent Variable	NT	G	CASH	HPM	IM	M1	M2	P	y
				(d) M1					
NT	8.960*	0.569	NI	NI	NI	2.507	NI	1.095	0.007
G	1.030	0.684	NI	NI	NI	0.067	NI	3.019‡	2.435
M1	0.098	10.177*	NI	NI	NI	0.898	NI	1.643	3.435‡
P	2.272	0.547	NI	NI	NI	0.643	NI	3.863‡	1.819
y	0.010	3.482‡	NI	NI	NI	0.034	NI	0.018	19.142*
				(e) M2					
NT	7.564*	0.444	NI	NI	NI	NI	0.573	0.571	0.004
G	0.916	1.047	NI	NI	NI	NI	1.098	1.819	2.450
M2	3.193‡	2.882‡	NI	NI	NI	NI	1.002	3.314‡	1.482
P	2.888‡	0.253	NI	NI	NI	NI	2.495	2.434	1.900
y	0.019	3.137‡	NI	NI	NI	NI	0.184	0.000	19.222*

Notes: An asterisk stands for significant at 5%. ‡ stands for significant at 10%. NI implies not included in the VAR model. NT stands for NEERT.

FIGURE 3.14: RESPONSE OF NON-OIL GDP TO UNANTICIPATED MONETARY(CASH) SHOCK
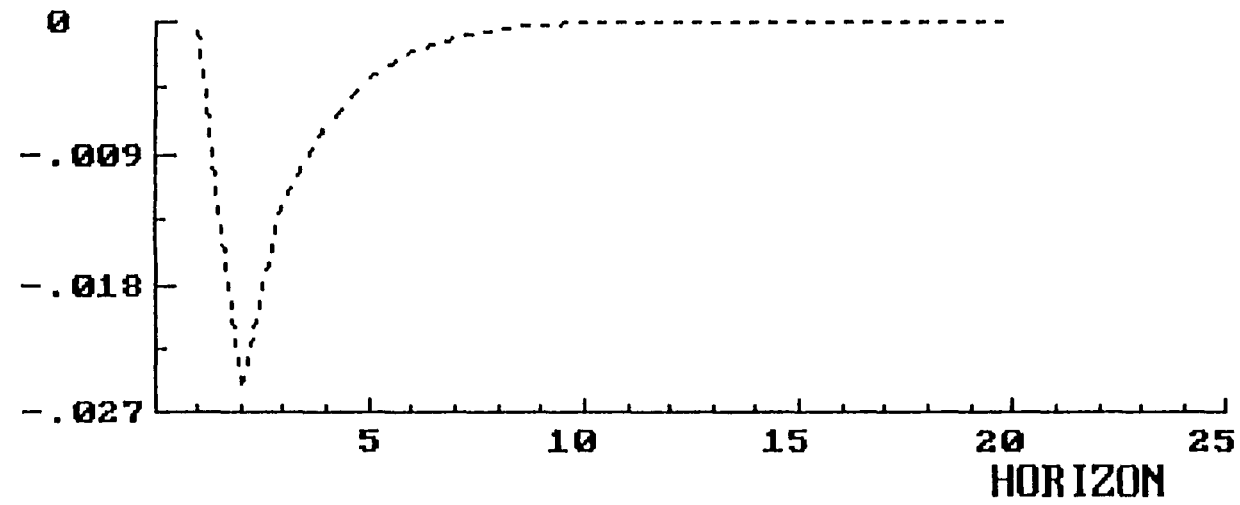
FIGURE 3.15: RESPONSE OF NON-OIL GDP TO UNANTICIPATED FISCAL POLICY SHOCK
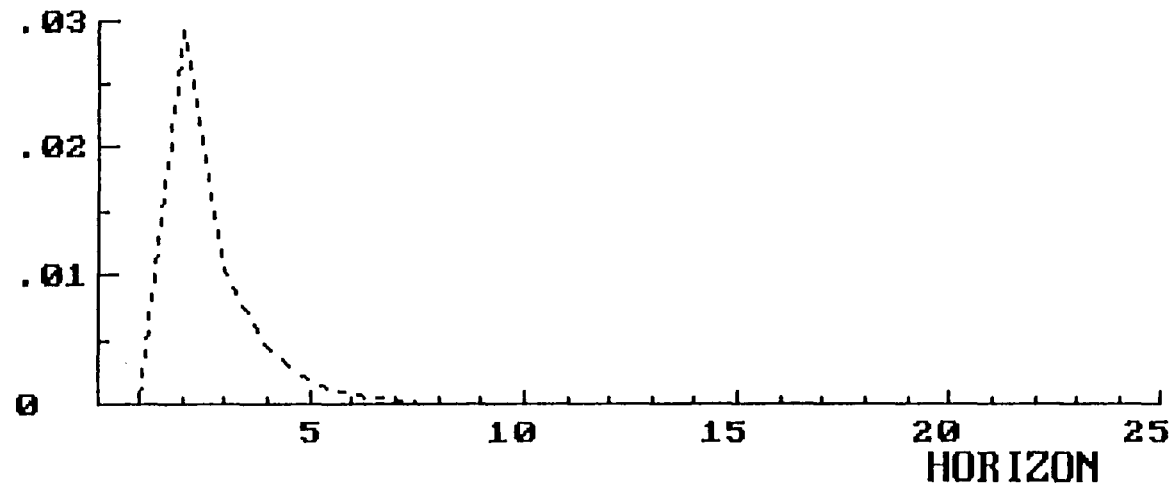
FIGURE 3.16: RESPONSE OF M1 TO UNANTICIPATED SHOCK TO NON-OIL GDP
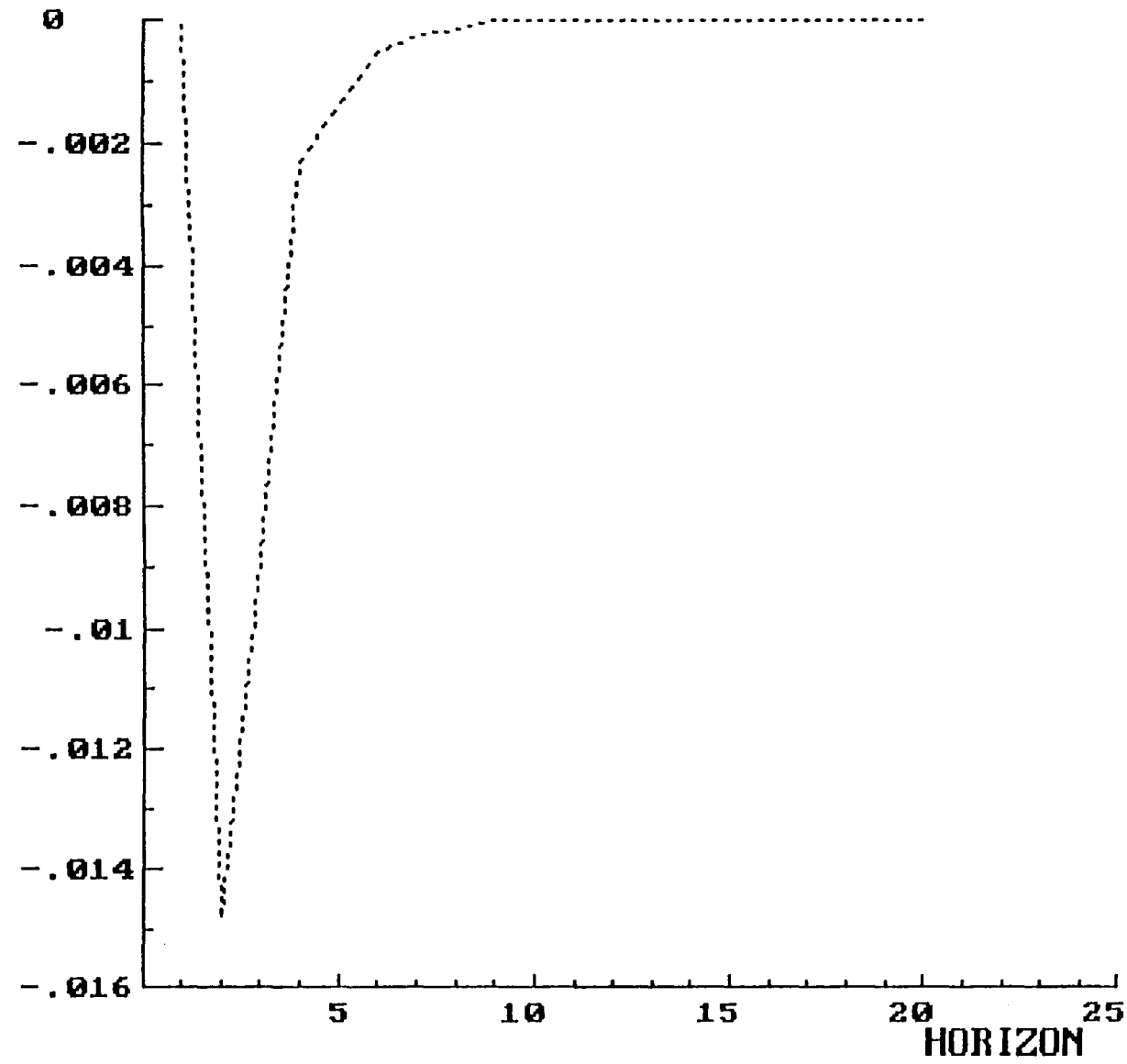
Chapter Four

The Choice of Exchange Rate Regime: A Literature Survey

4.1 Introduction

In an open economy, exchange rate policy is anticipated to play an important role in macroeconomic performance. Inspired by such expectations, the theoretical macroeconomic literature has devoted considerable attention to exchange rate policy: for example, Friedman (1953), Mundell (1961), McKinnon (1963), Johnson (1969) and Laffer (1973) have pioneered the work in exchange rate economics. From the dates of these studies one can see that the discussion on opting for the appropriate exchange rate regime is relatively long-established. Yet, there is still no consensus among economists on what constitutes an optimum regime. For example, some of the fixed rate advocates recognize its shortcomings, but they consider it more stabilizing. In contrast, early writings perceived the floating rate to be the "stability anchor" (see Friedman, 1953; Johnson, 1969).

In the period following the breakdown of the Bretton Woods system in March 1973, sovereign nations encountered a de facto situation of a broad choice of exchange rate regimes. The situation which then prevailed stimulated economists to engage in an intellectual search for the optimum regime. In the 1970s they arrived at conflicting outcomes based primarily on partial equilibrium solutions. Nonetheless, despite the fact that the solutions of studies conducted in the 1980s were generally carried out in a general equilibrium framework, little consensus existed

among them.[1] However, in more recent studies, advocates of
the different regimes have come to recognize that the
determination of the optimal exchange rate regime is
dependent upon a number of factors. These factors are: (a)
policy goals; (b) the nature of the stochastic environment;
(c) the structural characteristics of the economy;   (d)
constraints encountered by the home economy; and (e) the
credibility of decision makers (Argy, 1990; Aghevli et al.
1991).

Differences in findings are attributable to the
criterion or policy objective utilized for exchange rate
choice, the assumptions underlying model behaviour, and
under what equilibrium consideration the solution was
derived.   For instance, a partial equilibrium solution
usually allows for no feedback (Cornwall, 1984). In a sense
it assumes that variables on the right hand side are, at
least, weakly exogenous. Walley (1975) demonstrated that
results obtained using general equilibrium are considerably
better than those from partial equilibrium.

This chapter will carry out a survey of the literature
on the choice of exchange rate in competing models, in which
the choice is based on the assumption that an economy with
particular characteristics faces various kinds of additive

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[1]Flood and Marion (1991) referred to the different findings
as a "model-specific" phenomenon.

shocks.[2] An adequate policy prescription for the choice of exchange rate regime requires identifying the sources of shocks (foreign or domestic), its nature (real or monetary), and an objective function.

The studies assume that feasibility is conducted in a floating world. This assumption, which was not common among early studies on the choice of exchange rate, tends to have a profound impact on the choice of regime; for example, compare the results of Laffer (1973) with those of Buiter and Eaton (1987), both of which are demand-determined studies.

Recent developments in exchange rate economics emphasizes the role of capital mobility in determining, at least in the short-run, exchange rate equilibrium. It has long been argued, as we shall see shortly, that capital mobility is an essential prerequisite for a floating rate regime. Thus, the exercise of selecting an appropriate regime will be conducted on the basis of asset market availability and the extent of capital mobility.

Before commencing the literature review, it is essential to acknowledge the fact that the size of the literature on the exchange rate is indeed very large. For this reason we have decided to: (a) briefly discuss the various main views; and (b) postpone the discussion on the Horne-Martin method, which will be used in the thesis, to chapters 6 and 7.

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[2]Identified to be those shocks which cause the system to deviate from its natural rate path without affecting the system parameters. In contrast, multiplicative shocks incur changes in the parameters (see Stevenson, Muscatelli and Gregory, 1988).

Including a discussion on the Horne-Martin method would lead to too long a literature review.

The remainder of this chapter is organized as follows: section 4.2 provides a review on the choice of exchange rate regime with and without asset market considerations. Section 4.3 discusses the factors influencing a developing country's choice of exchange rate regime. Section 4.4 reviews the literature on the optimum peg. Section 4.5 concludes this chapter.

4.2 Selecting an Appropriate Exchange Rate Regime

4.2.1 The Choice of an Exchange Rate Regime Without Capital Mobility

In a study aiming at deciding on the optimum exchange rate regime for a small open economy, Flanders and Helpman (1978)[3] have relied on the principles of microeconomics to develop a two-sector model: traded and non-traded. They break with the neoclassical perfect competition case by assuming rigid wages and home goods prices. They take full employment to be the macroeconomic policy objective. In the model, wage and prices rigidities and resource allocation play crucial roles in determining the choice of the regime. Flanders and Helpman argue that a nominal foreign shock manifested in an equi-proportional increase in the prices of world tradeable goods can be ineffective under a fixed rate

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[3]Their solutions are based on a partial equilibrium model.

regime if monetary policy is accommodative. The dependency of resource allocation on relative prices requires that the money supply be increased to stimulate home goods' prices so as to inhibit an ex post unwarranted resource reallocation. Obviously, the result is dependent on the structural characteristics of the economy, i.e. on the sensitivity of domestic inflation (home goods price) to the money supply and on the slope of the transformation curve at the tangency point. If the latter is large, then a large increase in import prices results in an immediate shift to home goods. Hence, if the shift in demand is not considered, a rise in the money supply may produce an exacerbated inflation. Additionally, the rise in the money supply under a fixed rate can only be implemented by expanding domestic credit, which in turn may disrupt relative prices, thus destabilizing the cyclical component of real output in the traded and non-traded sectors (Blejer and Fernandez, 1980).

Despite the fact that monetarists argued in favour of a fixed exchange rate for a small open economy,[4] Fischer (1977) demonstrated, using the monetary model of the balance of payments, that such an economy's choice of regime is dependent on: (a) the type of shocks encountered by it ; and (b) the effects of policy intervention. In emphasizing the role of monetary policy on the choice of exchange rate while targeting the stability of consumption, Fischer showed that

[4]See Flanders and Katz's (1975) and Kindleberger's (1976) comments on Friedman and Meltzer's statements to the Joint Economic Committee of the United States Congress in June 1973.

if the monetary authority were to adopt a passive policy, i.e. no change in domestic credit, a rise in the foreign price level would result in a higher real consumption variance under a fixed exchange rate regime than under a floating rate. However, Fischer's model produces a different result when monetary policy is active. If the authorities were to follow an optimal monetary rule, defined to be the "certainty equivalence rule",[5] the variance of steady-state consumption could be lower under a fixed exchange rate.

It is important to note that in both the Fischer and Flanders and Helpman models, the absence of any intertemporal transfer of consumption played an important role in allowing policy interventions to alter the choice of the exchange rate regime.

Additionally, in both studies the assumptions of continuous PPP and no capital mobility implied that a floating rate economy will resemble a closed economy. As such, foreign disturbances have no effect on the domestic economy. For instance, both Fischer and Flanders and Helpman show that under a floating rate, a rise in tradeable goods' prices is offset by an appreciation of the exchange rate and that neither the domestic price of tradeable goods, nor the level of the domestic price, are affected. Thus the economy has insulated itself from external price shocks.

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[5] In Fischer's study it is the additional money supply created through domestic credit that is equivalent to excess demand in the money market.

According to Flanders and Helpman, the effect of a real domestically originated disturbance will depend on whether it induces a higher demand for tradeable or home goods. If tastes shift toward home goods, the equilibrium locus under a fixed rate will move away from the contract curve along the tradeable goods isoquant to an inferior locus. The shift in demand results in external equilibrium but internal disequilibrium. On the contrary, if the exchange rate is allowed to float, the economy will slide painlessly, and without cost, to the new equilibrium. Flanders and Helpman's second finding is strongly challenged in full equilibrium models with capital mobility. For instance, Dornbusch (1976b) shows that an increase in domestic demand for tradeables will alter relative prices irrespective of the exchange rate regime. Thus, in Flanders and Helpman's terms, the change in relative prices will reallocate resources, a case considered to be an outcome of fixed rates in a partial equilibrium model with no capital mobility.

Nevertheless, whenever prices and wages are flexible the Flanders and Helpman model is indifferent, i.e. the model cannot decide on the optimum regime.

In Fischer's model, the fixity of the exchange rate opens the domestic economy so that part of any domestic disturbances are leaked abroad to enhance optimality of the fixed rate. He demonstrates that the variance of steady-state real consumption is more stable under fixed than floating rates when disturbances are domestic and real. The result holds for both active and passive monetary

policy. For passive policy, the balance of payments behaves as a shock absorber as described by Laffer (1973).

Fischer's model produces an important result, particularly for developing countries, as they usually allow a limited role for monetary policy in their stabilization programmes. Fischer shows that, whether the disturbance is real or monetary, real consumption is substantially more stable under a fixed exchange rate if a discretionary monetary policy is pursued.[6]

Fischer's (1977) and Flanders and Helpman's (1978) models suffer from several weaknesses. These weaknesses can be summarized in the following:

(i) The assumption of continuous PPP, which suffers from the lack of sufficient empirical support (see subsection 4.3.1 for further discussion).

(ii) The insulation property of floating rates in both studies is enhanced by the absence of an interest-bearing asset effect on the exchange rate.

(iii) In a small open economy with a fixed rate, Fischer's assumption about the absence of non-traded goods implies that price fluctuations can only originate from external sources.

(iv) Knowing that home goods are demand-determined in Flander and Helpman's model allows fiscal

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[6]This finding runs against the monetary model's self-correcting proposition.

policy intervention to deflate excess demand. Unfortunately, they did not consider such interventions. For this reason, one may regard their model as less than realistic. In my opinion, this criticism is more apparent when viewed from a developing country perspective. It is well known that in developing countries, government expenditure is a major determinant of macroeconomic performance. In the case of Bahrain, the results of chapter three provide strong support for such a view.

(v) Fischer's model does not allow for the effect of wealth on consumption. Under such circumstances the model will lead to different results. (see Enders and Lapan (1979) in subsection 4.2.2.1).

Following a different approach, Branson and Katseli (1980, 1981)[7] advance two feasibility conditions for the choice of exchange rate regime. The first condition is based on McKinnon's (1963) openness proposition, while the second condition extends the asset approach to the exchange rate by assuming the existence of an internationally integrated asset market. A country defined to be highly open but lacking a sufficiently developed asset market will be better off pegging its exchange rate. Black (1976),

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[7]Both studies' are based on partial equilibrium models.

Tower and Willett (1976), Heller (1978), Crockett and Nsouli (1977) and Lipschitz and Sundararajan (1980) all arrived at a similar conclusion.

In the case in which a country is lacking an internationally integrated asset market, its exchange rate is strongly influenced by changes in trade balances. Hence, in the short-run, exchange rate stability is dependent on satisfying the Marshall-Lerner (ML) condition. Branson and Katseli (1981) argue that a developing country which satisfies the ML condition could float its exchange rate, even though its asset market is not internationally integrated.

In spite of the above, Branson and Katseli show that once the authorities decide to stabilize the terms of trade, their choice of exchange rate regime is conditional on the country's net market power in the international markets. They defined net market power to be:

$$k - k'$$

$$k \equiv \frac{d_x}{d_x - s_x} \qquad , \ 0 < k \leq 1$$

$$k' \equiv \frac{s_m}{s_m - d_m} \qquad , \ 0 < k' \leq 1$$

where d_x and d_m are the demand price elasticities of exports and imports respectively. s_x and s_m, respectively, are the

supply price elasticities of exports and imports. k is the
inverse index of the export market power index and k' is the
inverse of the import market power index. For a small
country, $d_x \to -\infty$, and k approaches unity. When $s_m \to \infty$, k' goes
to unity, and thus the country has no market power. A
country with asymmetric market power will tend to adopt a
managed float or basket peg as opposed to a freely floating
exchange rate regime. Testing their approach on 101
countries, Branson and Katseli (1980, p. 68) concluded:

> "It seems that it is indeed the case that
> countries which use formula flexibility or peg to
> a composite are countries which are characterized
> by significantly higher net export side market
> power than those countries which either float or
> peg to a single currency."

In other words, the Branson-Katseli criteria implies
that either a very large or a very small country can adopt a
floating exchange rate regime.

In this section the choice of exchange rate is discussed
without allowing for capital mobility. By allowing for
capital mobility, the above models become more realistic and
hence may produce different results, as we will see in the
following section.

4.2.2 The Choice of an Exchange Rate Regime With Internationally Integrated Asset Markets

In the 1970s two major events occurred which resulted in an enhanced role for capital in influencing the choice of optimum exchange rate regime. These were: (i) the relaxation of capital control laws; and (ii) the development in communication technology, which resulted in substantial reduction in the cost of financial transactions. Both events have increased the size of the capital account in the balance of payments. In fact, the capital account became the main determinant of changes in external balances. As a result, a hypothesis emerged postulating that, over the short-run, capital account transactions must exert more influence on the exchange rate than current account transactions (see Dornbusch, 1976b; Kouri, 1976). Since then, exchange rate studies have tended to draw attention to the influence of capital mobility on determining the exchange rate. Nonetheless, the extent of the influence is determined by the accepted degree of risk. The assumption of perfectly mobile capital with a risk-neutral speculator will alter the course of disturbances to allow for the accepted degree of risk to contribute to the determination of the exchange rate regime. This is explicitly stated in Lapon and Enders (1980) results.

Implementation of stabilization policies when capital is perfectly mobile implies that either fiscal or monetary policy is more effective, so that policy makers need to decide which of the policies becomes totally dependent on

external forces (Fratianni, 1976). The choice is shown by Mundell (1963) to depend on exchange rate flexibility. Under a fixed rate regime, the authorities can be better off freeing monetary policy. However, in an interdependent world, the authorities may have less choice. Cooper (1985) demonstrated that increases in foreign linkages reduces the impact of domestic policy variables on the domestic target variable.

The assumption of capital mobility enters the system to influence, among other things, the composition of wealth along its steady-state (Mathieson, 1974). Thus, capital mobility will indirectly exert influence on other variables to alter the choice of regime (compare the results of Enders and Lapan (1979) in section 4.2.2.1 with Fischer (1977) in section 4.2.1).

In the following four subsections the above factors are considered by looking at solutions to optimality under single country models, two-country models, a two-tier exchange rate model and a basket peg model.

4.2.2.1 A Single Country Model

Using the technique derived in the "target, instrument, and indicator" literature, Boyer (1978) strikingly produces results that confirm Fleming's (1962) and Mundell's (1963) propositions. In his model, Boyer shows that the optimal exchange rate reaction function is dependent on the structures of the stochastic as well as the deterministic

components of the model.[8] The reaction function stresses the importance of shocks in the market in which they occur rather than their geographical or functional origin. In solving the system in terms of the loss function, identified to be the deviation of actual from desired output, Boyer derived the following intervention coefficient:

$$(\gamma_m / \gamma_g) = - [\rho - (\sigma_m / \sigma_g)] / [\rho - (\sigma_g / \sigma_m)]$$

where

$$\gamma_m = - (c + d \cdot \delta_m)$$
$$\gamma_g = a + b \cdot \delta_g$$

ρ is the correlation coefficient between the stochastic disturbances of the goods and money markets, σ_m and σ_g are the standard deviation of the monetary and real disturbances respectively, c is the exchange rate coefficient in the money demand function, d is the money supply coefficient, a is the exchange rate coefficient in the goods sector, b is the budget coefficient in the goods sector, and δ_m and δ_g are the policy reaction function coefficients in the money and goods markets respectively. The model initially assumes that the setting of financial policy variables

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[8]All variables are deviations from their means. From the article we can associate the target with the deviation of output from its mean, instruments with both money supply and government expenditure, and the indicator to be embodied in the intervention index. In the model the assumption of imperfect information allows the possibility of employing the exchange rate for stabilization purposes.

minimizes the expected value of the loss function and since c, d, a and b[9] are structurally stable and known to the authorities, the decision maker will choose the appropriate values of the reaction functions coefficients so as to minimize the variance of the loss function.

As can be seen from the above index, it is partially dependent on the shock structure, precisely upon: (i) the ratio of the standard deviations of the shocks in the market of intervention to that in other markets; and (ii) the degree of correlation between these shocks.

The index can be used to determine the optimal intervention when shocks are occurring to a single market or when they simultaneously occur to both markets. Consequently, the index value will be in the $[0, \infty)$ domain. A value between these extremes reflects a policy mix which requires adopting a "dirty float" regime. In other words, extreme values are obtained only if shocks are occurring to either of the markets.

If shocks arise predominantly in the monetary sector and monetary authorities are following a contingent, fixed rule, Boyer's intervention index predicts that a fixed exchange rate policy will be optimal. From the above equations, if σ_g is negligible in size compared with σ_m, the optimal intervention index is indefinitely large. Thus the authorities utilize the policy variables to set δ_g equal to -a/b. This verifies the Mundellian proposition of fiscal

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[9]The coefficients c and d are determined by private agents while a and b are influenced by government decisions.

policy effectiveness when the exchange rate is fixed and capital is perfectly mobile (see Mundell, 1963). On the other hand, if shocks pertain to the goods market, the index predicts perfect floating to be the optimal exchange rate policy. Under such a regime, fiscal policy is rendered ineffective and the authorities utilize monetary policy to set the index equal to zero, i.e $\delta_m = -c/d$.[10] Eaton and Turnovsky (1983) show that the impotence of fiscal policy under such considerations can only be realized if uncovered interest parity (UIP) holds.

Boyer's policy reaction functions allow for a feedback rule, i.e. the contingent policy rule; thus a credible monetary policy can maintain a floating rate regime when shocks are real and the intervention coefficient in the goods market is large enough so that $(\gamma_m/\gamma_g)=0$. By intuition, a credible monetary policy is equivalent to Fischer's (1977) passive monetary policy; however, their results are opposite. On the other hand, monetary policy can never be credible by Boyer's index if the economy faces nominal shocks.

In addressing the issue of the optimal policy for exchange rate management, Frenkel and Aizenman (1982) developed an alternative foreign exchange market intervention index that is capable of specifying the magnitude of exchange rate flexibility. Contrary to Boyer's index, Frenkel and Aizenman's index stresses the role of

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[10]This is a restatement of Mundell-Fleming's proposition.

fundamentals as well as the system's geographical source of shocks. They developed the following index:

$$\gamma \equiv \frac{\log (S_t) - \log (S_{t-1})}{\log(M_t/k \cdot S_{t-1} \cdot p^* \cdot y) - (\mu+\varepsilon+x)}$$

where S_t is the exchange rate, M_t the actual money stock or money holding at the beginning of the period, k is the inverse of the velocity of circulation, p* is foreign prices, y permanent income, and μ and ε are stochastic disturbances in the money supply and demand functions respectively. $x=x_1+x_2$, where x_1 denotes shocks due to the variability of foreign prices and x_2 is the short-run deviation from PPP. The index is equal to zero when the exchange rate is fixed, and equal to one if the regime is completely flexible. Thus, under an optimal policy mix, the index value is between these extremes, $0 \leq \gamma \leq 1$.

The policy objective is to minimize the variance of consumption. The model assumes that the policy makers, as well as the private sector, possess incomplete information, so during any period only the joint outcome of the various shocks is known but not their separate values. Substituting the index into the objective function, Frenkel and Aizenman derived an intervention index reflecting different economic situations. The index is dependent on the covariance of real shocks and the sum of all the shocks, the saving propensity from transitory income, and the variance of the sum of all shocks. In contrast to Boyer's results, Frenkel and Aizenman show that if real shocks are absent then the

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index is unity, so that complete flexibility is the optimum regime and vice versa. The same results are obtained whenever the two types of shocks are orthogonal. Hence, as in Boyer's model, the plausibility of policy mix in Frenkel and Aizenman is conditional on the simultaneous occurrence of both types of shocks.

The index produces interesting results for a developing country when we consider the effects of the saving propensity on its optimal value. Despite the proposition that, since production in developing countries tends to be concentrated on a small number of goods, they may thus desire a fixed regime, a developing country seeking to save a fixed proportion from a transitory income induced by a real shock can do so by adopting a floating rate. The same country can maximize its saving when its exchange rate is completely flexible. In this situation the developing country will have an infinitely sloped saving schedule. This result holds even when capital is immobile.

Enders and Lapan (1979) extended Fischer's (1977) model by allowing for capital mobility in a one good sector and assuming domestic residents hold a constant proportion of their wealth in foreign currency. They show that, whenever disturbances are real, an intertemporal transfer of consumption produces a lower consumption variance. In their model, the variance of consumption is negatively related to the degree of capital mobility. Thus the larger the

proportion of foreign assets in the domestic resident portfolio, the lower is the real consumption variance. This result holds for both exchange rate regimes.

In the Enders and Lapan (1979) model, the insulation proposition of flexible exchange rates will not hold when shocks are emanating from foreign prices. Changes in foreign prices induce similar changes in the exchange rate, therefore causing residents to experience capital loss or gains. The change in wealth alters real consumption.

In a later study, Lapan and Enders (1980) analyzed the choice of an exchange rate regime under conditions of uncertainty in a monetary intergenerational model. They questioned Laffer (1973) and Fischer's (1977) argument for a fixed exchange rate. Laffer and Fischer point out that under a fixed rate regime, the balance of payments behaves as a shock absorber in smoothing out the effects of unforeseen output shocks. Lapan and Enders show that in the case of a foreign price disturbance, coupled with output shocks, the choice of exchange rate depends on the degree of risk aversion. For a low degree of risk aversion, a fixed rate will be preferred to a floating rate; but for very risk averse individuals, a floating rate is preferable.

4.2.2.2 Two Country Model of Exchange Rate Determination

The literature on two-country models suggests that such models have an advantage over a single-country model, that of demonstrating the interdependence of domestic and rest of

the world economies. Inclusion of the foreign sector into the model's information set allows domestic residents to identify the underlying real and monetary disturbances that are associated with external shocks. In such models disturbances across the border are no longer independent and the level of correlation between domestic and foreign shocks is dependent on the assumptions underlying the model. Cooper (1985) describes strongly linked economies as being structurally interdependent.[11] If an economy possesses such characteristics, scope for retaliation in order to offset the effect of an external disturbance may be quite limited, in that a one-shot discretionary monetary adjustment cannot succeed (Bhandari, 1982). This underscores the need to coordinate economic policies.

Additionally, the literature on economic interdependence tends to stress the role of economic openness in the domestic economy irrespective of exchange rate regime. Unlike single country models, where rate fixity may allow the model to behave similarly to a closed economy, modelling economic interdependence emphasizes the effect of disturbances even when the exchange rate is fixed (see Hamada, 1974).

Flood (1979), aiming to reduce the expected price variance, developed an "extended small country analysis" where the small country and the rest of the world are

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[11]Cooper defined structural interdependence to be the situation where two or more economies are highly open to each other, so economic events in one economy strongly influence economic events in the other.

modelled explicitly. Flood assumes non-structural interdependence. The model allows for capital mobility, so that residents of a small country can split their portfolio between money and securities. The small country is assumed not to be a securities issuer and is linked to the rest of the world through interest rate parity and PPP.

The implicit assumption that the exchange rate is floating entails that the rest of the world's money supply is exogenously determined. In turn, foreign prices are subject to monetary as well as real disturbances. In an interdependent world, these disturbances are included in the reduced form of the domestic price equation. Under a fixed rate regime, Flood shows that the deviation of actual prices from expected prices is entirely determined by foreign real and monetary disturbances. Flood's result is a classic example of the international transmission of disturbances in an interdependent world with fixed exchange rates (see Friedman, 1953; Johnson, 1969). On the other hand, if the economy is encountering domestic disturbances, whether real or nominal, a fixed rate will minimize the variance of domestic prices. This result is a direct outcome of continuous PPP when the exchange rate is constant. Considering the same objective but allowing for structural interdependence, Buiter and Eaton (1987) show that, when domestic disturbances are real, a flexible exchange rate is preferable.

Flood shows that introducing the assumption of perfect capital mobility into interdependent economies renders the

effects of foreign disturbances ambiguous and the final outcome to be dependent on the size of the loss function's parameters. For instance, a foreign monetary shock requires the product of the elasticity of world interest rate prediction errors with respect to monetary disturbances and the domestic elasticity of real money demand with respect to the rate of interest to be large enough for a floating rate to be a feasible regime. For this reason, Dornbusch (1983) argues that a future exchange rate system would have to be flexible enough to yield long-run inflation autonomy. However, Buiter and Eaton (1987) demonstrate that if monetary authorities cooperate when currency substitution is perfectly elastic, then a fixed exchange rate regime can insulate domestic prices. The form of policy cooperation suggested by Buiter and Eaton requires both authorities to commit their exchange rate to the same peg. Under such a policy regime, speculation is completely stabilizing.

Nonetheless, if currency substitution is less than perfect and each economy faces only foreign disturbances, Buiter and Eaton's model reduces to the Mundell-Fleming model. To insulate domestic prices, money supply rules in both countries are entirely accommodating on speculation. Consequently, exchange rates must be allowed to fluctuate to insulate the capital account from speculation.

The results obtained by Flood confirm the weak version of the "monetary variability" proposition concerning the choice of exchange rate regime when disturbances are

monetary and domestic.[12]   Testing this proposition for 64 countries, Melvin (1985) was able to assert the "monetary variability" proposition.

4.2.2.3 Optimality of a Two-Tier Exchange Rate Regime

In a perfectly integrated asset market, the asset approach produces a short-run or "money-market" theory of exchange rates in which the rate of a floating regime is entirely dominated by the conditions of equilibrium in the asset markets and expectations (Dornbusch, 1976a). Exchange rates in this perspective are determined by interest arbitrage together with speculation about future spot rates. Thus it is suggested that a policy maker can insulate the current account from exchange rate fluctuations by adopting a dual exchange rate regime (Dornbusch, 1976b; Sheen, 1979).

Contrasting the insulation properties of a dual exchange rate with that of uniform regimes, Flood and Marion (1982) examined the choice of exchange rate regime under optimal wage indexation. Their model extends Argy and Porter's (1972) examination of the effects of domestic and foreign shocks under alternative exchange rate regimes. They consider the feasibility of four regimes: (1) a uniform flexible exchange rate, (2) a uniform fixed exchange rate,

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[12]The weak version of the "monetary variability" proposition suggests that a domestic monetary shock increases the desirability of a fixed exchange rate, while a foreign monetary shock increases the advantage of a floating regime (Flood, 1979).

(3) a two-tier exchange rate in which the commercial (current account) exchange rate is fixed and the financial (capital account) exchange rate is flexible, and (4) a two-tier exchange rate with separate floating rates for current and capital account transactions. The model is borrowed from Flood (1979), whose analysis draws on Fischer (1977). Thus their model falls within the early monetarist model of the exchange rate.

Assuming the expected deviation of real output from desired output to be a feasibility criterion, Flood and Marion's solution to the optimal degree of wage indexation shows that fixity of the current exchange rate means that fluctuations in domestic prices occur only as a result of fluctuations in the foreign price level. Hence, full indexation can always be optimal for fixed and two-tier fixed/flexible rate regimes. On the other hand, they show that partial indexation is optimal for uniform and two-tier floating rates.

The indexation solutions in Flood and Marion's study have direct relevance to the insulation properties of each exchange rate regime. They show that full indexation under both fixed and two-tier fixed/flexible regimes insulates the domestic economy from foreign shocks. On the other hand, a two-tier floating is capable of providing full insulation only when the net foreign asset position is zero. This result is similar to those obtained under a flexible exchange rate with no financial integration (see Fischer's (1977) and Flanders and Helpman's (1978) results in section

4.2.1). Contrary to flexible rate advocates, Flood and Marion argue that, with financial integration, a floating exchange rate can never provide full insulation. The financial openness of the small economy operates to weaken the insulation properties of the flexible rate regime by allowing foreign disturbances to enter the domestic economy through the domestic interest rate.

Flood and Marion's (1982) interesting results are applicable only when the home country is small in all markets and domestic supply and foreign price disturbances are orthogonal. However, when the home country possesses market power in the sense of setting its output price, Flood and Marion show that no matter what exchange rate regime is adopted, the degree of indexation that minimizes the loss function is generally less than one. Thus, fixed rates cannot provide full insulation, since correlation of domestic shocks and price prediction errors will cause the private sector to index less than completely.

In an earlier study, Marion (1981), assuming full wage indexation, shows that a two-tier fixed/flexible rate is able to insulate a small open economy from foreign financial disturbances. In the model, the two-tier fixed/flexible rate neutralizes the wealth channel as a transmission mechanism of non-domestic financial shocks. This result is obtained when private wealth holders keep their foreign assets in the form of foreign consols.

However, the two-tier fixed/flexible rate is incapable of insulating the domestic economy from foreign price

disturbances. Marion's result resembles those of continuous PPP.

The two-tier exchange rate regime faces several criticisms. These are:

(i) The insulation properties of a two-tier fixed/flexible regime are conditioned by the assumption that the two markets for foreign exchange, arising from commercial and financial transactions, can be separated completely with zero cost. Bhandari and Vegh (1990) demonstrate that when agents are optimizing, the spread between the two rates will be eliminated even if devaluation takes place. To preserve the spread, the monetary authority must impose exchange control, which is considered to incur substantial cost on the system.[13] Thus, if the two rates are incompletely separated, the insulation properties of a two-tier fixed/flexible rate under single traded or traded and non-traded models do not hold (Guidotti, 1988).

(ii) Cumby (1984) and Gardner (1985) show that allowing for sticky prices and wealth effects will limit the insulation properties of the two-tier fixed/flexible rate.

(iii) Sheen (1979) shows that if speculative behaviour is long lasting, the dual system will

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[13]See Dickie and Noursi (1975) for Syrian Arab Republic experience.

induce real effects. The distortion of the capital account increases the likelihood of instability of capital formation and, therefore, the whole system.[14]

4.2.2.4 Minimizing Disturbance Effect: The Basket Approach[15]

The above methods are argued in the optimal basket literature to be a necessary, but not a sufficient, condition for the choice of exchange rate regime. In a general equilibrium model, Bhandari (1985) extends Turnovsky's (1982) model to consider additional optimality criteria, arguing that the impact of disturbances can be neutralized by altering the weight of the disturbance originating currency in the basket. The magnitude and direction of the weight change will depend on the target variable. In the model, four separate target variables are identified. These are: (i) domestic output around its expected value; (ii) output around its full-employment level; (iii) the domestic money supply (a proxy for the reserve stock); and (iv) the trade weighted real exchange rate (competitiveness). The weight assigned to a country's currency is subject to disturbance related variances. If the home country's trade is perfectly symmetric and all

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[14]Sheen assumes a Cobb-Douglas production function.

[15]In this section we will not consider partial equilibrium solutions. For such studies, see Flanders and Helpman (1977, 1979); Lipschitz (1978); Lipschitz and Sundararajan (1980, 1982); Connolly and Yousef (1982).

prices and income elasticities of bilateral trade are identical (the benchmark case), monetary or real shocks result in a unity relative variance and induce no changes in weights. In Turnovsky's model[16], random disturbances in the goods market imply that the relative weight is indeterminate, since variation between trading partners' currencies is unaffected. In Bhandari's model, a shock emanating from one trading partner necessitates a reduced weight being assigned to its currency in the basket under each of the first three optimality criteria. Turnovsky's model produces a similar result whenever a shock is monetary. Turnovsky's result is obtainable only when the demand for output is interest elastic. The fourth optimality criterion in Bhandari's model requires increasing the weight attached to the shock originated currency. By implication, the first three criteria increase the flexibility of the home currency in terms of shock originated currency, while the opposite holds for the last criterion.

The most realistic scenario in Bhandari's study is of the biased trade case (non-symmetric trade). A move from neutral to biased trade, associated with an equivalent foreign monetary disturbance, results in a reduction in the relative weight assigned to that trading partner for the first three criteria. In contrast, the competitiveness criterion increases the relative weight substantially. In

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[16]He assumes symmetric trade.

the case of a foreign real disturbance, the first criterion leads to decreasing the weight of the trading partner, but increasing it for the other targets.

Bhandari's results are influenced by three strong assumptions. First, he assumes prices are flexible. Consequently, this leads him to the second assumption of continuous equilibrium in both asset and commodity markets. Third, with perfect commodity arbitrage, the real exchange rate is PPP biased even in the short run. The assumption of continuous PPP has little empirical support.

4.2.2.5 Critique of the Reviewed Literature

The analyses of sections 4.2.1 and 4.3.1 face several criticisms. These are:

(i) In many cases, the above studies concluded that a fixed exchange rate is an optimum regime. They do so without explaining what they mean by a fixed rate. Is it a basket or a single peg?

(ii) The models do not specify the ex ante exchange rate regime; thus when expectations are formed rationally a change in regime will destabilize the fundamental structure of the system and give rise to the "Lucas critique" (see Lucas, 1976).

(iii) Under rational expectations the disturbances are white noise and can only occur if the authorities follow an unanticipated policy. If

agent's expectations are rational, then by intuition they know the systematic part of the government policy reaction function, and hence can eliminate its impact on the economy (Sargent and Wallace, 1976; McCallum, 1977). Only when shocks are serially correlated do the system's properties promote the possibility of government intervention (Friedman, 1975).

(iv) The above studies tend to use Lucas, surprise supply function for output. In an open economy, where PPP is assumed to hold continuously, Lucas' supply function behaves in a monotonic fashion on foreign prices when the exchange rate is fixed. Thus, if the policy maker aims to minimize output variation, a rise in foreign prices diminishes the argument for fixed exchange rates.

(v) Generally, they allow little or no role for fiscal policy. In developing countries the public sector is a major economic participant in economic activities.

(vi) Intervention can be costly in terms of reputation (Agenor, 1991). Additionally, since all models are static and non-deterministic, they preclude the incorporation of information lags (Poole, 1970; Friedman, 1975). In real life, information about targets lags behind the availability of information on intermediate targets. Thus the decision maker may lack

knowledge about the structural disturbances and, hence, the feedback rule may not be utilized properly.

(vii) Even though the models discuss the reaction of the economy to foreign shocks, none of them explicitly models the foreign trade sector. Thus a stochastic disturbance to domestic output reflects the effects of both foreign trade and domestic real shocks. Hence, policy makers may encounter situations where they are continuously seeking to identify the source of a real shock. Under such circumstances, policy prescription may operate on a trial and error basis.

(viii) The result represents the immediate response of the state variables to a shock. Although the shock may not effect the target variables in the very short-run, they may impinge on other variables, which may influence the target variables in the long-run.

(ix) Generally, they assume perfectly flexible prices. This assumption is strongly contested in the exchange rate literature as being an over-simplification of real life (see Dornbusch, 1976a).

4.3 Factors Influencing a Developing Country's Choice of Exchange Rate Regime

In the previous section we considered the choice of exchange rate regime under various types of shocks. The literature on developing countries' exchange rate policy perceives the choice of exchange rate to be determined by two broad factors. The first is related to the structure of developing countries' economies, while the second is based on empirical findings on floating regimes. Both promote fixed exchange rates.

In this section we will discuss both factors, starting with the second.

4.3.1 Empirical Regularities of Floating Exchange Rates

MacDonald (1989) summarizes the claims made in the 1950s and 1960s by proponents of floating exchange rates as follows :

(i) Purchasing power parity will hold continuously, so the exchange rate under a floating regime will offset any differences in relative prices. Hence, the regime must be stable.

(ii) Internal price levels are sticky in a downward direction, so that a flexible exchange rate will ensure the restoration of balance of payments equilibrium without painful adjustment.

(iii) A floating exchange rate will insulate a country's economy from external shocks.

(iv) A floating regime will allow a country to pursue its monetary policy independently. The authorities can conduct monetary and fiscal policies in accordance with internal policy objectives, while allowing exchange rate adjustment to equalize the balance of payments.

(v) It will allow the world economy to function without recourse to trade barriers.

(vi) Finally, under "clean" floating, the central banks need not hold foreign exchange reserves, since official intervention will be zero.

Surprisingly, even though theoretical arguments in favour of a floating exchange rate were put forward by early monetarists in the 1950s, serious empirical justification of the above propositions came only in the 1970s. Frenkel (1976) was the first serious article to enquire about the validity of the floating rate regime. His study had two main weaknesses. First, the results were confined to hyperinflation economies. Second, by comparison with present studies on PPP, his time series were relatively short: for instance, compare them with Frankel (1986). In a later, but expanded model, Frenkel (1980) attained similar results to his previous study. Following Frenkel's (1976) publication, several empirical studies were conducted on different currencies and periods using various lengths of

time series (see Bilson, 1978, 1979; Hodrick, 1979). Their work is classified in the exchange rate literature as the "first monetary models of the exchange rate". A common characteristic of these studies is that they tend to concentrate primarily on investigating the behaviour of exchange rates, taking the "law of one price " as the guiding principle and paying little or no attention to other claims.

Nevertheless, as floating exchange rate regimes were accepted in the academic circles of developed countries, differences among schools of thought shifted attention towards investigating the validity of the above claims. In particular, the literature has concentrated on investigating the relationship between exchange rates and relative prices. However, despite the contradictory findings, a consensus on the "empirical regularities" of the behaviour of floating exchange rates is widely held among economists.

Swoboda (1983), IMF (1984), Mussa (1984), Isard (1987), Boughton (1988), Zervoyianni (1989), and MacDonald and Taylor (1992) all discuss the "empirical regularities" of floating rates. These can be summarized as follows:

(i) By the 1980s it was widely recognized that continuous or short-run PPP does not hold. A weaker form of the PPP assumption, the hypothesis of a time-invariant value of the expected long-run PPP level, was developed. It has been a building block for the sticky-price model (see Frankel, 1979, 1981, for empirical studies using this

approach).[17]

In the long-run, relative PPP implies that real effective exchange rates have a tendency to return to PPP. Thus PPP is rejected if the exchange rate follows a random walk, or changes in the real effective exchange rate exhibit no serial correlation.

Later studies utilizing the cointegration approach cast doubt on whether PPP holds over the long-run (Corbae and Ouliaris, 1988; Mark, 1990). Such studies share a common property: their tests are based on "medium" length disaggregated time series, usually annual series disaggregated into monthly observations. Hendry (1986) warned of using such disaggregation as a mean of estimating long-run relations as it may bias the asymptotic properties of the cointegration coefficient. Frankel (1986) estimated that ten or more years may be required for PPP to be reestablished after a disturbance. To test the proposition of PPP as time-invariant over the long-run, a sufficiently long time series is essential. In a sample of 116 annual observations, Frankel (1986) was able to reject the random walk hypothesis for the US dollar-pound Sterling.

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[17]This is known as the "real interest rate differential" approach to the exchange rate.

(ii) Exchange rate variations indicate that there is no close correlation between changes in monetary aggregates and changes in exchange rates. (iii) Exchange rate variabilities under floating rates are substantially higher than under fixed rates. As a consequence, demand for protectionist trade policy has intensified. McCulloch (1983, p. 17) argues that:

"A floating rate obviates the perceived need for direct controls on foreign transactions only to the extent that protection is motivated by overall balance of payments considerations; it does not eliminate incentives for protection as a tool of macroeconomics stabilization or to achieve sector-specific goals."

Furthermore, recent studies reveal that volatility of exchange rates was a factor in the slowdown in growth of international trade. De Grauwe (1988) attributes 20 per cent of the observed decline in the growth of international trade among industrial countries in the period 1973-84 to the increase in real exchange rate volatility.[18],[19]

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[18]For further supportive studies, see the references cited in De Grauwe (1988).

[19]Increases in integration between various economies are usually attributed to real exogenous factors such as trade and capital liberalization.

(iv) In the recent period of floating exchange rates, the deficit (surplus) in the current account did not cause the depreciation (appreciation) of the nominal exchange rate. In other words, changes in exchange rates did not result in a rapid elimination of current account imbalances.

(v) Intervention in the foreign exchange markets has intensified. Managed or "dirty" floats have been the rule rather than the exception. Under the present floating regime, the exchange rate is viewed as a policy tool to be utilized the macromanagement of the economy, and intervention is the means by which it can be manipulated.[20]

(vi) There is little evidence to support the insulation claim. Under a floating regime, the transmission process of foreign disturbances is altered, but such a regime by no means eliminates the effects of such disturbances. In the early 1980s, the European countries were compelled to adopt interest rate policies which were more in tandem with the tight US monetary policy. The impact of floating rates in allowing business cycle transmission in the context of the above events is described in MacDonald (1989, p. 15):

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[20]Dunn (1983) claims that interventions were biased toward undervaluing currencies against the US dollar.

"To a large extent then capital mobility and the unwillingness of the central banks, by and large, to allow large real exchange rate changes have meant that the international transmission of the business cycle, which was such a prominent feature of the Bretton Woods fixed exchange rate regime, remained in force during the floating rate period."

MacDonald (1989) shows that correlations between industrial countries' output, inflation and interest rates were higher under the floating than the Bretton Woods regimes.

4.3.2 Developing Countries Structural Characteristics and Their Choice of an Exchange Rate Regime

Some of the arguments advanced by fixed exchange rate proponents to justify its legitimacy for developing countries are derived from the optimum currency area literature. Since the publication of Mundell's (1961) pioneering article, systematic attempts have been carried out to define the characteristics of an area for which it is optimal to have a single currency regime. A developing country seeking to adopt an exchange rate regime will find that the literature on optimum currency areas provides a theoretical justification for a fixed rate regime. However, in recent years many developing countries have opted for

flexible exchange rate regime.

Below we will discuss the factors that influence a developing country's choice of exchange rate regime. Of the factors discussed below, the first four are attributed to the literature on optimum currency areas (see Ishiyama, 1975; Tower and Willet, 1976). From a theoretical perspective, the following factors influence a developing country's choice of exchange rate regime:

(i) The size of the domestic economy. A relatively small economy, depending on the production of a primary commodity or with a narrowly diversified manufacturing sector, can minimize fluctuations in exports receipts by pegging its exchange rate to the currency in which most of its trade is denominated. Bird (1979) and Crockett and Nsouli (1977) advance similar arguments.

A floating rate can be feasible only when domestic economic activities are adequately diversified and when foreign and domestic products price cross elasticities are sufficiently large. Additionally, due to their size in import and export markets and the nature of their produce, developing countries' exchange rate policies cannot influence output prices in foreign currency. This characteristic enhances the argument for pegging.

(ii) The degree of economic openness. This point

was first introduced by McKinnon (1963).[21] He noted that if a small open economy allows its exchange rate to float, the fluctuation of the rate will limit the domestic currency's ability to conduct its monetary functions and will encourage agents to substitute foreign currency for domestic currency. Summarizing the effect of openness on the choice of exchange rate regime, Tower and Willett (1976, p. 7) stated:

"It can be argued that small, open, undiversified economies adopting freely floating exchange rates are likely to find that their exchange rates vary a great deal and that the purchasing power of their currency over all goods will tend to be unstable....In other words, adoption of freely floating exchange rates by a small, open undiversified economy will tend to reduce markedly the liquidity of its domestic currency unit."

Due to the potential costs to international transactions of frequent adjustment for an open economy, the case for a fixed rate regime gains more support. Moreover, it is argued that the openness of the economy makes fixed exchange rates

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[21]McKinnon defined openness in terms of the proportion of tradeables (both exportable and importable) in total output.

more effective in channelling abroad a domestic monetary shock (Aghevli et al. 1991; Aghevli and Montiel, 1991).

(iii) The availability of an internationally integrated asset market. Black (1976) described the asset markets in developing countries as having several characteristics. First, the degree of substitution between domestic and foreign assets is comparatively low. Second, the markets for domestic securities are thin and there are no sufficiently operating securities brokers and dealer networks. Hence, due to low substitutability and political and economic uncertainties, speculation is more likely to be destabilizing. Third, the absence of a forward market. Fourth, interest rates on domestic securities are unrealistic. Finally, the governments are likely to impose foreign exchange controls. Thus the rudimentary nature of developing countries' financial sectors reduces the possibility of floating their rates. In fact, according to the fixed exchange rate advocates, the experience of floating rates enhances the argument for pegged exchange rates. Lipschitz and Sundararajan (1980, p. 81) argue:

"In a world of generalized floating, there are various reasons why a country might wish to peg the value of its currency in terms of some

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standard. Exchange rates are determined in an asset market - a market for different monies - and, even in a relatively stable world, asset market prices tend to fluctuate sharply. It is widely believed that real economic costs are associated with such fluctuations; they inhibit trade, increase uncertainty, and serve generally to frustrate economic decision making. If the market for a particular currency is thin, the exchange rate fluctuations are likely to be even more volatile, and, for a country without a well-developed financial market, the hedging costs for transactors may be prohibitively high. These factors are sufficient to induce many countries to peg their exchange rates."

Nevertheless, even if the asset market is relatively developed, then if capital markets among a group of countries are highly integrated, there will be no need for a floating rate. Thus, in a developing country with a developed asset market that is strongly linked to a major market, the authorities may find it rewarding to fix their rate to the currency of the large country.

(iv) Trade concentration. This can be viewed from two aspects. First, from the geographical aspect, if a country's trade is classified as being geographically narrowly diversified, it will be

better off pegging its exchange rate to the currency/currencies of its trading partners (Heller, 1978). Second, if the share of a particular primary good in total trade is large, then the small country can be better off pegging its currency to the primary good denominated currency.

Using discriminatory analysis, Heller (1978) tested the above propositions and was able to confirm their effects on the choice of an exchange rate regime.[22]

(v) Institutional. The social and, particularly, the political institutions of developing countries may hamper the possibility of a floating rate. For such an exchange rate regime, political support is essential, especially in the early stages. The fragile political regimes in developing countries contribute to reducing the possibility of floating.

(vi) Under a fixed exchange rate regime, the exchange rate is a policy variable. In a developing, small and open economy, the exchange rate can be utilized to help fulfill policy objectives in the short-run and to contribute towards bringing about the desired structural

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[22]Heller's test included an additional independent variable (the inflation differential).

changes in the long-run (Johnson, 1976; Crockett and Nsouli, 1977).

4.4 The Choice of an Optimum Peg[23]

By the 1980s, the issue of selecting an exchange rate regime by developing countries overwhelmingly resulted in the pegging of their rates. However, the issue of an optimal peg persisted, i.e. what weight should be assigned to different currencies? This section will discuss the various types of peg regimes.

4.4.1 Single Currency Peg

Under such an exchange rate arrangement, a developing country will usually peg its exchange rate to an industrial country's currency. The peg choice is usually based on several factors. These are:

(i) Trade with the industrial country should account for a fairly large proportion of total trade. Thus, to avoid uncertainties and to enhance trade between the two countries, the developing country will seek to fix its rates to this major trading partner.

The same argument applies to exports of primary

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[23]This section draws upon the works of Black (1976), Crockett and Nsouli (1977), Flanders and Helpman (1977, 1979), Lipschitz (1978, 1979), Lipschitz and Sundararajan (1980, 1982), Connolly (1982), Connolly and Yousef (1982), Wickham (1985) and Horne and Martin (1989).

goods. If the primary commodity constitutes a large proportion of total trade and the international price of the commodity is denominated in a particular currency, the developing country will tend to peg its rate to that currency in order to minimize fluctuations in exports receipts.

(ii) If the industrial country pursues a credible monetary policy.

(iii) If the industrial country's monetary policy results in a rate of inflation that is acceptable to the authorities of the pegging currency.

A single peg implies that the pegging currency will float jointly with the peg currency at a fixed rate. Consequently, the developing country's economy will import the effects of the developed country's monetary policy but may not enjoy the proposed insulation properties of a floating rate.

The peg rate can be maintained by two methods. The first is through reserve movements in which the central bank in the pegging country intervenes in the foreign exchange market to sell or buy any amount of foreign exchange necessary to maintain the rate at its peg level. The second method controls capital movements so as to restrict foreign exchange outflow. This can be implemented by legislative measures and/or by imposing a quota and/or a tariff on luxury goods: it usually leads to the development of a black

market.

The single currency peg has some advantages which make it attractive to developing countries. These advantages are:

(i) It eliminates exchange rate fluctuations between the pegging and peg currency. In turn, this reduces uncertainties and can contribute positively to trade development between the two countries.

(ii) If the peg currency's monetary policy is considered credible by its trading partners, confidence in the pegging currency might increase.

(iii) It provides a clear criterion for intervention in the foreign exchange market.

(iv) Maintaining the peg rate by means of reserve movements can help to eliminate a foreign exchange black market.

(v) The peg is a restraint against expansionary monetary policies.

However, the single currency peg has disadvantages that can be summarized as follows:

(i) The developing country will import its monetary policy.

(ii) The need for reserves may increase, especially when the peg is maintained through reserve movements. However, if the authorities resort to the other approach that of restricting

capital movement, such policy may give raise to black market and possibly a differential between market and official rates for the exchange rate.

(iii) Since fluctuations of the exchange rate are exogenous and independent of government policy, they may interfere with the pursuit of internal policy objectives. Indeed, exchange rate fluctuations may prevent domestic policy objectives from being fulfilled.

(iv) Interest rates in the pegging country will be mainly determined by the peg currency's interest rates. Thus, excluding the possibility of legislative measures, the influence of a small country's monetary policy on capital movements is minimized.

4.4.2 Multicurrency (Basket) Peg

If a country's trade is relatively diversified and it wishes to peg its exchange rate, then to avoid some of the disadvantages of the single currency peg, a basket of currencies can be an appropriate choice. The basket setting must express a specific policy objective. Simultaneously, the basket peg will aim to produce a relatively stable nominal effective exchange rate (NEER) by allowing for a compensatory mechanism that stabilizes the NEER around its steady state value. In a sense, the deviation of the NEER from its long-run value can be a policy outcome.

It is useful at this point to illustrate the concept of a basket. Let us suppose that country A expresses its currency in terms of a basket composed of n currencies. Country A's NEER is:

$$e = w_1 \cdot e_1 + w_2 \cdot e_2 + \ldots + w_n \cdot e_n \qquad (1a)$$

or

$$e = w'E, \qquad \sum_{i=1}^{n} w_i = 1 \qquad (1b)$$

where

e: the domestic NEER.

E: the exchange rate vector (units of foreign currency per unit of domestic currency).

w: the weight vector assigned to each currency.

n: the number of currencies included in the basket.

For simplicity, let us assume that the basket contains only two currencies, the US dollar and the pound sterling. Then

$$e = w_1 \cdot e_1 + w_2 \cdot e_2 \qquad (2)$$

In equation (2) e_1 and e_2 stand for the dollar and the pound respectively. The monetary authorities will assign weights such that $w_1 + w_2 = 1$. If the pound price of dollars is one half, $e_1 / e_2 = 1/2$, and $w_1 = 1/2$, and the basket value in dollars is:

$$e = 3/2 \cdot e_1 \qquad (3)$$

The basket is 1.5 times the price of the domestic currency in terms of dollars. Thus, if the dollar appreciates by one per cent against the pound, the domestic currency will depreciate by 2/3 of one per cent against the dollar but appreciate by 1/3 of one per cent against the pound.

There are several ways to measure the NEER. The ideal NEER index would incorporate the effects of trade structure, price sensitivity to changes in exchange rates, the price elasticity of different products, export competitiveness, the pattern of bilateral trade, and its impact on capital flows. Although such a comprehensive index is not available, a proxy index (the Multilateral Exchange Rate Model- MERM) was developed for industrial countries to account for some of the above factors. Unfortunately, the absence of essential data in almost all developing countries makes it impossible to construct the MERM for this group of countries.

4.4.2.1 Special Drawing Rights

Pegging to Special Drawing Rights (SDR) is considered to be a peg that is determined exogenously. As a special basket of the five major industrial countries (USA, Japan, Germany, France and the UK) and as an internationally recognized unit of account, the SDR attracted the attention of several small developing countries.

An important advantage of pegging to the SDR is that it will encourage the development of financial and forward

markets vis-à-vis the intervention currency.

However, it has some drawbacks. They are:

(i) It is a narrow basket; thus a country with diversified trade will find pegging to the SDR less attractive.

(ii) Even if the SDR's five countries are the only trading partners of a developing country, their weights in the basket are highly unlikely to match their share in the country's trade. As a result, this may not reflect the country's NEER movements properly.

(iii) The weights do not reflect domestic policy objectives.

(iv) Perhaps another worrying disadvantage of pegging to the SDR is the weight criteria. The IMF can alter each currency's weight according to its significance in international trade and finance. Such changes may not suit domestic policy objectives.

4.4.2.2 Weight Determination Methods

4.4.2.2.1 Import Weight Method

Under an import weighted basket the NEER is a weighted average of all currencies contained in the basket. Usually the basket will comprise currencies of major trading partners whose exports are important, in terms of investment and consumption. A non-major trading partner can be added

to the basket because of the significance of its exports to the domestic economy. The prospect of developing trade with a small partner may also justify its addition to the basket.

Import weighted baskets have the tendency to stabilize the domestic currency's purchasing power by reducing price instability engendered by foreign exchange rate changes. Thus, a country dependent on imports to satisfy investment and/or consumption will find an import basket appealing.

The NEER of an import weighted basket is expressed as the following:

$$e = \sum_{i=1}^{n} w_i \cdot e_i$$

and

$$\sum_{i=1}^{n} w_i = 1$$

where

e: the NEER.

w_i: weight allocated to country i using import data.

e_i: bilateral exchange rate (units of country i currency per unit of the domestic currency).

n: number of currencies included in the basket.

Pegging to an import weighted basket has the disadvantage that it is a backward looking basket, since it only considers what is coming into the country, not what can be exported.

4.4.2.2.2 Export Weight Method

Unlike the import basket, the export weighted basket is a forward looking basket. The NEER under this method is a weighted average of export partners whose currencies are included in the basket. That is:

$$e = \sum_{j=1}^{m} w_j \cdot e_j$$

and

$$\sum_{j=1}^{m} w_j = 1$$

where

e: the NEER.

w_j: weight allocated to country j using export data.

e_j: bilateral exchange rate (units of country j currency per unit of the domestic currency).

m: number of currencies included in the basket.

For a country pursuing an export oriented strategy, and where its exports are exchange rate elastic, the export weighted basket can be an appropriate peg. But if the same country's capital inputs are import-dependent, this method may not be feasible. In fact, in this case, the peg's optimality will depend on the Marshall-Lerner condition and on the marginal propensity to import. The latter will account for the indirect effects of higher exports on the

country's demand for imports.

4.4.2.2.3 Trade Weight Method

To avoid some of the disadvantages of import and export weighted baskets, a trade weighted basket can be adopted, where its value is the weighted average of import and export trading partners' currencies.

The aggregation characteristics of a trade weighted basket may render it ineffective. For instance, a country experiencing continuous foreign price shocks may find an import weighted basket more stabilizing.

4.4.2.2.4 Target-Instrument Weight Method

This method uses the approach developed by Horne and Martin (1989). Unlike the previous approaches, the Horne-Martin approach requires testing for the optimum regime using a parametric method. Once the null of no optimum peg is rejected, the weights are estimated using the Kalman regression. The advantage of this approach is that it is directly related to the goal of the policy makers. If they aim to have a regime that enhances their ability to forecast a target variable, the orthogonality of the system shocks is utilized to derive these weights.

In the other methods, the weights are not calculated using a parametric approach. Instead, they depend on the share of each trading partner in the country's foreign trade. Additionally, they are calculated without being

directly linked to the aim of the policy makers, hence reducing the probability of achieving the policy aim. Obviously, in terms of opting for a peg regime, the extensions to the Horne-Martin approach increases its accuracy. For instance, weights are estimated for the exchange rates only if each of them contribute to enhancing the forecast of the target variable and if each exchange rate Granger causes the target variable (see chapters 6 and 7 for detailed discussion on the Horne-Martin approach).

4.5 Conclusion

The literature on exchange rate policy is indeed vast and emanates from the wide range of topics covered. Having this in mind, our discussion has attempted to touch upon some of the main topics within the exchange rate literature. Indeed, with respect to developing countries, one may need to read Wickham (1985) to appreciate the diversification of this topic alone.

Nevertheless, the diversity of the literature has not resulted in a common consensus on what constitutes an optimum exchange rate regime. Each model usually leads to different results, thus making it impossible to summarize the above discussion. However, it is necessary to remember that these models are theoretical and that many of them are developed using very strong assumptions: an example of this being the assumption of continuous PPP. From an empirical perspective, this will lead us to suggest altering the "model-specific" term used by Flood and Marian (1991) to

describe the conflicting findings of the theoretical models to "country-specific". This means that the model specification must reflect the true structural characteristics of the economy rather than be based on pure theoretical assumptions. The Horne-Martin approach used in the thesis will incorporate such characteristics by using the results of an empirically tested model to test for the optimum regime. The discussion of this method is provided in chapters 6 and 7.

Chapter Five

Bahrain Dinar Exchange Rate Policies

5.1 Introduction

This chapter aims to investigate the effect of the Bahrain Dinar (BD) exchange rate arrangement on the behaviour of the BD rate vis-à-vis trading partners' currencies, on the conduct of interest rate policy, and on the asymptotic property of the exchange rate with respect to domestic inflation. Generally the question of the choice of exchange rate regime by developing countries is solved by aiming at stabilizing either output or the price level (see the studies cited in the literature review of chapter four). Having addressed the optimality of the exchange rate with respect to output in chapter three, this chapter will concentrate on the relevance of exchange rate policy to domestic inflation.

In section 5.2 we briefly review the BD exchange rate arrangements. Section 5.3 provides a description of the BD nominal and real effective exchange rates, the NEER and REER respectively.

In estimating the REER, the non-oil GDP deflator is utilized. Even though different price index reflects the aim of writer, however, commenting on his findings on the choice of an appropriate price index to measure the real effective exchange rates of 32 developing countries, Edwards (1989) concluded that the choice of an index causes no divergence in the behaviour of either the bilateral or multilateral real effective exchange rate. Herberger (1986) argues that, given availability and periodicity, the consumer price index represents the best real world

counterpart to the ideal theoretical price index.

Section 5.4 discusses the impact of exchange rate arrangements on the conduct of domestic interest rate policy. In this section an implicit hypothesis on the divorce of interest rate policy from domestic fundamentals is developed, discussed and tested using Granger and Sims definitions of causality. The findings fail to reject the tested hypothesis.

It was hypothesized that under the fixed exchange rate arrangement of the Bretton Woods system, domestic inflation will converge to the world average inflation rate. This constituted one of the major drawbacks that led to the collapse of the Bretton Woods system. Thus the post-Bretton Woods system was anticipated to reduce such effects. The extent that foreign price shocks effect domestic inflation will be dependent on the pursued exchange rate regime. A floating regime is anticipated to insulate domestic prices from foreign price shocks, while a single currency peg will result in the convergence of the domestic inflation rate to the peg currency inflation rate. For Bahrain this will imply testing the hypothesis of whether or not Bahraini post-Bretton Woods exchange rate regimes diminished the exposure of domestic inflation to world price shocks. Thus if the test fails to reject this hypothesis it will lead us to question the optimality of the post-Bretton Woods peg arrangements. In fact, the test fails to reject the hypothesis of the convergence of domestic inflation to world average inflation using post-Bretton Woods data.

Section 5.6 concludes this chapter by providing a summary on the results and their implications for exchange rate policy.

5.2 A Background to Bahrain Dinar Exchange Rate Arrangements

The history of the exchange rate arrangements of Bahrain can be traced back to the period following the formation of the Bahrain Currency Board in 1964. Prior to this period, Bahrain has used various types of currencies as the means of exchange. For instance, in 1880 the Indian Rupee replaced the long used Austrian Schilling "Maria Theresa" (AlKhalifa, 1980). In 1959 the British administration decided, for administrative convenience, to refer to the Indian Rupee, which was in circulation in the Arab countries of the Gulf, as the "Gulf Rupee". Both regimes had the same arrangement and both were in the scheduled territory of the Sterling area.

The decree that led to the formation of the Bahrain Currency Board assigned to the Board the duty of undertaking responsibility for issuing the Bahrain Dinar (BD). On 16 October 1965 the BD was issued and recognized as the country's official currency. The BD was pegged to gold at a par value of 1.86621 grams per BD of fine gold (IMF, 1975). Under the new exchange rate regime the BD continued to be within the Sterling Area. However, Bahrain ceased to be within the scheduled territory of the Sterling Area in June 1972, when the currency was unpegged from the sterling pound

(AlMeer, 1980). The unpegging of the BD from sterling was inspired by the realization of the importance of the US dollar to domestic economic activities, particularly to the oil and gas sectors.

Following the collapse of the Bretton Woods system, Bahrain, as well as other countries, encountered a situation in which each country had to adopt either a floating or a peg exchange rate regime, and if a country opted for the second option it needed to determine what that peg sould be. In the case of Bahrain, Heller (1978) showed that it would be better off pegging its exchange rate. In a later study, Crockett and Nsouli (1979) demonstrated that pegging the BD to the SDR would enhance economic stability.

Approximately five years after joining the IMF, the Bahrain Monetary Agency (BMA) announced in January 1978 that the BD pegged to the SDR at the rate BD=SDR2.1. Bahrain agreed to confine the BD exchange rate to be within the narrow margins of 2.5 per cent of the central rate. However, following the depreciation of the BD against the SDR in August 1978, the BMA opted for the wider margin of 7.25 per cent.

In December 1980 the monetary authorities modified the existing exchange rate arrangement by dually pegging the BD to the SDR and maintaining a fixed rate with the US dollar at the rate BD1=$2.6596 (IMF, 1985). The appreciation of the US dollar in the first half of the 1980s caused the BD rate in terms of the SDR to move outside the permitted margin. However, following the depreciation of the dollar

after the Plaza Agreement in September 1985, the BD exchange rate against the SDR depreciated steadily to fall in July 1986 within the official margin. The 1980s exchange rate policy showed BD to be an exogenous foreign-dependent currency whose rate was solely determined by the US dollar. This would suggest that a shock to the US dollar would instantaneously spill over to Bahrain's exchange rate.

The move to a fixed dollar regime can be explained by the following:

(i) The US dollar is the main foreign trade and investment denominating currency (BMA, 1991).

(ii) The weights allocated to currencies composing the SDR were not in tandem with Bahrain's foreign trade shares.

(iii) The US appeared to have a relatively stable inflation rate. Additionally, the inflation differential between the US and Bahrain was relatively low. Fleming (1971), regarded the similarity in inflation rates as an important factor in determining a currency area. Empirical studies found Fleming's proposition to be significant in determining the type of exchange rate regime (see Heller, 1978; Holden et al. 1979; Melvin, 1985). Thus a stable exchange rate versus the dollar might have been considered compatible with internal price level stability.

Connolly and Yousef (1982) demonstrated, using monetary stability comparisons for 1973-1979, that

if Bahrain were to opt for a single peg, the dollar would provide a suitable anchor for the stability of domestic inflation. They ascribed their result to the stability of US monetary policy.

(iv) Crockett and Nsouli (1977) argued that pegging to a major currency would enhance domestic and international confidence in the domestic currency and might stimulate foreign investments.

(v) A single peg is the simplest and least costly arrangement (Crockett and Nsouli, 1977).

5.3 Developments in BD Exchange Rate Indices

In this section we will attempt to measure and describe the behaviour of the nominal effective exchange rate (NEER), the real effective exchange rate (REER) and the bilateral exchange rate of the BD versus Bahrain's main trading partners. These are the US, Japan, Germany, UK, Australia, France and Italy. The weights for the NEER and REER are calculated using non-oil imports as suggested by the IMF. Linking exchange rate policies to oil will not be a sensible decision given that oil prices are exogenously determined. The following formulae are used to calculate the NEER and REER:

$$NEER_t = \sum_{i=1}^{7} w_i e_{it} \qquad (1)$$

$$REER_t = \sum_{i=1}^{7} (w_i e_{it}) P_t / FP_t \qquad (2)$$

The terms w_i, e_i, P and FP stand for partner i's share in non-oil imports, the bilateral exchange rate of partner i (units of foreign currency per unit of domestic currency), the domestic non-oil GDP deflator and an average weighted foreign wholesale price index.

From Table 5.1 and Figures 5.1-5.8 below we can infer the following:

(i) Prior to fixing the BD to the US dollar, the NEER, REER and bilateral exchange rates were less volatile. For nominal rates the volatility indicates that, during the fixed dollar arrangement, either the BD exchange rate was frequently exposed to shocks induced by dollar fluctuation, or that the size of the exchange rate shocks were smaller under the previous arrangements. The variations in real rates tends to be higher than nominal rates. The noticeable increase in the REER during the period 1981-89 was mainly caused by increases in the volatility of the NEER and to a lesser extent to volatility in relative prices. Between the periods 1975-80 and 1981-89 the variability in relative prices increased by 113.9% and 6.0% respectively.

According to recent studies, the volatility of developing countries' exchange rates was found to enhance uncertainty, and hence to have negative effects on economic growth, investment and trade expansion (see Coes, 1981; Edwards, 1989).

The exchange rate literature predicts that a positive terms of trade shock, such as that of 1977, would lead to a higher real rate over the short-run (see Edwards, 1986; Herberger, 1986).[1] In a sense, their proposition is based on the assumption that the data generating process of the exchange rate series is stationary and that a shock to the process thus tends to have a transitory effect, i.e. the process has a short memory. This is a standard assumption in the exchange rate literature. However, testing for the stationarity of the BD exchange rate proves the contrary.[2] The results are in conformity with Khan and Montiel's (1987) finding that a shock to the real rate will have a persistent effect.

(ii) The BD was fixed to a booming sector currency (the US dollar) in December 1980. However, the appreciation of the BD nominal

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[1]For theoretical and empirical discussion of the determinants of developing countries' REER, see Edwards (1988).

[2]An augmented Dickey-Fuller test yields a unit root test statistic of -1.136. At the 5% level the critical value is -3.49.

effective exchange rate following 1980 cannot be
identified with the literature's view on the
effects of a natural resource boom, i.e. the
1979/80 oil price shock. The appreciation of the
BD in the first half of the 1980s is entirely
attributable to the appreciation of the US
dollar.[3]

The movement of the US dollar during the 1980s
against major currencies was basically dominated
by two contradictory phases. In the first half of
the 1980s, the dollar steadily appreciated against
the major currencies, but depreciated
substantially during the second half (see Figures
5.3-5.8). Frenkel and Razin (1986) and Krugman
and Baldwin (1987) attributed the appreciation of
the dollar in the first half of the 1980s to the
US current account deficit. Their model, however,
failed to explain the subsequent depreciation of
the dollar. Hoffman and Homburg (1990) modified
the approach by using a choice-theoretic model of
real exchange rate movements to show that a
persistent current account deficit led initially
to a currency appreciation but ultimately induced
a depreciation.

From Figure 5.1, there appears to be an obvious
similarity between the movements of the BD NEER

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[3]For the literature on exchange rate behaviour in a natural
resource based economy see (Corden, 1982; Corden and Neary,
1982; Neary and Wijnbergen, 1985).

and movements of the dollar. In the first half of the 1980s, the BD NEER appreciated annually by 5.4%. As can be seen from Figure 5.1, in 1986 the BD NEER encountered a nominal shock which led to a large (14.8%) fall in its level. The effect of such a shock on the exchange rate itself and on output depends on the integration properties of both series and on whether or not they are cointegrated. Studies of the effect of exchange rate devaluation on output tend to provide contradictory results.[4] Johnson (1958) and Dornbusch (1973) argue that depreciation can have a positive effect on domestic output. Krugman and Taylor (1978) show that devaluation will have a contractionary effect on domestic output due to demand factors. Wijnbergen (1986) extends Krugman and Taylor's contractionary argument to the supply side. Edwards (1986) demonstrated using traditional econometric methods that devaluation will have only transitory effects. Nonetheless, recent studies tend to support the contractionary argument (see Solimano, 1986; Sheeley, 1986; Rojas-Suarez, 1987; Buffier, 1989).

There is no doubt that such a shock will have some effects on the economy, particularly on non-oil

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[4]The continued fixing of the BD rate to a depreciating currency implies that the authorities were effectively willing to allow for BD devaluation.

import prices. Klai and Abdullah (1989) estimated that the depreciation of the BD nominal rate increased non-oil import prices by 9.3% in 1986 alone.

On the real side, the appreciation of real rates in the period 1980-84 can partially be attributed to increases in non-oil prices due to the "expenditure effect" of the 1979/80 positive oil price shock. The literature on natural resource booms anticipates the "expenditure effect" to lead to higher price levels in non-booming sectors (see Corden and Neary, 1982; Neary and Wijenbergen, 1985). In 1986 the REER was exposed to a shock induced by a large depreciation in the US dollar nominal rate and a decrease in the domestic non-oil price level. The shock resulted in a 23.9% fall in the REER.

(iii) Overall, the BD exchange rate arrangement seems to result in a slight overvaluation of the BD rate. For the 1975I-1989IV period the average NEER rate was overvalued by 0.9%. In the pre and post BD-dollar fix arrangement the BD was slightly overvalued by 0.05% and 1.5% respectively. However, it should be noticed that since the 1986 exchange rate shock, the BD rate has been undervalued (see Figures 5.1-5.8). Thus, in 1989 the NEER was undervalued by 14.6%.

(iv) It appears from Figures 5.1 and 5.3-5.8 that, following any exchange rate shock, the changes in the exchange rate will continue for several years. This is a clear indicator of the non-stationarity of the exchange rates.

Table 5.1
Volatility in the BD Exchange Rates

Series	1975I-80IV	1981I-1989IV	1975I-89IV
NEER	5.3	10.7	9.7
REER	5.5	18.0	14.6
US$ Nominal	2.0	0.0	2.0
US$ Real	9.0	7.4	8.1
Yen Nominal	13.9	25.0	23.0
Yen Real	4.4	23.3	18.4
DM Nominal	12.2	19.1	17.5
DM Real	5.9	23.5	22.6
Pound Nominal	10.6	15.0	19.1
Pound Real	10.4	21.9	18.5
AS$ Nominal	7.3	17.3	24.1
AS$ Real	9.2	19.5	16.6
FF Nominal	5.6	18.2	27.5
FF Real	10.4	29.3	27.3
IL Nominal	10.5	16.7	32.2
IL Real	8.0	22.6	20.5

Notes: Volatility is measured by the coefficient of variation as suggested by Williamson (1983).

FIGURE 5.1: THE NEER AND REER

NEER=_____ REER= ....

FIGURE 5.2: INDEX OF US DOLLAR NOMINAL AND REAL EXCHANGE RATE VS BD

US$=_____ RUS$= ....

FIGURE 5.3: INDEX OF YEN NOMINAL AND REAL EXCHANGE RATE VS BD

YEN=_____ RYEN= ....
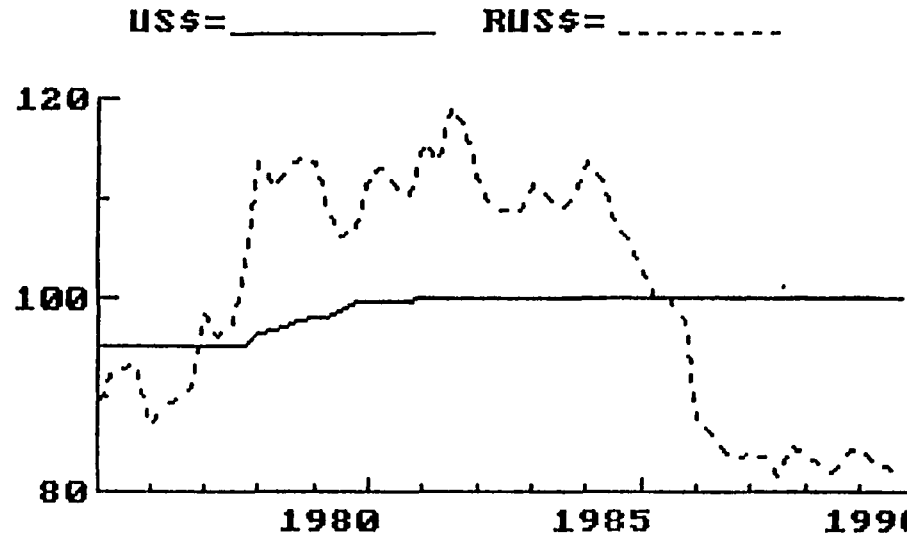
FIGURE 5.4: INDEX OF POUND STERLING NOMINAL AND REAL EXCHANGE RATE VS BD

PS=_____ RPS= ....
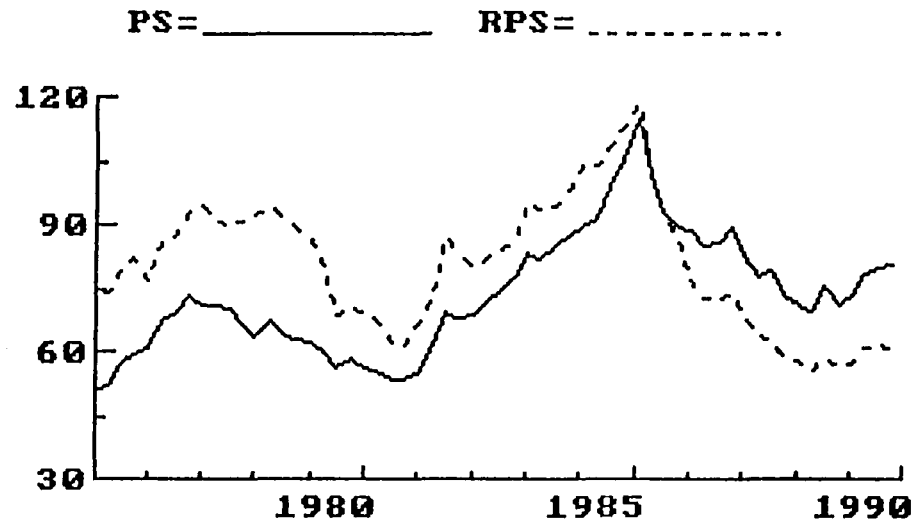
NOTE: RUS$: REAL US DOLLAR RATE; RYEN: REAL YEN RATE; AND RPS:REAL POUND STERLING RATE.

FIGURE 5.5: INDEX OF DEUTSCHMARK NOMINAL
AND REAL EXCHANGE RATE VS BD
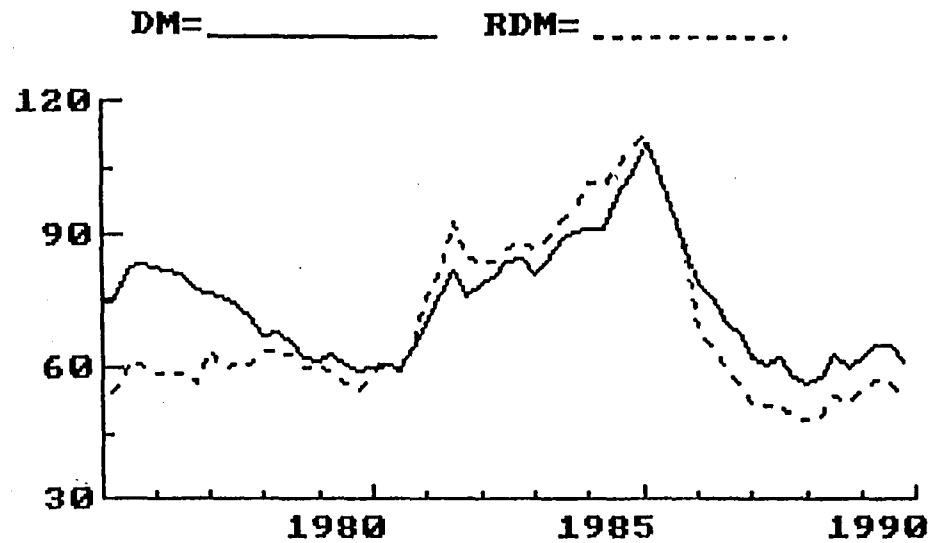
FIGURE 5.6: INDEX OF AUSTRALIAN DOLLAR
NOMINAL AND REAL EXCHANGE RATE VS BD

DM=_____ RDM= ....

AS$=_____ RAS$= ....
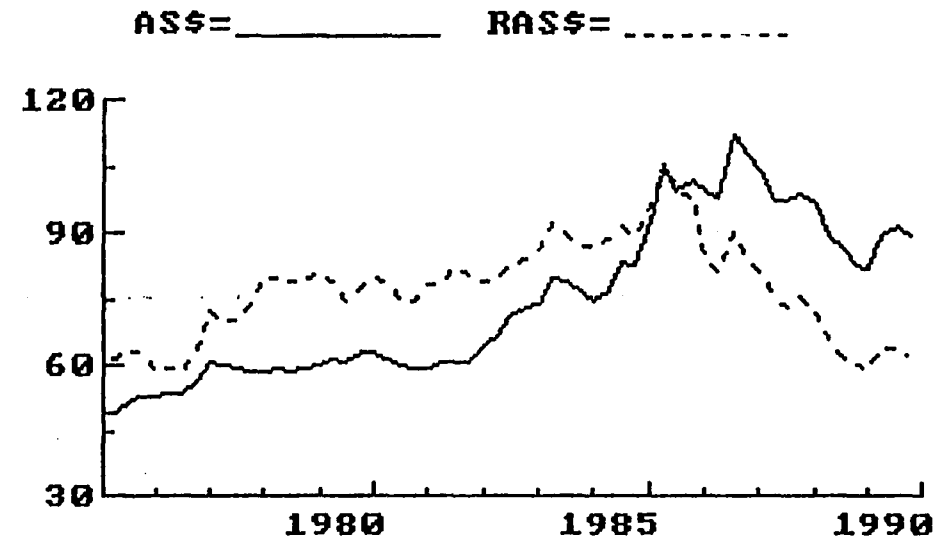
FIGURE 5.7: INDEX OF FRENCH FRANC NOMINAL
AND REAL EXCHANGE RATE VS BD
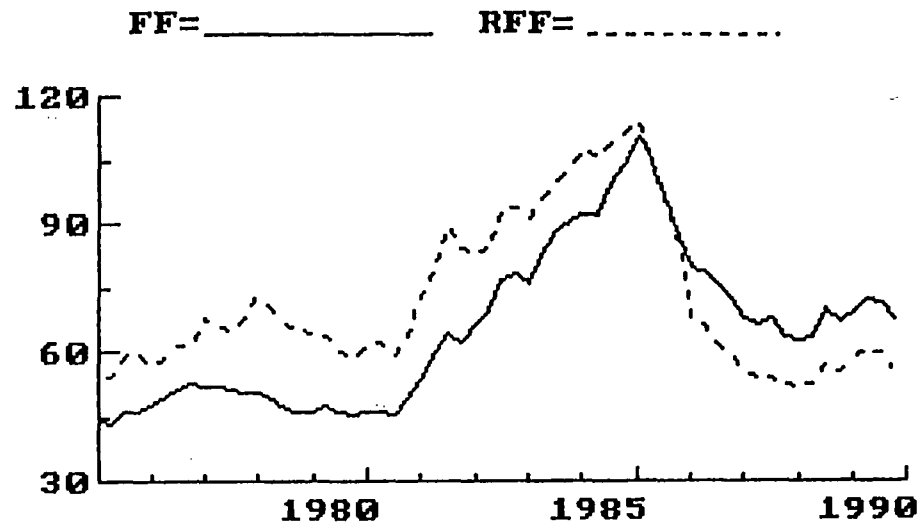
FIGURE 5.8: INDEX OF ITALIAN LIRA
NOMINAL AND REAL EXCHANGE RATE VS BD

FF=_____ RFF= ....

IL=_____ RIL= ....
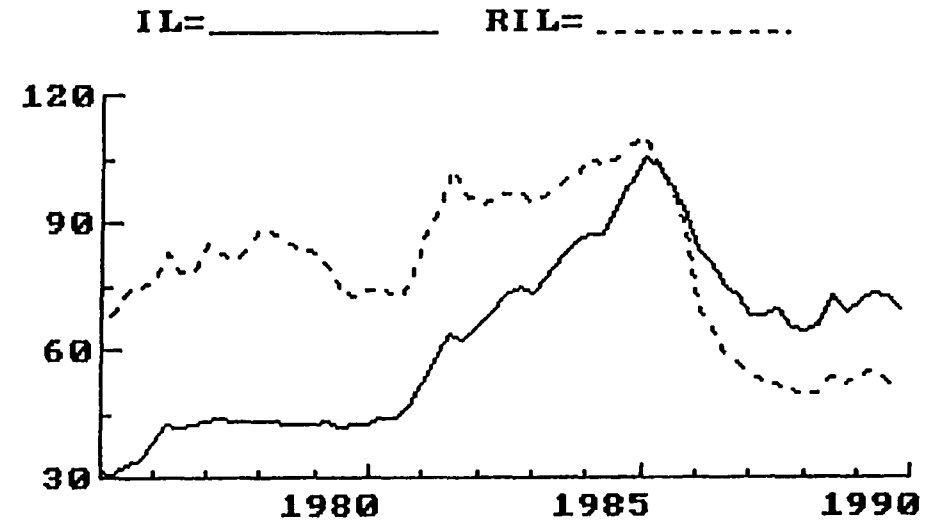
NOTES: RDM: REAL DM; RAS$: REAL AS$; RFF: REAL FF; AND RIL: REAL IL.

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5.4 Implications of the BD Exchange Rate Arrangements for the Conduct of Interest Rate Policy

The existence of capital mobility under a fixed exchange rate regime implies that the authorities have agreed to surrender their interest rate policy to the peg currency policy. The loss of an important monetary instrument, the interest rate, means that such a regime provides the appropriate monetary conditions to enhance the exposure of the domestic economy to foreign interest rate shocks (Flood, 1979). Flood shows that through wealth effects, a foreign interest rate shock increases the forecast error of a target variable. Additionally, pursuing such a policy would mean that interest rates may fluctuate in a manner contrary to the aims of policy makers.

As Bahrain has always pegged its exchange rate and has had no restriction on capital movements, its interest rate is strongly influenced by international interest rates. Following the fixing of the BD to the US dollar in December 1980, the Bahraini rate basically shadowed the dollar rate (see Figure 5.9). Interest rates on US treasury bills represent an obvious opportunity cost for holding domestic assets (Osborne, 1989; Alyousha, 1990).

In general, the interest rate policy pursued by the Bahrain monetary authorities was based on setting a recommended maximum interest rate for the Dinar customer. Changes in the ceiling rate do not correspond to one to one changes in US rate. For instance, during 1975-89 period the ceiling rate changed 14 times while US rate Changes almost daily. Additionally, as data on market rate is not

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published, it will not be an easy task to infer on the exact relationship between the ceiling and the market rates. Nevertheless, they are anticipated to be close.

Such an interest rate policy was argued by McKinnon (1973) and Shaw (1973) to lead to disequilibrium; a domestic rate below the market clearing rate. The McKinnon-Shaw proposition postulates that the disequilibrium rate discourages saving, causes lower real output growth and hampers the development of the financial system. Fry (1982) described such an outcome as the result of a "financially repressed" economy.

Acknowledging the effects of such an interest rate policy, BMA (1991, p. 166) stated:

> "The policy was not, however, very conducive to encouraging domestic saving or discouraging outflow of capital."

Thus on 16 June 1990 the ceiling rate policy was abandoned. The McKinnon-Shaw proposition predicts that the abolition will eliminate much of the low risk, low yielding investment in favour of relatively higher risk, higher yield projects. Consequently, this will increase the marginal productivity of capital and, hence, output.

It seems, however, that the McKinnon-Shaw proposition pays little attention to the effect of exchange rate policy on domestic interest rates. Combining capital mobility with the existing exchange rate regime, the abolition of the ceiling policy cannot enhance the influence of domestic factors on domestic interest rates. The issue that remains

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to be addressed is the ability of the domestic monetary authorities to mobilize domestic interest rates to achieve domestic economic objectives, rather than the type of interest rate policy. In a sense, as long as there is neither foreign exchange risk nor restrictions on capital movements, the monetary authorities' ability to influence interest rates remains extremely limited.

FIGURE 5.9: INTEREST RATE ON BD AND US DOLLAR

RBD=_____ RUS=..........
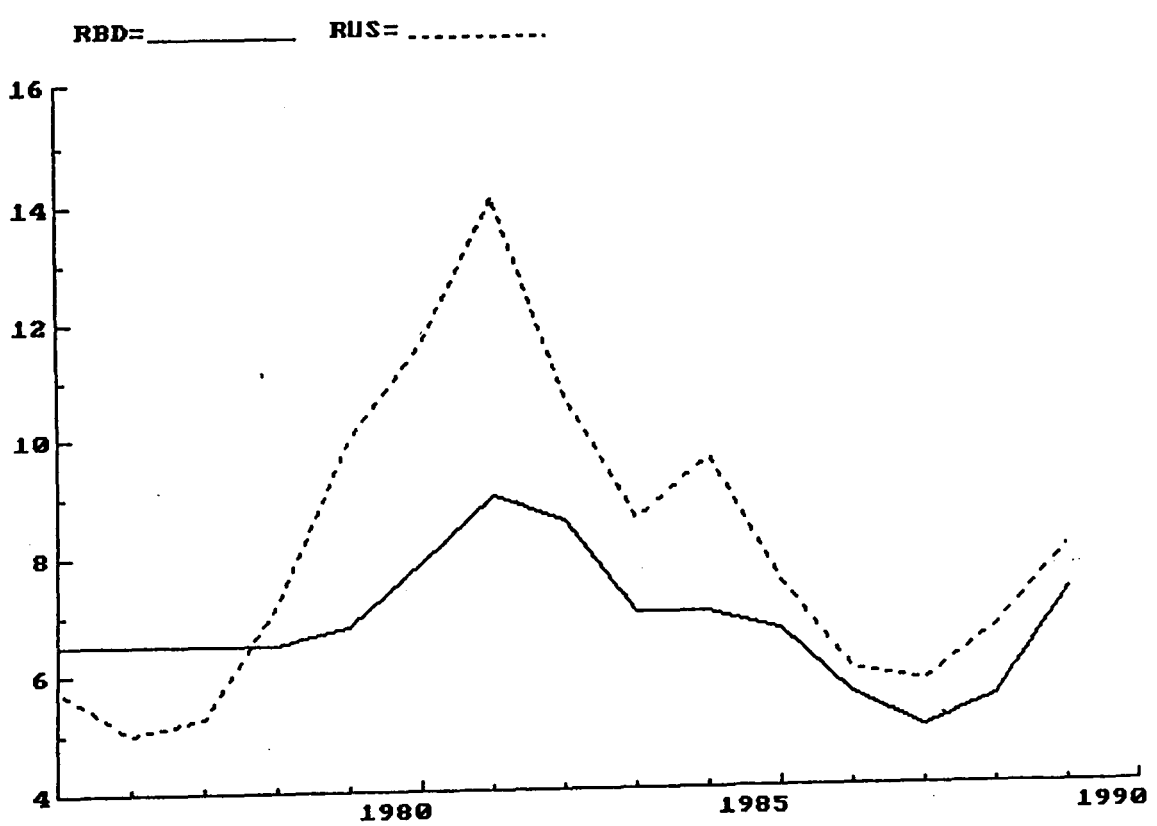
NOTES: RBD IS THREE MONTHS INTEREST RATE ON BD DEPOSITS. RUS IS US TREASURY BILL RATE.

5.4.1 Interest Rate Policy and Domestic Inflation

To provide an insight into the effect of post-Bretton Woods exchange rate regimes on the relevance of interest rate policy to domestic fundamentals, we will focus on the short-run causation between interest rates and domestic inflation. In discussing the relationship between interest rates and inflation Goodhart (1982, p. 210) stated:

> "The course of nominal interest rates has accompanied changes in the pace of inflation very closely, which accords with the hypothesis that expectations of inflation are the main determinant of the level of nominal interest rates...."

Goodhart's statement is equivalent to Fisher hypothesis, however, cointegration between the two series is rejected on the ground that the cointegrating parameter on the interest rate possess the wrong sing. Nevertheless, Goodhart's statement implies that nominal interest rates can be utilized over the short-run to reflect changes in economic activities. Thus, if domestic prices are rising and are expected to continue rising, the authorities may allow the real rate of interest to rise, thus easing demand pressures on prices. Hence, if real interest rates were to rise and to continue rising for more than one period, agents may interpret such an event as a signal of a policy change to an anti-inflationary stance. Agents' perception of the policy change would be reinforced if a positive real interest rate were to persist during a recessionary period.

Table 5.2 reveals that, irrespective of its fluctuation, the real interest rate in Bahrain was predominantly positive and continued to be so, despite the slowdown in economic activities between 1986 and 1989. This gives the impression that priority is given to inflation in the conduct of interest rate policy.

In this section the hypothesis on the divorce of interest rate policy from domestic fundamentals is investigated by testing for the existence of a short-run causative relationship between the nominal interest rate and domestic inflation. Thus, the hypothesis will be accepted if and only if the null hypotheses of the absence of causality are not rejected.

Table 5.2
Real Interest Rate

Year	Real interest Rate (Percentage)
1975	-9.8
1976	-16.0
1977	-11.1
1978	-9.2
1979	4.5
1980	4.1
1981	-2.3
1982	-0.3
1983	4.0
1984	6.7
1985	9.3
1986	7.9
1987	6.7
1988	5.2
1989	5.8
Average	1.4

Notes: Real interest rate is measured as nominal rate minus inflation. Inflation is defined to be the growth rate of the consumer price index.

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5.4.1.1 Testing Causal Relationships Between Interest Rates and Inflation[5]

In the late 1960s, Granger (1969) developed a method of testing causal relationships between economics variables. Granger causality is formulated in terms of the forecasting ability of the series under consideration. If a series, say Y_t causes X_t then this implies that X_t is better forecast if the information in Y_{t-1} is used than if it is not used. This is referred to as "in mean" causality (see Granger, 1988b).

Granger's causality test aims at testing for causal direction between time series. Geweke (1982, 1984) has reformulated the causality tests and developed a canonical form to measure the degree of dependence and feedback among stationary time series. Geweke's canonical measures can be used to test for linear feedback $(F_{X \leftrightarrow Y})$, instantaneous linear feedback $(F_{X.Y})$ and linear dependence $(F_{X,Y})$. In the instantaneous and linear dependence cases, the roles of X and Y are symmetric. Since the null hypotheses of linear feedback and instantaneous feedback are nested, $F_{X \rightarrow Y}$, $F_{Y \rightarrow X}$, and $F_{X.Y}$ are asymptotically independent. The independence of these hypotheses implies that these restrictions can be tested jointly. This is carried out using the measure of linear dependence between X and Y. Thus $F_{X,Y}$ can be

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[5]This section will briefly discuss causality and causality tests. For discussion on causality and its relation to economic analysis and model building, see Geweke et al. (1983); Vercelli (1992). For different definitions of causality, see Granger (1969, 1988b); Sims (1972); Zellner (1979, 1988b).

decomposed additively into the three linear feedbacks:

$$F_{X,Y} = F_{X \to Y} + F_{X.Y} + F_{Y \to X} \qquad (3)$$

Hence the absence of a particular causal ordering is equivalent to one of the three measures being zero.

To test the null of no feedback, Geweke (1982) suggested using the likelihood ratio (LR) statistic. In addition to the LR statistic, Geweke (1984) suggested using the Wald (W) and Lagrange Multiplier (LM) test statistics. Using Granger's definition of causality, tests of the null hypothesis $F_{X \to Y} = 0$ will take the following forms:

$$W^G : n[tr(\hat{\Sigma}_1 \hat{\Sigma}_2^{-1}) - k] \sim \chi^2(klp) \qquad (4)$$

$$LM^G : n[(k - tr(\hat{\Sigma}_2 \hat{\Sigma}_1^{-1}))] \sim \chi^2(klp) \qquad (5)$$

$$LR^G : nln(|\hat{\Sigma}_1| / |\hat{\Sigma}_2|) \sim \chi^2(klp) \qquad (6)$$

where n stands for sample size, $\hat{\Sigma}_1$ and $\hat{\Sigma}_2$ are, respectively, the residual covariance matrices from the regressions of X on its past values and X on its and Y's past values. k is the number of variables in the system minus the number of restricted variables (l). p is the lag length. However, when testing the same null hypothesis for Sims causality, the above test statistics take the following forms:

$$W^S : n(tr(\hat{\Sigma}_3 \hat{\Sigma}_4 - 1)) \sim \chi^2(klr) \qquad (7)$$

$$LM^S : n(1 - tr(\hat{T}_4 \hat{T}_3)) \sim \chi^2(klr) \qquad (8)$$

$$LR^S : nln(|\hat{T}_3| / |\hat{T}_4|) \sim \chi^2(klr) \qquad (9)$$

where r is lag length. $\hat{\Sigma}_3$ is the residual covariance matrix from the regression of X on its past values and Y's present and past values. $\hat{\Sigma}_4$ is the covariance matrix from the regression of X on its past values and Y's future, present and past values. $\hat{T}_3$ and $\hat{T}_4$ directly correspond to $\hat{\Sigma}_3$ and $\hat{\Sigma}_4$ but are from regressions of Y on X. Under the null hypotheses $F_{X \rightarrow Y}=0$, $F_{Y \rightarrow X}=0$, $F_{X.Y}=0$ and $F_{X,Y}=0$, the above test statistics have χ^2 distributions with (klp), (kl) and $(kl(2p+1))$ degrees of freedom corresponding to each null. The relation between the three test statistics is defined by the following inequality:

$$W^G \geq LR^G \geq LM^G$$

Similarly,

$$W^S \geq LR^S \geq LM^S$$

A difficulty which arises with the application of any causality test is determining the order of the polynomials. Given our data, the models are estimated with four lags.

5.4.1.1.1 Interpreting the Results

The results show the absence of any causal ordering between interest rates and inflation, implying that they are independent of each other (see Table 5.3). In all cases, the inequality between test statistics is observed.

However, it is important to acknowledge that in the case of Bahrain there are two factors that might distort the

causality tests. The first factor is attributed to using the ceiling rather than the actual interest rate. The second factor is related to a religious (Islamic) doctrine which prohibits muslims from either receiving or paying interest on their banking transactions. This second factor may seriously distort the transmission mechanism. Nevertheless, in the period 1983-89 the Bahrain Islamic Bank's average annual shares in total deposits and advances were only 4.0% and 2.1% respectively. Hence it is highly unlikely that this was a decisive factor in determining the causality tests results. With respect to the first factor, the causality tests were also carried out using a US interest rate: this is a good proxy for Bahrain's actual interest rate. The results from using the US data reveal that it is not possible to reject the null of the divorce of interest rate policy from domestic fundamentals (see Table 5.4).

These results have serious implications for Bahraini interest rate policy: namely, that movements in interest rates do not lead to changes in the domestic inflation, thus limiting the influence of monetary policy. It will not be imprudent to attribute these results to the pegged exchange rate regimes pursued by Bahrain. Consequently, these findings question the optimality of the pegged exchange regimes adopted by Bahrain.

Table 5.3
Results on Causality Tests/ Bahrain Interest Rates
(1975I-1989IV)

	W	LM	LR

Granger Causality

	W	LM	LR
$F_{INF \rightarrow r}$	2.754	2.631	2.691
$F_{r \rightarrow INF}$	4.547	4.222	4.380
$F_{r.INF}$	0.438	0.435	0.436
$F_{r,INF}$	3.523	3.325	3.422

Sims Causality

	W	LM	LR
$F_{INF \rightarrow r}$	0.065	0.065	0.065
$F_{r \rightarrow INF}$	0.183	0.182	0.182
$F_{r.INF}$	0.395	0.393	0.394
$F_{r,INF}$	0.337	0.335	0.336

Notes: The regressions are estimated with polynomials of order four. INF is inflation measured by the first difference of the natural logarithm of the consumer price index and r is the nominal interest rate. INF is an I(0) process while r is an I(1) process, thus the models are estimated for the level of INF and the first difference of r. The critical values of the χ^2 statistic at 5% significance levels are:

$$n\hat{F}_{r \longleftrightarrow INF} \sim \chi^2_{0.05} \quad (k1p)=9.488$$

$$n\hat{F}_{r.INF} \sim \chi^2_{0.05} \quad (k1)=3.841$$

$$n\hat{F}_{r,INF} \sim \chi^2_{0.05} \quad (k1(2p+1))=16.919$$

Table 5.4
Results on Causality Tests/ US Interest Rates
(1975I-1989IV)

	W	LM	LR
Granger Causality			
$F_{INF \to rUS}$	1.420	1.387	1.403
$F_{rUS \to INF}$	1.645	1.600	1.623
$F_{rUS.INF}$	0.004	0.004	0.004
$F_{rUS,INF}$	2.221	2.141	2.180
Sims Causality			
$F_{INF \to rUS}$	1.446	1.089	1.100
$F_{rUS \to INF}$	0.000	0.000	0.000
$F_{rUS.INF}$	1.086	1.066	1.076
$F_{rUS,INF}$	0.000	0.000	0.000

Notes: The regressions are estimated with polynomials of order four. rUS is the nominal US interest rate and it is a I(1) process, thus the models are estimated for the the first difference of rUS. The critical values of the χ^2 statistic at 5% significance levels are:

$$n\hat{F}_{r \leftrightarrow INF} \sim \chi^2_{0.05} \quad (k1p)=9.488$$

$$n\hat{F}_{r.INF} \sim \chi^2_{0.05} \quad (k1)=3.841$$

$$n\hat{F}_{r,INF} \sim \chi^2_{0.05} \quad (k1(2p+1))=16.919$$

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5.5 Inflation Under Pegged DB Exchange Rate Regimes

Inflation theories of a small open economy predict that, under a world fixed exchange rate regime, the national rate of inflation will converge over the long-run to the average world rate of inflation (Claassen, 1976). In such a regime, exchange rate effects are neutralized. In contrast, under a floating regime, inflation is fundamentally a national phenomenon (Claassen, 1976; Corden, 1976). Hence, it was argued, to inhibit international transmission of inflation the monetary authorities must consider abandoning fixed rate regimes (Friedman, 1953; Johnson, 1969; Emminger, 1973).

Johnson (1973) and Corden (1976) argued that under a floating regime, the authorities can choose their own desired inflation rate, irrespective of the world rate. Corden (1985) pointed out that in a world fixed exchange rate regime, the authorities may obtain such a rate by incurring some cost in terms of payments imbalances. Claassen (1976) argues that this can be achieved only over the short-run.

5.5.1 International Transmission of Inflation Under Fixed Exchange Rates

Both the Keynesian and Monetary theories of inflation agree that, in the long-run and under world fixed exchange rate regimes, the national rate of inflation will not diverge from the world rate of inflation (Branson, 1977;

Swoboda, 1977). In both theories, the exchange rate plays a neutral role over the long-run. However, these theories differ in their perception of the transmission mechanism.

The Keynesian models, being demand determined, tend to pay specific attention to the role of aggregate demand and relative prices when explaining the convergence process (see Turnovsky and Kaspura, 1974; Branson, 1977). In his model, Branson (1977) showed that a Keynesian-Phillips model will predict that real domestic variables, real output and unemployment will adjust to foreign shocks in a way that makes inflation rates converge. The convergence in Branson's model is conditioned by the assumption of sterilization. Branson (1975) argued that in a Post-Keynesian world, inflation rates may diverge under the assumption of complete sterilization. For obvious reasons, this assumption is acceptable only for the short-run solution.

In a Keynesian model of an open economy, Dornbusch (1977) pointed to two main channels through which foreign disturbances can affect the equilibrium price level. The first channel is the trade balance, which encompasses shocks originating from foreign demand and import prices, while the second is the capital market, which captures disturbances attributed to foreign interest rate shocks.

As in Keynesian models, the monetary approach emphasizes the role of balance of payments in the international transmission of inflation. However, this role is dependent upon the exchange rate regime under consideration. From the

assumption of continuous PPP,[6] exchange rate movements in a floating regime will insulate domestic prices from foreign price shocks. In such a regime, monetarist models postulate that money supply-inflation causal links operate similarly to monetarist models of a closed economy (Laidler 1975). The exogeneity of the money supply in a floating regime allows the monetary authorities to pursue a monetary rule that will determine the domestic rate of inflation.

For monetarists, exchange rates tend to preserve their parities; thus if prices are related by the law of one price and the exchange rate is fixed, domestic inflation rates will converge to the world rate. In a sense, the monetarist view of the international transmission of inflation is a by-product of the monetary approach to the balance of payments (Swoboda, 1977). According to this approach, domestic and foreign shocks will have only transitory effects on the balance of payments (Whitman, 1975). If the same shocks have no influence on foreign prices, the domestic price level will remain unaffected.

The monetary approach proposes two complementary channels for the international transmission of inflation. The first emanates from the assumption of non-stochastic PPP, in which commodity arbitrage will equate prices (Parkin, 1977; Corden, 1985). The second rests on a fundamental proposition of the monetary approach to the

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[6]For continuous PPP to hold, traded goods have to be perfect substitutes (see Laffer, 1975).

balance of payments, that in a perfect capital mobility environment, external disequilibrium can only be maintained over the short-run by systematic sterilization. In the long-run, the forces of ratification will set in to eliminate payments disequilibrium (Corden, 1985). The restoration, and in fact stability, of external balance equilibrium is ensured by convergence of the domestic inflation rate to world average inflation.

The above discussion can be summarized in the following: if PPP were to hold,

$$E_t = CPI_t / FPI_t \qquad (10)$$

where E is the nominal effective exchange rate (units of domestic currency per unit of foreign currency), CPI is Bahrain's consumer price index and FPI is an index of world average price. Taking the logarithm of both sides and differentiating with respect to time yields

$$\dot{e}_t = \dot{cpi}_t - \dot{fpi}_t \qquad (11)$$

If E is fixed, then in the long-run both theories predict

$$\dot{cpi} = \dot{fpi} \qquad (12)$$

For Bahrain this implies using data from the post-Bretton Woods system to test for cointegration between Bahrain's price level and the world average price level, so that if the null of no cointegration is rejected, the result

is interpreted as supporting the convergence hypothesis. Additionally, if the test leads to a rejection of the null of no cointegration then the results can be interpreted to represent a major deficiency in the pegged exchange rate regimes pursued by Bahrain following the collapse of the Bretton Woods system, for they imply that, even in a floating world, these regimes resulted in an inflation rate that is considered to be an outcome of a world with fixed exchange rate arrangements.

5.5.2 Testing For Unit Roots

Recent studies on the statistical properties of time series show that modelling relationships between macroeconomic variables often requires discarding the estimation and inferential procedures of standard econometric methods (Granger and Newbold, 1974; Granger, 1981). This is attributed to the fact that standard econometric theory is based on the assumption that the series data generating processes are stationary. Empirical studies reveal that many macroeconomic variables are non-stationary (see Nelson and Plosser, 1982; Hall, 1986; Schwert, 1987; Perron, 1988).

Granger and Newbold (1974) noted that a high degree of fit is often accompanied by highly autocorrelated residuals (indicated by an extremely low Durbin-Watson statistic) when regressions are estimated on the levels of non-stationary series. They and Phillips (1986) demonstrated that such a

result can be a consequence of a "spurious regression", which will possess the following statistical properties:

(i) The regression coefficients will not converge in probability to constants and will have non-degenerate limiting distributions as the sample size increases. Additionally, the distribution of the intercept diverges as the sample size increases.

(ii) The coefficient of correlation will have a non-degenerate limiting distribution as the sample size increases. The Durbin-Watson statistic converges to zero.

(iii) More seriously, the distribution of the t and F statistics diverge as the sample size increases, so that there are no asymptotically correct critical values. Granger and Newbold (1974) contended that these tests are seriously biased towards the rejection of the null hypothesis of no relationship even when the series are independent random walks.

Realizing the danger of regressing levels of integrated processes, several tests were developed to test for unit roots in the level of a series. Among these tests are those of Dickey and Fuller (1979, 1981), Sargan and Bhargava (1983), Said and Dickey (1984), Bhargava (1986), Phillips (1987) and Phillips and Perron (1988).

If the series mean or trend function were subject to infrequent shocks, the full sample unit root tests suggested by the above studies may not reflect the true integration property of the series. Perron (1989, 1990), Rappoport and Reichlin (1989) and Balke and Fomby (1991a,b) demonstrated that the effect of such shocks could be represented by a segmented trend, and that, without modelling such shifts, the power of standard unit root tests will be very low.

Consequently, we will not only have to test for unit roots but we will need to insure that we are using the appropriate test. Inspecting the plots of the price indices show that none of their trend functions are subject to the sort of shocks described above. Hence, the unit root tests are carried out using the standard Dickey-Fuller procedure.

The test for a unit root is carried out for Bahrain's CPI and the world average price index (FPI). The FPI is measured as a weighted average of the wholesale price indices of the US, Japan, Germany, UK, Australia, France and Italy. The weights are calculated from the non-oil imports.

Each unit root test aims at testing the null hypothesis

$$H_0: \text{I(1)} \text{ / First Difference Stationary}$$

versus the alternative hypothesis

$$H_a: \text{Trend Stationary}$$

Comparing the ADF statistics provided by Table 5.5 with the critical values given in Fuller (1976, Table 8.5.2) do not allow us to reject the null hypothesis that the CPI and

FPI are I(1) series. The result suggests that the actual series require differencing to achieve stationarity. In other words, a shock to the actual series will have a persistent effect. This is evident from the autocorrelation functions of the series.

Table 5.5

Results of the Unit Root Tests

(1975I-1989IV)

Series		ADF
CPI	[1]	-1.894
FPI	[1]	-1.595

Notes: Figures   in   square
brackets   are   the   lag   length
order   used   to   whiten   the
residuals.

5.5.3 Testing for the Existence of a Steady-State Relationship

To test for the presence of long-run relationships between time series, Engle and Granger (1987) suggested a two-step procedure that aims at testing for cointegration.

The Engle and Granger two-step procedure has a number of disadvantages. Hall (1989) pointed to two. The first concerns the assumption of a unique cointegrating vector. This assumption can be troubling when there are more than two series. In such a situation the OLS estimate can be a linear combination of the statistically significant cointegrating vectors (Cuthbertson et al. 1992). The second disadvantage stems from the fact that the two-step procedure

does not have a well defined limiting distribution. Consequently, testing for cointegration is not a straightforward procedure.

Additionally, Kremers et al. (1992) demonstrated that the two-step and, in fact, all residuals based cointegration tests suffer from the presence of invalid common factor restrictions. They show that, for such an approach, the Dickey-Fuller test remains consistent, but loses power relative to other cointegration tests that do not impose the common factor restriction.

Johansen (1988, 1991) and Johansen and Juselius (1990) developed a maximum likelihood (ML) based method that overcomes the difficulties associated with the Engle-Granger procedure. Johansen's procedure allows for the existence of more than a single distinct cointegrating vector. Thus with N variables there could be N-1 distinct cointegrating vectors. These vectors are determined by the rank of the cointegrating matrix. In the present case, for the CPI to cointegrate with FPI, the rank of the cointegrating matrix must not exceed one.

Compared to other cointegration approaches, the ML test is considered to be the most appropriate method. For instance: (i) Phillips (1991) shows that the ML estimator is super-consistent and optimal inference theory applies; and (ii) Kremers et al. (1992) demonstrated that, unlike residual based cointegration tests, the ML method does not encounter the common factor problem, hence it has better test power than the two-step procedure.

In this section, the joint integration property of a bivariate process is investigated using the following model:

$$(1-L) \ X_t \ = \ C(L)(1-L)X_{t-1} \ + \ \Pi \ X_{t-k} \ + \ \varepsilon_t \qquad (13)$$

Here X is a (2×1) vector and C(L) is a polynomial in the lag operator L. ε is a (2×1) vector of white noise disturbances. The matrix $\Pi=\alpha\beta'$ is a (2×2) matrix, known as the long-run matrix. α and β are (2×2) matrices, identified as the loading and cointegrating matrices respectively. Once the rank of β is determined, the loading matrix can be used to test for weak exogeneity (see Johansen, 1992a; Urbain 1992). This tests the null $\alpha_{ij}=0$ against the alternative $\alpha_{ij}\neq0$. The test statistic has a χ^2 distribution and it is essential for the efficiency of a partial or a single equation model. Since we are not interested in estimating the error correction model for any of the above series, exogeneity tests will not be carried out.

Using the Johansen procedure requires addressing the question of a constant term in (13). Johansen (1991, 1992b) shows that the asymptotic distribution of the test statistic is not independent of the hypothesis maintained about the constant term. Visual inspection of the data reveals that all of the series are trending, i.e. a drift is not included in the cointegrating vectors but it is considered to be in the $\{X_t\}$.

In the bivariate model, FPI is said to be cointegrated with the CPI only when the FPI cointegrating parameter is

significantly different from zero. This will require testing for the significance of the cointegrating parameters when the null of no cointegration is rejected. This is done for the reason that the maximum eigenvalue and the trace are statistics for a joint significance test and hence may not reject the null of no cointegration even when some of the cointegrating parameters are not significantly different from zero.

The cointegration tests show that FPI and CPI do have a long-run relationship (see Table 5.6). Additionally, the significance test rejects the null at the 5% level (see Table 5.7). Hence we conclude that, if inflation convergence was one of the reasons for abandoning the Bretton Woods fixed exchange rate regime, the Bahraini adopted peg regimes during the generalized floating period did not inhibit domestic inflation from tracking the world average inflation rate. This is, indeed, a very strong result that questions the validity of the pursued peg exchange rate regimes. In a world fixed exchange rate, such results is anticipated, however, it is not expected to hold in a world in which the main including the peg currencies are floating.

Table 5.6
Results on Cointegration Tests

Null Hypothesis	Eigenvalue	Maximum Eigenvalue	Trace
r = 0	0.237	16.216*	22.419*
r ≤ 1	0.098	6.203	6.203

Normalized Cointegrating Parameters

β_{CPI}	-1.000
β_{FPI}	2.592

Notes: An asterisk denotes significant at 5% level. The VAR is estimated with four lags.

Table 5.7
Testing the Significance of the cointegrating Parameter

Null Hypothesis	Test Statistics
$\beta_{FPI} = 0$	$\chi^2(1) = 5.847*$

Notes: An asterisk denotes significant at 5% level.

5.6 Conclusion

The results of this chapter show that, by following a pegged exchange rate policy, the Bahraini authorities have implicitly decided to reduce their control over monetary policy. Interest rate policy is no longer domestically determined and, given this, we have tested the implication

of such a loss of control over domestic inflation. Granger and Sims causality tests were carried out and the results show that inflation and interest rates are independent. The causality tests show that the post-Bretton Woods pegged regimes followed by Bahrain not only resulted in decreasing the monetary authorities ability to determine domestic interest rates but, further, these regimes led to the divorce of interest rate policy from domestic fundamentals. More seriously, the causality results reveal that these regimes have limited the ability of monetary policy to influence the domestic economy. Additionally, cointegration analysis was carried out to test whether the post-Bretton Woods pegged exchange rate regimes followed by Bahrain altered the inflation relation that is hypothesized to exist in world fixed exchange rate regimes. The cointegration tests revealed that, in spite of following different peg exchange rate arrangements, the hypothesized inflation relation was not altered, i.e. the post-Bretton Woods exchange rate regimes pursued by Bahrain did not lower the exposure of the Bahraini price level to foreign price shocks.

Combining the results of this chapter with that of chapter three lead us to doubt the optimality of the existing exchange rate regime. Thus, the following two chapters will address the question of the optimum exchange rate regime using the Horne-Martin approach.

Chapter Six

Solving for the Optimum Exchange Rate Regime: Methodological
Considerations

6.1 Introduction

This chapter discusses in detail the method by which the basket weights will be determined. As mentioned in chapter four, the method is based on the control theory approach pioneered by Turnovsky (1982) and developed by Horne and Martin (1989). This method requires identifying a target variable by which the basket weights will be determined subject to the contribution of the bilateral exchange rates to the forecasting ability of the target variable. As Bahraini decision makers recognize the diversification of economic activities as the main goal of economic policy,[1] the present chapter takes non-oil gross domestic product (GDP) to be the target variable.

In addition to its original purpose, the present chapter will extend the Horne-Martin approach in three directions:

(i) To set the criteria identifying the appropriate basket.

(ii) To investigate the integration properties of the variables entering the VAR.

(iii) To exploit our prior knowledge on the target variable. To do so, the question of the optimum exchange rate regime is solved using the Bayesian approach to VAR modelling.

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[1]As stated in the 1986 and 1991 stabilization programmes.

The remainder of the chapter is organized as follows. In section 6.2 we discuss the relevance of the conditions by which a developing country may choose its exchange rate regime to the case of Bahrain. Since the Horne-Martin approach models the economy using a VAR , section 6.3 will provide a brief review of VAR modelling. Section 6.4 discusses the Horne-Martin approach and the reasons for modifying (extending) this approach. In section 6.5 we will discuss the reasons for using the Bayesian approach.

6.2 Factors Determining the BD Exchange Rate Regime

The literature on the choice of an exchange rate regime by developing countries proposes conditions by which the choice can be determined. These conditions are strictly related to the structural characteristics of developing economies. They are considered to be the main determinants of a regime choice.[2] This section reviews the relevance of these theoretical factors to the Bahraini economy.

The reasons advanced in section 4.3.2 are found, to a large extent, to match Bahrain's economic structure. They can be summarized as the following:

(i) The size of the economy. Bahrain output accounted for only 0.016% of world output in 1988. Manufacturing and export sectors are oil-dominated. Such indicators are prominent

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[2]For a theoretical discussion of these factors see section 4.3.2.

factors in discouraging the adoption of a floating regime (see Bird, 1979; Crockett and Nsouli, 1977).

(ii) Bahrain has an extremely open economy. The ratio of imports to gross domestic product is estimated to be 90.5% for the 1980s. Looney (1989) found that governments in small economies are more inclined to increase their role in economic activities compared to governments of large countries. He attributes such an outcome to the relative openness and the susceptibility of small economies to external shocks.

(iii) Despite the fact that Bahrain has a well developed financial sector, its domestic asset market is weakly linked to the international market. Until 1986, the law prohibited foreign ownership of domestic equities. The relaxation of the law in that year was set in accordance with the Gulf Cooperation Council economic agreement, in which citizens of the council were allowed to own a maximum of 25% of a company's share capital. The law does not exempt other nationalities. In other words, these restrictions resutls in one way capital mobility: that is from Bahrain to the rest of the world.

By international standards, Bahrain's asset market is extremely shallow, and there exists a fairly low degree of substitutability between domestic

and foreign securities. The absence of a secondary market for domestic securities exacerbates these problems, thus making it difficult to argue for the integration of Bahrain's asset market with the world market.

(iv) The exchange rate is a policy variable under a pegged regime. Hence it can be utilized, among other instruments, to assist in achieving the output diversification goal.

(v) The current institutional arrangements may not provide the required support for adopting a floating regime.

However, in choosing between a single and a basket peg, the latter has the following advantages:

(i) A basket peg provides more flexibility in terms of: (a) the domestic interest rate. Under such a regime, the domestic rate of interest may not be a reflection of the pegged currency interest rate. (b) over the short-run, the inflation rate can be influenced by the weights and size of the basket.

(ii) The basket can be more flexible in absorbing foreign currency shock(s).

(iii) A single peg is a form of basket in which the authorities announce the weights of one to the pegged currency and zero to the rest. By not announcing the basket weights in more than a

single currency peg, the authorities credibility may not be as clearly exposed as in a single currency peg.

(iv) The diversification goal implies diversifying international trade. Such a goal is considered to increase the cost of a single currency peg (Takagi, 1988).

6.3 Modelling with VARs: A Brief Literature Review

The poor performance of standard structural models in the 1960s and 1970s led to severe criticism of such modelling methods. The problems of these models were not confined to poor forecasting ability; instead, these models have reached contradictory and, at times, counter-intuitive conclusions even when the models were based on the same schools of thought. Charemza and Deadman (1992) discuss two weaknesses associated with standard models. First, they point to the practice of data mining in the case of a single equation model and, secondly, to the assumption of zero coefficient restrictions and the endogenous-exogenous division of the variables in a multi-equation system. In general, zero restrictions are imposed for identification purposes, while the endogenous-exogenous division is based on a theoretical model. According to Sims (1980b), this is an "incredible assertion".

The absence of any knowledge about the true "structural relations" prompted the search for alternative modelling

methods. Sims (1980b) introduced a more flexible method of modelling economic relations. Sims' vector autoregressive (VAR) approach concentrates on enhancing the economist's ability to capture the empirical regularities in the data and is known to possess the following characteristics:

(i)   The   system   has   no   a   priori endogenous-exogenous division of variables.

(ii)   The   assumption   of   zero   coefficient restrictions may not be acceptable, and no such restrictions are imposed a priori in VARs, although they may be tested for.

(iii) More importantly, the data are left to speak for themselves.   In a sense, the model is developed without strict adherence to economic theory.

For having such characteristics, VAR models are considered atheoretical (see Cooley and LeRoy, 1985; Leamer, 1985). However, subsequent developments have revealed that the VAR modelling procedure is more flexible than was earlier anticipated, so that it is possible to use VARs to model structural relationships based on economic theory (see Blanchard and Quah, 1989; King et al. 1991, among others). The latter approach is known as the structural VAR.[3]

According to Sims (1980b), VAR modelling induces the model builder not to impose prior restrictions on the model

[3]See Keating (1992) for discussion on atheoretical and structural VARs.

parameters. Sims (1980b) shows that prior restrictions do not necessarily improve the forecasting ability of structural models, rather they have led to model over-identification.

In a VAR model the endogeneity of variables allows the forecaster not to have to worry about the values of the exogenous variables in the forecasting period. Since a VAR model uses only the information contained in the observed data to make inferences on the properties of the stochastic processes, it will allow unconditional forecasts on all variables (Todd, 1984).

VAR models are highly desirable for forecasting purposes (see Sargent, 1979; Litterman and Supel, 1983; Doan et al. 1984; Litterman, 1984). According to Litterman (1984), unconditional or baseline forecasts from a VAR model have the benefits of providing a statistical measure of uncertainty. Based on this measure, confidence bands for the forecasts can be estimated, thus giving decision makers important information on the uncertainty of the forecasts. Moreover, since VAR models require no judgemental adjustment, they can provide a more realistic multivariate probability description of the possible future paths of the economy. In spite of the fact that non-VAR models are probabilistic, the forecast error distribution generated by these models ignores errors arising from uncertainties in their own specification, thus limiting their practical use (Sims, 1986).

Like other modelling methods, VARs will not escape the effect of the Lucas critique when conditional projections based on alternative policy rules are made (Sargent, 1979). However, the endogeneity of the variables in VAR models can be used to make unconditional projections (Sargent, 1979; Todd, 1984).

Stationarity is essential to VAR modelling since non-stationarity eliminates the possibility of attaining the moving average representation (MAR) of a VAR.[4] The MAR is an important stochastic process for revealing the response of the system variables to a shock for conditional forecasting purposes (Litterman, 1984). Additionally, the MAR is useful in tracking the effect of an innovation to any component of the autoregressive system.

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[4]Consider an $N \times 1$ time series vector $Y_t = (y_{1t}, \ldots, y_{nt})$ represented by

$$C(L) Y_t = B(L) \varepsilon_t \tag{1}$$

where the roots of $C(L)$ are on or outside the unit circle. The roots of $B(L)$ are assumed to be outside the unit circle, and ε_t is a vector of white noises.
Let

$$C(L) = C^*(L)(1-L) \tag{2}$$

such that $C^*(L)$ has all its roots outside the unit circle. Thus the above equation can be written as:

$$(1-L) Y_t = H(L) \varepsilon_t \tag{3a}$$

$$H(L) = C^{*-1}(L) B(L) \tag{3b}$$

Equation (3a) is known as the moving average representation of the above VAR. To invert $C^*(L)$ it has to have all its roots outside the unit circle.

To carry out policy analysis, model builders usually appeal to economic theory when estimating the MAR of a VAR. By doing so, they are implicitly imposing an identification restriction which, in general, reflects their a priori perception of the system's exogeneity.

From the MAR a variety of features such as impulse response functions and variance decompositions can be estimated. Both are useful in analyzing the effect of unanticipated policy shocks.

The nonuniquness of the MAR induced Sims (1980b, 1982) to propose a normalization that does not allow for contemporaneous correlation between MAR elements. The result of such an assumption led to the development of innovation accounting. Sims' normalization aims to prevent a shock to a particular variable from inducing shocks contemporaneously to other variables and hence allows the variance to be decomposed into orthogonal components.

In discussing the use of VARs, Sims (1986) postulated that such a method is compatible with rational expectations equilibrium, in which optimal policy can be made using VAR models. An implication of the rational expectations hypothesis is that it is difficult to justify classifying variables as exogenous and endogenous (Hartley and Walsh, 1992). In fact, the rational expectations hypothesis may lead us to view some of the observed variables as functions of unobserved and uncorrelated disturbances. Thus, given the stationarity assumption implicit in rational

expectations models, the Wold decompsition theorem postulates that the actual processes of the unobserved variables are autoregressive.

Even though rational expectations models are highly regarded for their theoretical analyses, their forecasting abilities, however, are worse than those of VAR models. In this respect Sims (1986) pointed to an additional advantage in using VARs: that they make explicit the link between the model and the reduced form.

Commenting on the use of VARs in policy analysis, Sims (1986, p. 8) stated:

> "The point of VAR based policy evaluation is to display explicitly the imposition of identifying assumptions.... This makes it easier to separate analysis of uncertainty about identification from analysis of uncertainty about the probability structure of the data."

The above discussion must have influenced Horne and Martin to the extent that they developed their approach so that inference on optimum exchange rates is conducted within the VAR framework.

6.4 The Basket Determination Method: An Extended Horne-Martin Approach

The approach developed by Horne and Martin (1989) uses the control theory approach to exchange rate determination

pioneered by Turnovsky (1982). Such a method uses the notion of general equilibrium to decide on the optimum regime. Horne and Martin (1989) have demonstrated that the control theory approach to weights determination can be carried out within the Kalman filter framework.

In their approach, the basket is composed of exchange rates that contribute to the forecasting ability of the target variable. Once these exchange rates are determined, the residual series from the target variable and exchange rate equations are used to derive the basket weights. Since the Kalman filter is an optimal method of updating the state vector, Horne and Martin (1989) show that, given the orthogonality assumption, the basket weights can be extracted from the updating equation of the Kalman filter.[5] In a VAR model the link is captured by estimating the Kalman regression; the regression of the target variable forecast error on the forecast errors of the bilateral exchange rates. Thus a regressor with a significant and large coefficient is expected to attain a higher weight compared to other control variables with smaller coefficients. In a sense, the weights are based on the contribution of each of the bilateral exchange rate forecast errors to the

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[5]The state vector is the set of variables which the economist wants to forecast. The Kalman filter provides an optimal estimator of the state vector and the error covariance matrix, known as the prediction equations (see Harvey, 1992, 1993). Once new observations become available, both estimators can be updated. The new equations are known as the updating equations. The prediction and updating equations make up the Kalman filter.

forecasting ability of the target variable.

To see this, let $\omega_{k+1,t}$ be the forecast error of the target variable, y, and let k stand for the number of exchange rates included in the basket. Then $\omega_{k+1,t}$ is equivalent to

$$\omega_{k+1,t} = \hat{Y}_t - Y_t \qquad (1)$$

Here $\hat{y}_t$ is the OLS estimate of y_t. Assuming that y* is the conditional forecast of y and using the orthogonality property of the residual series yields

$$y_t^* = P[y_t | \Omega_{t-1}] + P[\omega_{k+1t} | \omega_{1t}, \omega_{2t}, \ldots, \omega_{kt}] \qquad (2)$$

where P is the projection operator, Ω is the information set and $\omega_{1t}, \ldots, \omega_{kt}$ are the forecast errors of the exchange rate equations. The second term on the right hand side of (2) is simply a regression of the target variable forecast error on the forecast errors of the bilateral exchange rate equations. Horne and Martin refer to this as the Kalman regression. The second term on the right hand side of (2) has two implications for the forecast of y. First, it represents the deviation of the target variable from its mean value. Second, these deviations are solely determined by changes in the forecast errors of the bilateral exchange rates. Horne and Martin (1989) demonstrate that the weights in the exchange rate basket are directly related to the

parameters of the Kalman regression. In fact, their demonstration shows that the weights derived by control theory and the Kalman filter are equivalent. To see this, let Ψ_t stand for the basket indicator, which is defined as a set of k weighted bilateral exchange rates, e_{it}, such that the forecast variance of the target variable is minimized. Consequently, the basket will be

$$\Psi_t = \sum_{i=1}^{k} \lambda_i e_{it} \tag{3}$$

where

$$\sum_{i=1}^{k} \lambda_i = 1 \tag{4}$$

The Kalman regression is

$$\omega_{k+1,t} = \sum_{i=1}^{k} \phi_i \omega_{it} + \eta_t \tag{5}$$

The ϕ_is are the Kalman coefficients and η_t is a white noise disturbance.

Equation (5) can be rewritten as

$$\omega_{k+1,t} = \sum_{i=1}^{\wedge} \phi_i (e_{it} - P[e_{it}|\Omega_{t-1}]) + \eta_t \tag{6}$$

Solving for e_{jt} in (3) and (6) yields

$$e_{jt} = [\Psi_t/\lambda_j - \sum_{i=1}^{\wedge} (\lambda_i/\lambda_j) e_{it}] \tag{7}$$

$$e_{jt} = (\omega_{k+1,t} - \eta_{it} - \sum_{i=1} P[\hat{e}_{it}|\Omega_{t-1}]) - \sum_{i \neq j} (\hat{\phi}_i/\phi_j) e_{it} \qquad (8)$$

Comparing the coefficients in (7) and (8) shows that

$$\phi_i/\phi_j = \lambda_i/\lambda_j \qquad (9)$$

Summing both sides of (9) gives

$$\sum_{i=1} \hat{\phi}_i/\phi_j = \sum_{i=1} \hat{\lambda}_i/\lambda_j \qquad (10)$$

Since $\sum_i \lambda_i = 1$, (10) can be written as

$$\lambda_j = \phi_j \ / \ \sum_{i=1} \hat{\phi}_i \qquad (11)$$

Equation (11) shows that the basket weights from the control theory are equivalent to the weights derived using the coefficients from the Kalman regression.[6]

In the Horne-Martin approach the VAR is not used for conditional forecasting purposes, so that its parameters will not be subject to Lucas' critique. In fact, an advantage of the Horne-Martin approach is to allow for structural changes and hence varying basket weights. On this point Horne and Martin give the following explanation: (1989, p. 1150)

"a shift in policy regime may alter the structural parameters and cause the optimal weights to change. This means that it is unlikely that the weights for a currency basket estimated over a

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[6]A proof of the equivalence between the two methods can be obtained from the author upon request.

given sample period can be assumed to be fixed for new sample periods. This need for flexibility in the weights is automatically achieved in computing optimal weights since structural shifts will results in larger prediction errors in variables, and this is translated into changes in the weights."

Thus, in part, the Horne-Martin method is capable of capturing the effect of structural shifts identified with the Lucas critique by updating the Kalman filter estimates. This is a major advantage of the Horne-Martin weights determination approach compared to other approaches, for their approach reflects the actual economic relations.

Additionally, the Horne-Martin approach has another implicit advantage in that it has the potential to decide upon the type of exchange rate regime, i.e. whether or not to peg: for once the target variable is identified, but none of the policy instruments (exchange rates) are capable of explaining the variations in the target variable, then the results provide sufficient evidence on whether or not to abandon the idea of pegging the exchange rate.

However, in spite of these advantages, the original Horne-Martin approach suffers from two important drawbacks. These are:

(i) The absence of a criterion for determining which of the exchange rates is contributing to the

forecasting ability of the target variable. Without such a criterion the basket may contain exchange rates that do not contribute to minimizing the forecast variance of the target variable.

(ii) The model was estimated using levels of the series without testing for unit roots. This may result in spurious relationships which might ultimately influence our decision about the optimum regime.

In this thesis we overcome the first drawback by basing the choice of the basket components on the following criteria:

(i) The ability of each element of the basket to contribute to the forecasting ability of the target variable. This is estimated using the root mean square error (RMSE).

(ii) The ability of exchange rate innovations to explain the variation in the target variable forecast error. Using a variance decomposition will not protect the VAR from the Lucas critique since such analyses are conditional on the source and type of shocks. Hence, the results on Granger causality tests are taken to represent an indirect way of finding the variables explaining the variations in the target variable.

With respect to the second drawback, the models are estimated using stationary series after removing all unit roots.

In addition to these extensions to the Horne-Martin approach, the thesis will use our prior knowledge on the relationship between the target variable and government expenditure provided by chapter three. To do so we will use the Bayesian vector autoregression (BVAR) to estimate the models.

Hence the present procedure extends the Horne-Martin approach in three directions:

(i) It sets criteria by which the basket can be determined.

(ii) It ensures the stationarity of the system by testing for the presence of unit roots.

(iii) It uses our prior knowledge to enhance the model's forecasting ability by taking the results of chapter three to form a prior.

6.5 Explaining the Reasons for Using the Bayesian Approach

Resorting to the Bayesian approach to solve for the optimum exchange rate regime for Bahrain is inspired by the facts that, in the Bayesian approach:

(i) It is possible to incorporate prior knowledge on the variables in the estimation process. As a

result, the VARs in this chapter use the knowledge provided by the results of chapter three on the target variable and government expenditure. In fact, any modeler using any estimation method (structural or time series) will impose some sort of restrictions on the model they are estimating using their prior knowledge. For instance, structural and time series usually use flat priors. For this reason, Leamer (1991) has pointed out that the issue is no longer whether prior information should be used or not, rather the issue is only how to use it.

If the modeller has no information on the joint probability distribution of the variables they are modelling, they will usually assign a probability value to each coefficient in the VAR based on the random walk hypothesis (see Doan et al. 1984; Litterman, 1986a). This is known as the Minnesota or Litterman prior (for discussion on this topic see Todd, 1984; Lütkepohl, 1991; Hamilton, 1994). Obviously, such a prior will not be suitable for a cointegrated system and in the present case it will not be an appropriate prior for the target variable.

(ii) Unlike the structural approach, the Bayesian approach does not impose exclusion restrictions to avoid the problem of overparameterization. On the

contrary, the BVAR can be used to test these restrictions (Todd, 1984). In the structural approach the restrictions are a priori imposed by the economic theory. Such an approach usually leads to an oversimplification of the model. In contrast to the structural approach, the absence of prior distributions in standard VARs is regarded by Bayesian econometricians as leading to overparameterized models (see Todd, 1984; Litterman, 1986a,b,c; Leamer, 1991). Thus to overcome this problem the modeller will need to use prior knowledge to specify the prior distributions of the model parameters. By doing so the modeler will be able to eliminate both problems. This argument is more appropriate when the prior knowledge is based on statistical theory.

(iii) When the model is to be used for forecasting purposes, such as in the Horne-Martin approach to exchange rate selection, the trade-off between overparameterization and oversimplification is overcome by using the out-of-sample prediction error. Compared to other approaches, the BVAR tends to result in better forecasts (see Litterman, 1986a; McNees, 1986; Raynauled and Simonato, 1993).

(iv) By specifying the prior distributions the

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modeler is implicitly incorporating uncertainty into the model. The structural and time series approaches lack such characteristics.

The above points are important advantages that characterize the Bayesian approach. However, we need to note that in spite of the fact that the Bayesian approach tends to improve model forecast ability, it may result in meaningless parameter estimate. Economists such as Juseluis (1991, p. 125) have acknowledge that:

> "In most cases these parameters will have no clear meaning to economists."

Indeed this is a drawback to the Bayesian approach to macroeconomic modelling.[7] For this reason we will perform a Granger causality test on each variable in the target variable equation so as to insure that the improvement in forecasting is emanating from the exchange rates. Equally important, this causality test must show a meaningful result, i.e. the signs on the significant coefficients must not be counter-intuitive.

Hence, extending the Horne-Martin approach to testing for the optimum exchange rate using the Bayesian approach to VAR modelling will give us a better knowledge of the contribution of the exchange rate to the forecasts of

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[7] Bayesian econometricians such as Arnold Zellner have stressed the need to report the results and discuss their adequacy (see Zellner, 1993).

non-oil GDP.   Combining this with the results on Granger causality tests will assure us of the decision on the optimum regime.   These tests are carried out in the following chapter.

Chapter Seven

Determining the Optimum Exchange Rate Regime:
A Bayesian Approach

7.1 Introduction

In this chapter the problem of determining the optimum exchange rate regime is solved using the Bayesian vector autoregression (BVAR) approach. This is done so that we can incorporate our prior knowledge about the target variable using the results of chapter three. The unidirectional causation between government expenditure and non-oil GDP is utilized as part of the models priors as well as forming the benchmark model. An optimum peg regime is that regime which can forecast the target variable better than the benchmark model as well as having an interpretable pattern of Granger causality.

It is important to note that it is not possible to compare the results of this chapter with those obtained in the literature since the latter are arrived at using standard econometric techniques. Furthermore, it should be realized that the extensions to the Horne-Martin approach have improved its estimation accuracy. In fact, placing their approach within a VAR modelling framework has made these extensions possible. This is a characteristic of the flexibility of the Horne-Martin approach.[1]

Having to solve for the appropriate regime implies testing the optimality of the existing regime. This will require testing for a single basket (US dollar, US$) and for the Special Drawing Rights (SDR) currency composite basket

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[1] Some may use the original approach under the pretext of avoiding "loss of information". However, the results from using the original approach can be very misleading.

(US$, Japanese Yen (Yen), Pound Sterling (PS), Deutschmark (DM) and French Franc (FF)). If neither of them are optimal, the results imply the need to seek an alternative regime. One difficulty that arises from searching for an alternative regime is that of deciding which currencies to enter into the new regime, i.e. that of determining the number of currencies and the selection criterion. To overcome this problem, we have selected Bahrain's seven largest trading partners and have used a multi- to single-currency basket approach. The alternative regime may include the above five currencies plus the Australian dollar (AS$) and the Italian Lira (IL).[2]

The results obtained show: (i) the existing exchange rate arrangement, that of the single and SDR baskets, is not optimal; and (ii) there is no optimum peg available for policy makers. The authorities may opt for a second best regime (peg), but that will be at the expense of achieving the diversification goal. Consequently, Bahraini decision makers are left with the choice of a floating regime. This result and the experience of some developing countries, which have adopted a floating regime, seriously questions the validity of the conditions advanced in the theoretical literature for inhibiting developing countries from floating their exchange rates.[3] It is concluded that these

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[2]Saudi Arabia is one of Bahrain's main trading partners. However, the Saudi Riyal has been fixed to the US dollar since 1986. For this reason the Saudi Riyal is not included.

[3]For a review of these conditions see chapter 4.

conditions are not as important as the country's economic aim for conditioning the choice of exchange rate regime.

The rest of the chapter is organized as follows. Section 7.2 discusses the Bayesian model which will be used in this chapter. Section 7.3 examines the univariate integration properties of the series. Section 7.4 uses these results to estimate BVARs, and hence to decide on the optimum regime. Section 7.5 concludes the chapter by providing a summary of the results.

7.2 The BVAR Model

The proposed VAR specification is designed to capture the main economic features of the Bahraini economy by modelling the sources of shocks and the objective of the 1991 stabilization programme: that of diversifying economic activities. Additionally, the present VAR takes into account our prior knowledge on the target variable.

The relationships between the target variable, government expenditure and the bilateral exchange rates are modelled in the following way:

$$
\begin{bmatrix} Y_t \\ G_t \\ e_{1t} \\ \cdot \\ \cdot \\ \cdot \\ e_{nt} \end{bmatrix} = \begin{bmatrix} \Phi_1(L) & \Psi_1(L) & \cdots & \Theta_1(L) \\ \Phi_2(L) & \Psi_2(L) & \cdots & \Theta_2(L) \\ \Phi_3(L) & \Psi_3(L) & \cdots & \Theta_3(L) \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ \Phi_m(L) & \Psi_m(L) & \cdots & \Theta_m(L) \end{bmatrix} \begin{bmatrix} Y_{t-1} \\ G_{t-1} \\ e_{t-1} \\ \cdot \\ \cdot \\ \cdot \\ e_{mt-1} \end{bmatrix} + \begin{bmatrix} \omega_{1t} \\ \omega_{2t} \\ \omega_{3t} \\ \cdot \\ \cdot \\ \cdot \\ \omega_{mt} \end{bmatrix}
$$

Here Y is real non-oil GDP, G is government expenditure, and e_i is the ith bilateral exchange rate (units of foreign currency per unit of domestic currency). n is the number of exchange rates included in the basket, which are selected in accordance with their importance to Bahrain's foreign trade and m=n+2. $\Phi_1(L)...\Theta_m(L)$ are lag polynomials in the lag operator L. $\omega_1,..., \omega_m$ are stochastic disturbances, all assumed to be white noise.

Since the Bayesian approach to VAR modelling is aimed at enhancing model forecast accuracy, the decision on the optimum exchange rate regime is guided by the ability of this regime to increase the VAR forecasting ability of the target variable. Each BVAR is estimated for the period 1975I-87IV so as to leave eight out-of-sample observations. For each BVAR the resulting posterior mean estimate is used as the basis for forecasting non-oil GDP. The forecast accuracy of the models are estimated using the root mean square error (RMSE) criterion for the eight observations of the target variable equation.

Following Zellner's "Simplicity Postulate" challenge to model selection and forecasting, the results of chapter three are taken to represent a benchmark model with which to compare the forecasting ability of exchange rate augmented BVARs.[4]   This benchmark model is a bivariate VAR(1)

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[4]Zellner (1988a,b) has issued a challenge based on the Jefferys-Wrinch Simplicity Postulate.   Zellner (1988a) issued the following challenge:
    "Demonstrate that a very complicated model in any area of science has performed well in promoting understanding of past data and in predicting as yet unobserved data."

consisting of government expenditure and the target variable. Thus the benchmark model can be interpreted as forming the null hypothesis of the absence of an optimum peg. However, to insure that the improvement in forecasting is emanating from the exchange rate, Granger causality tests are carried out for each exchange rate. Hence, any exchange rate augmented VAR that has a forecast accuracy better than the benchmark model but where none of its exchange rates Granger cause non-oil GDP forces us to accept the null hypothesis that exchange rates do not contribute to the forecast improvement.

Using the benchmark model allows us to overcome the problem of searching for an appropriate model specification. Additionally, it minimizes the problem of overparameterization that is usually associated with VAR modelling. Thus, statements such as that of Litterman (1986b, p. 80):

> "It is doubtful, however, that any one paradigm can explain more than a very small part of the behaviour of any macroeconomic time series.
>
> For forecasting purposes, it seems quite reasonable to suppose that small bits of useful information concerning the macroeconomy are scattered throughout the data, and a narrowly focused approach is thus unlikely to find useful information."

will not be an appropriate description of the present case. Indeed, the results of chapter three show that adding additional variables such as the money supply will not effect the target variable and, hence, a "narrow" model in effect represents the best specification.

7.2.1 The Prior Distribution

To simplify our exposition of the prior distribution let us write the VAR as:

$$Z_t = C(L) Z_{t-1} + V_t \qquad (1)$$

where $Z_t = [z_{t1}, z_{2t}, \ldots, z_{mt}]'$, $C(L)$ is a $(m \times m)$ matrix of polynomials in the lag operator L, and $V_t = [v_{1t}, v_{2t}, \ldots, v_{mt}]'$. According to Nelson and Plosser (1982) and Litterman (1986a), most macroeconomic variables can be approximated by the random walk model. In this case the ith equation of (1) will take the form:

$$z_{it} = c_i + z_{it-1} + v_{it} \qquad (2)$$

Doan et al. (1984) and Litterman (1986a) have suggested using (2) as the prior distribution. Hence, if the model is estimated for the levels of the series, $C(L)$ is a diagonal matrix with unity along its diagonals.

In a Bayesian system, the prior distribution requires specifying the mean and variance of each parameter in the model. If we let ξ_{ij}^L be the standard deviation of the prior

distribution of the coefficient on lag L of variable j in equation i, then

$$\xi_{ij}^{L} = \lambda f(i,j) D(L) \frac{\sigma_i}{\sigma_j} \qquad (3)$$

where λ is the overall tightness parameter and $f(i,j)$ is the relative tightness of variable j in equation i; this is used when $i \neq j$. $D(L)$ is a distributed lag function that tightens the standard errors as the lag length increases. For instance, a harmonic specification corresponds to $D(L) = L^{-Decay}$, where Decay is a constant. σ_i and σ_j are the estimated standard errors of univariate AR models for variable i and j respectively. σ_i/σ_j is used to adjust the a priori information to the relative scale of the variables. Thus the prior standard deviation is a function of the hyperparameters: λ, $f(i,j)$ and Decay.

For a random walk prior, the modeller will specify the prior by assigning very low values to the overall and relative tightness. For such models, the prior distributions of the other coefficients (other than the own first lag) will have zero prior mean and the model will have a very low value assigned to the overall tightness so as to ensure that these coefficients are not significantly different from zero.

For non-oil GDP the random walk prior is very restrictive. This is attributed to the following reasons:

(i) non-oil GDP is trend stationary. Thus assuming that it can be approximated by a random walk could be a very serious misspecification.

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(ii) The results of chapter three provide us with a more informative prior than that of a random walk. Litterman (1986a, p.29) has stated:

"When there are known relationships among variables...that information should be imposed in the estimation process."

Obviously, to allow for cross-effects we will need to relax the overall and relative tightness. The hyperparameters used in this chapter are selected as follows:

(i) The hyperparameter λ and the relative tightness of government expenditure in the non-oil GDP equation are obtained by using the hyperparameters from the BVAR in which government expenditure Granger causes non-oil GDP. In the search for these hyperparameters, the own lag coefficients were assigned distributions in which the means are those of chapter three. We have found that setting $\lambda=0.35$ and choosing 2.0 for the relative tightness on the coefficient of government expenditure in the non-oil GDP equation meets the above requirement. Additionally, since chapter three shows the absence of a causal relationship between the exchange rate and non-oil GDP, each of the bilateral exchange rates is assigned a low value of relative tightness in the non-oil GDP equation so as to reflect our prior

knowledge: each has a relative tightness of 0.1. In fact, this is not a very tight prior (see Litterman, 1986b). Hence, if there are causal relationships between the bilateral exchange rates and non-oil GDP, the not-very tight hyperparameters are sufficient to allow for them.

(ii) For the government expenditure equation, the relative tightness parameters were given similar values to those above.

(iii) An important empirical regularity of exchange rates are that they behave as random walks. Thus, as the exchange rate variables are modelled in first differences, the means of the prior distributions of these variables are obtained by fitting each series by an ARIMA process and using the coefficient on the first lag.[5] Additionally, as in the target variable and government expenditure equations, each of the exchange rate equations has all relative tightness parameters set at 0.1.

(iv) The Decay constant has a value of 1.0. This reduces the probability that the coefficients on variables with large lags are significant.

Since we are only concerned with forecasting non-oil GDP, the priors on the other equations are of little

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[5]For all exchange rates the ARIMAs have significant coefficients on the first lag. AS$ is the only exception in which the first lag is not different from zero.

interest. Nevertheless, the detailed discussion of the priors on other variables is given so as to provide a clear exposition of the priors used in the estimations.

7.3 Determining the Univariate Integration Property of the Series

The integration properties of the series are investigated using Dickey-Fuller tests. Following inspection of the plot of each series, integration tests for real non-oil GDP (Y), government expenditure (G) and AS$ are calculated by including a time trend in the deterministic component of each ARIMA model. For these series, the null hypothesis is

H_0 : I(1)/ Difference stationary

while the alternative is

H_a : Trend stationary

For the rest of the series, we test the null hypothesis:

H_0 : I(1)/ Difference stationary

versus the alternative

H_a : I(0)/ mean constant stationary

The results provided in Table 7.1 show that, except for non-oil GDP, all other series contain unit roots. This is further supported by the associated confidence intervals, all of which include unity.

From the macroeconomic theory perspective, the integration property of non-oil GDP can be reconciled with the conventional view of macroeconomic fluctuations. This decomposes output into secular and cyclical components. In the literature, the growth theories are mainly concerned with explaining the former, long-run, component, while business cycle theories are devoted to studying the cyclical component. The growth theories attribute the smoothly evolving long-run component to real variables. On the other hand, some of the business cycle theories, such as the Keynesian, monetarist and new classical theories, allow for unanticipated shocks emanating from macroeconomic policies to influence the cyclical component. Hence, if we accept such explanations of the short and long-run fluctuations, then the integration property of non-oil GDP has the following implications for exchange rate policy:

(i) It is not possible to estimate the steady state optimum exchange rate. In fact, the exchange rate basket in the Horne-Martin approach is a short-run result and hence, given the integration property of the target variable, this chapter will only determine the optimum regime over the short-run horizon.

(ii) We will be able to avoid the problem of determining the optimum regimes over the short and long-runs. There is no guarantee that the data will give similar regimes for the short and long-run, thus resulting in contradicting regimes. If policy makers are faced with two optimum regimes over the short and the long time horizon, they will have to decide on the switching period. By doing so the authorities will be introducing a destabilizing factor into the macroeconomy.

(iii) Hence, for credibility reasons the authorities are better off following a time consistent policy that keeps the short and long-run regimes as close as possible to each other over both time horizons.

Table 7.1
Tests of Integration Order and Confidence Intervals of the Unit Roots

Series		ADF	95% Confidence Intervals
Y	[4]	-6.195*	cc
G	[3]	-2.666	(0.646, 1.064)
US$	[3]	-2.217	(0.714, 1.049)
Yen	[1]	-1.089	(0.899, 1.074)
DM	[5]	-2.323	(0.691, 1.046)
PS	[1]	-1.932	(0.769, 1.057)
AS$	[1]	-1.438	(0.852, 1.069)
FF	[1]	-1.735	(0.798, 1.063)
IL	[1]	-2.109	(0.739, 1.052)

Notes: An asterisk stands for significant at 5% level. cc denotes cannot calculate. Figures in square brackets are the lags required to whiten the residuals. The confidence intervals are calculated using Stock's (1991, Table A1 parts A and B).

7.4 Deciding on the Optimum Exchange Rate Regime

Using the integration properties of the series, VAR models are estimated for the existing regime, that for a single currency basket(US$) and the SDR basket.[6] This is done to test for the validity of the existing regime. Additionally, if none of the above is an optimum regime, VARs will be estimated for an alternative regime.

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[6]For further discussion of the BD exchange rate arrangement see chapter 5.

To determine the basket size of the alternative regime, a multi- to single-currency basket approach will be followed. The adopted strategy can be described in the following way:

The BVAR is estimated for a seven-currency basket. Once the results show that it has a lower RMSE than the benchmark's, but some of the exchange rates are not Granger causing non-oil GDP, these currencies are removed from the basket and a new BVAR estimated for the remaining currencies. If the new BVAR produces similar results to the previous one, the corresponding exchange rate(s) will be removed from the basket and a new BVAR estimated for the new basket. This process will continue until we find a basket with lower RMSE than the benchmark model and in which each exchange rate Granger causes non-oil GDP.

Due to the sample size, all VARs in this chapter are estimated with four lags.

The results on the above regimes can be summarized in the following:[7]

(i) The single currency basket peg does not constitute an optimum regime (see Table 7.2 and Table 7.3 for Granger causality tests).

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[7]Using standard VAR did not change the results on Granger causality tests in the non-oil GDP equation thus providing further support to the above findings. The author is willing to support these results upon request.

(ii) The SDR basket cannot be accepted as an optimum regime (see Table 7.2, for Granger causality test see Table 7.3). However, this basket is reestimated to remove possible multicollinearity between the French Franc and the Deutschmark arising from pegging the former to the latter currency through the European Exchange Rate Mechanism (ERM). The estimated target variable equation and the Granger causality test strongly reject this basket as an optimum peg regime (see Tables 7.2 and 7.3).

(iii) For the alternative peg regime, two BVAR models are estimated. The different systems are estimated so as to account for possible multicollinearity between the DM, FF and IL. The estimates of these models show that none of them can be an optimum regime (see Tables 7.2 and 7.3).

The above findings have two important implications. The first is related to the relationship of these findings to the theoretical literature. The second is related to the conduct of exchange rate policy. These implications can be explained as follows:

(i) From the theoretical point of view these results are very surprising, given that Bahrain's assets markets are not internationally

integrated.[8]   However, experience shows that a developing country like Lebanon, which has a similar asset market, has managed to float its exchange rate.   The Lebanese experience and the results of this chapter suggest that: (a) the choice of an exchange rate regime must not be based on theoretical considerations alone; (b) the conditions set out in the theoretical literature for inhibiting developing countries from floating their exchange rates are sufficient but not necessary conditions; and (c) the choice of exchange rate regime must be conditioned on the goal of economic policy.

(ii) The implication of this chapter's findings for exchange rate policy is summarized in the following proposition:

Given that diversification of economic activities is the aim of the decision makers, the present exchange rate regime does not contribute to achieving this aim. Additionally, the data show that if the authorities are opting for an optimum regime, pegging the BD rate is not going to

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[8]This is referring to the literature devoted to developing countries' choice of exchange rate regime.   For further details see chapter 4.

be a sensible decision.[9]

7.5 Conclusion

In this chapter the problem of determining the optimum exchange rate regime is solved using the Bayesian vector autoregression approach. The results strongly reject the existing exchange rate regime as an optimum regime and, in fact, show that there is no optimum peg. Because the model rejects the optimality of any peg, the Bahraini authorities may either allow the BD to float or opt for a second best strategy by pegging the BD rate. Given the selection criteria, the seven-currency basket will be the regime that is closest to the second best. If the authorities do so they will be opting for an extremely unreliable regime.

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[9]We know from chapter 5 that since 1986 the BD rates versus the rates of Bahrain's main trading partners are undervalued, thus there is a high probability that, following flotation the BD rate will be pushed upward. This may prove, over the short-run, to be a popular policy. The appreciation of the BD rate will increases real wages and hence individual's purchasing power.

Table 7.2
Root Mean Square Error of the Non-Oil GDP Equation

Model	RMSE Lag		
	1	4	8
g,y	0.0611	0.0247	0.0393
US$,g,y	0.0847	0.0379	0.0437
US$,YEN,PS,DM,FF,g,y	0.0851	0.0380	0.0438
US$,YEN,PS,DM,g,y	0.0857	0.0382	0.0437
US$,YEN,PS,DM,AS$,FF,IL,g,y	0.0851	0.0376	0.0436
US$,YEN,PS,DM,AS$,g,y	0.0863	0.0379	0.0435

Table 7.3
Results on Granger Causality Tests: Non-Oil GDP Equation

Basket	US$	Yen	PS	DM	AS$	FF	IL	g
(i)	NI	NI	NI	NI	NI	NI	NI	3.909*
(ii)	0.008	NI	NI	NI	NI	NI	NI	3.596*
(iii)	0.007	0.010	0.017	0.008	NI	0.013	NI	3.565*
(iv)	0.007	0.009	0.017	0.007	NI	NI	NI	3.588*
(v)	0.008	0.010	0.016	0.008	0.060	0.011	0.022	3.542*
(vi)	0.008	0.010	0.017	0.008	0.061	NI	NI	3.605*

Notes: An asterisk stands for significant at 5% level. NI stands for not included in the VAR model. Baskets are identified as follows:
(i): Benchmark model;
(ii): US$ basket;
(iii): SDR composite basket;
(iv): SDR composite without FF;
(v): seven currency basket; and
(vi): seven currency basket without FF and IL.

Table 7.4
Results on Granger Causality Tests: Other Equations

Equation	US$	YEN	PS	DM	AS$	FF	IL	g	y
(ia)	28.166*	NI	NI	NI	NI	NI	NI	0.015	1.081
(ib)	0.002	NI	NI	NI	NI	NI	NI	4.217*	0.463
(iia)	28.501*	0.034	0.037	0.011	NI	0.001	NI	0.015	1.080
(iib)	0.009	32.091*	0.005	0.022	NI	0.025	NI	0.004	0.079
(iic)	0.022	0.004	14.249*	0.046	NI	0.115	NI	0.003	0.201
(iid)	0.005	0.004	0.001	36.221*	NI	0.021	NI	0.003	0.693
(iie)	0.010	0.013	0.010	0.018	NI	43.256*	NI	0.006	0.556
(iif)	0.001	0.026	0.040	0.015	NI	0.029	NI	4.292*	0.473
(iiia)	159.455*	0.007	0.022	0.035	NI	NI	NI	0.033	0.970
(iiib)	0.009	32.089*	0.005	0.025	NI	NI	NI	0.004	0.077
(iiic)	0.021	0.002	12.290*	0.060	NI	NI	NI	0.003	0.207
(iiid)	0.005	0.005	0.001	36.355*	NI	NI	NI	0.003	0.697
(iiie)	0.001	0.026	0.040	0.015	NI	NI	NI	4.268*	0.467
(iva)	28.519*	0.034	0.037	0.016	0.001	0.001	0.002	0.015	1.080
(ivb)	0.009	32.151*	0.005	0.021	0.019	0.024	0.002	0.009	0.078

(continue)

Table 7.4 Continued

Equation	US$	YEN	PS	DM	AS$	FF	IL	g	y
(ivc)	0.022	0.005	12.462*	0.043	0.005	0.109	0.088	0.003	0.196
(ivd)	0.005	0.004	0.001	36.314*	0.034	0.019	0.014	0.003	0.705
(ive)	0.003	0.001	0.067	0.009	0.011	0.066	0.054	0.013	0.423
(ivf)	0.010	0.014	0.009	0.015	0.029	43.302*	0.032	0.006	0.559
(ivg)	0.004	0.008	0.013	0.023	0.011	0.041	47.811*	0.004	0.312
(ivh)	0.001	0.026	0.042	0.015	0.015	0.027	0.052	4.348*	0.479
(va)	28.508*	0.035	0.037	0.011	0.001	NI	NI	0.015	1.080
(vb)	0.010	32.180*	0.005	0.025	0.020	NI	NI	0.003	0.076
(vc)	0.021	0.003	14.136*	0.056	0.004	NI	NI	0.003	0.204
(vd)	0.005	0.005	0.001	36.554*	0.033	NI	NI	0.003	0.712
(ve)	0.003	0.001	0.077	0.016	0.012	NI	NI	0.013	0.441
(vf)	0.001	0.026	0.039	0.015	0.015	NI	NI	4.280*	0.470

Notes: An asterisk stands for significant at 5% level. Baskets are identified as follows:
(ia): US$ equation in basket model; (ib): g equation in US$ basket model; (iia): US$ equation in SDR basket; (iib): YEN equation in SDR basket; (iic): PS equation in SDR basket; (iid): DM equation in SDR basket; (iie): FF equation in SDR basket; (iif): g Equation in SDR basket; (iiia): US$ equation in SDR basket without FF; (iiib): YEN

(continue)

Notes from Table 7.4 continued

equation in SDR basket without FF; (iiic): PS equation in SDR basket without FF; (iiid): DM equation in SDR basket; (iiie): g equation in SDR basket without FF; (iva): US$ equation in seven-currency basket; (ivb): YEN equation in seven-currency basket; (ivc): PS equation in seven-currency basket; (ivd): DM equation in seven-currency basket; (ive): AS$ equation in seven-currency basket; (ivf): FF equation in seven-currency basket; (ivg): IL equation in seven-currency basket; (ivh): g equation in seven-currency basket; (va): US$ equation in seven-currency without FF and IL; (vb): YEN equation in seven-currency basket without FF and IL; (vc): PS equation in seven-currency basket without FF and IL; (vd): DM equation in seven-currency basket without FF and IL; (ve): AS$ equation in seven-currency basket without FF and IL; and (vf): g equation in seven-currency basket without FF and IL.

Chapter Eight

Conclusions

8.1 Introduction

This thesis has utilized recent developments in macroeconomics and econometrics to carry out an empirical analysis of the Bahraini economy. To do so, the annually observed series of GDP, non-oil GDP, government expenditure, GDP deflator and the non-oil GDP deflator are first disaggregated into their quarterly components. In subsequent chapters these series are used to: (i) establish stylized facts about the Bahraini economy; (2) study the BD exchange rate arrangements; (3) test the optimality of the BD regime; and (4) solve for the optimum regime.

The main findings and their implications for macroeconomic and exchange rate policies are discussed in the next two sections. The chapter is concluded by some recommendation for future research.

8.2 Summary of the Findings

The main findings of the thesis can be summarized as follows:

(i) In the case of Bahrain, the use of time series techniques requires increasing the number of observations. The Harvey-Kalman filter approach was used to estimate quarterly missing observations for GDP, non-oil GDP, government expenditure, the GDP deflator and the non-oil GDP deflator. The disaggregation results show that these estimates are robust and that the

Harvey-Kalman filter approach is a very useful method for estimating missing observations.

(ii) Since chapter three is the first attempt at establishing stylized facts on the Bahraini economy, the empirical investigation is divided into two sections. In the first section the Campbell-Mankiw and Cochrane univariate approaches are utilized to measure persistence in GDP, non-oil GDP and oil GDP. The second section tests for the determinants of the non-oil business cycle. Confining the investigation to the non-oil business cycle is determined by the fact that the authorities are targeting non-oil GDP and that macroeconomic policies cannot influence oil GDP. The empirical analyses of this chapter produced several stylized facts. First, an innovation to the level of GDP, non-oil GDP and oil GDP will have transitory effects. This is further supported by unit root tests. Second, money is neutral, i.e. none of the monetary aggregates can explain the non-oil business cycle. Third, the real business cycle hypothesis on the endogeneity of the money supply is strongly rejected. Fourth, government expenditure is an important macroeconomic stabilizing instrument. In fact, the results from VAR models show it to be the only macroeconomic variable that Granger causes non-oil GDP, thus pointing to the importance of fiscal

policy in driving the non-oil business cycle. Additionally, the results reveal the absence of a feedback from non-oil GDP to government expenditure, thus rendering government expenditure weakly exogenous. Fifth, government expenditure is an important determinant of the monetary aggregates. Sixth, inside money is the only monetary aggregate that Granger causes prices. These stylized facts are robust, this being verified using McCallum's method for testing robustness. Using this method gives rise to a seventh stylized fact, that the exchange rate does not Granger cause non-oil GDP. For a small open economy, this constitutes a major drawback for the post-Bretton Woods exchange rate arrangements adopted by Bahrain. This result warranted further investigation of the optimality of the existing peg regime.

(iii) Generally, the optimality of an exchange rate regime is determined either by targeting output or inflation. Since the results of chapter three rejected the optimality of the BD exchange rate with respect to output, this optimality was further investigated with respect to domestic prices. Two tests were carried out. The first investigated the consequences of the BD rate arrangements on the conduct of interest rate policy by testing the divorce of interest rate

policy from domestic fundamentals. The second test investigated whether or not BD post-Bretton Woods exchange rate arrangements inhibited domestic inflation from converging to the world average rate. Inflation convergence was one of the major drawbacks that led to the collapse of the Bretton Woods system.

The first test failed to reject the hypothesis of the divorce of interest rate policy from domestic fundamentals. Similarly, the cointegration test failed to reject the convergence of Bahrain's inflation to the world average rate. Combining the results from the above two tests with that of chapter three leads us to doubt the optimality of the BD peg exchange rate arrangement.

(iv) The optimality of the BD exchange rate is tested using an extended Horne-Martin approach. Extensions are added to enhance the accuracy of the inferential process. By doing so, the thesis differed from conventional methods. In fact, it has used a selection procedure and econometric method that is not found in other studies. Consequently, it is not possible to compare the results from this thesis with those found in the earlier literature.

The BVAR results show that there is no optimum peg for the BD. Instead, the authorities are left with the floating option. They may opt for a

second best regime by pegging the BD to the seven-currency basket, but this regime will lead to counter intuitive results.

8.3 Implications of the Findings for Macroeconomic and Exchange Rate Policies

The empirical findings of the thesis have important implications for the conduct of macroeconomic and exchange rate policies. These implications can be summarized in the following:

(i) To have an enhanced understanding of economic behaviour and to allow for policy reaction, the authorities are better off using quarterly observations on value added aggregates. Using annual data has several disadvantages: (a) the authorities may not perceive a change in the direction of economic activities at the appropriate time; and (b) it reduces the number of observations, consequently inhibiting the application of very useful time series techniques which can improve the authorities understanding of the economy and hence policy prescriptions. For a small country like Bahrain collecting quarterly data will not be a difficult task. However, in the meantime the Harvey-Kalman filter can be used to disaggregate the annual data.

(ii) An innovation originating either from domestic or foreign sources will have transitory

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effects on GDP, non-oil GDP and oil GDP. With respect to the target variable, this implies that macroeconomic policy (fiscal policy) will have short-run effects on non-oil GDP. Over the long-run the growth of non-oil GDP is independent of macroeconomic policy.

(iii) Stabilizing non-oil GDP mainly rests with fiscal policy. Thus, the call for expenditure rationalization must be considered in the context of this fact.

(iv) Monetary policy will not contribute to stabilizing non-oil GDP. However, this must not be interpreted as a prima facie case for abandoning monetary policy.

(v) In a small and highly open economy, exchange rate policy is expected to have a role in stabilizing output. For Bahrain, the thesis has demonstrated the non-optimality of the existing regime. In other words, the existing peg arrangements can neither contribute to stabilizing output nor to achieving the diversification goal. Additionally, the results show that continuing to pursue the same exchange rate policy will have serious implications for the conduct of monetary policy. Therefore, the authorities are better off abandoning this regime and adopting the optimum floating exchange rate arrangement.

The switch to the new regime may give rise to some difficulties; however, this must not deter the authorities from pursuing their new policy. Prior to adopting the new regime, the authorities can educate the public of the disadvantages of the existing regime and of the need to adopt a new regime.

Obviously, the monetary authorities will need to monitor the money market during the preparation period. In effect, the authorities may index the success of their education programme by the behaviour of the money market. However, educating the public may not guarantee a smooth transition, so that the authorities may either resort to using reserves to defend the BD rate or to allowing the market to determine the new value of the BD. Pursuing the first option can be costly by depleting the country's reserves. Nevertheless, a laissez faire policy may result in a BD value that is not compatible with the target variable. Hence, the authorities may resort to a policy-mix which should be guided by the aim of setting a credible exchange rate policy.

8.4 Further Research

It was demonstrated in this thesis that the existing exchange rate regime was not optimal and we suggested an

alternative regime. As a result, further research can be carried out prior to switching to the new exchange rate arrangement:

(i) It is important to study the experience of other countries that have floated their currency.

(ii) The effects of an anticipated exchange rate change on uncertainty and hence on foreign trade and investment should be assessed.

(iii) The effects of an anticipated exchange rate change on inflationary expectations should similarly be examined.

The VAR models of chapter three did not account for oil price shocks. The VAR models are specified so as to determine the macroeconomic variables that cause the non-oil business cycle. The VAR models of chapter three can be respecified by including an oil price variable and replacing non-oil GDP with GDP. In VAR modelling, such respecification requires extreme care with respect to the variable ordering. Additionally, the causal ordering of such models can tested using Geweke's canonical form.

It is obvious from our literature review that the theoretical models pay little attention to empirical findings. For instance, some theorists continue to assume PPP even though the empirical studies doubt such a relationship exists. Thus the theoretical literature can be more coherent given that it is based on realistic assumptions.

Appendix 2A

Discussing The Regressor Selection

Selection of Regressors

Regressor selection is based on the following:

(i) Regressers have quarterly observations.

(ii) The relationship to the dependent variable is theoretically justified.

Total exports (E), non-oil visible foreign trade (NTR), oil exports (OE), the oil price index (OPI), and the consumer price index (CPI) are all available on a quarterly basis. The relationship between each of the variables is justified on the following ground:

(a and b) GDP on E and NGDP on NTR

The literature on export policies points to the existence of a significant relationship between exports and output (see Balassa, 1978). For a small and highly open economy, where the annual ratio of exports to GDP averaged 110.9% for the 1975-89 period, we will expect the above proposition to hold for Bahrain.

Regressing NGDP on total visible trade is done for two reasons. First, the non-oil export series exhibit high volatility. Second, a large proportion of non-oil imports are production inputs. For instance, Klai and Abdulah (1989) have estimated that 62.3% of non-oil imports are either intermediate or capital goods.

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(c) G on OE

For an oil driven economy, Salih et al. (1991) show the existence of a positive correlation between government expenditure and revenues.[1] Knowing that oil revenues constitute 67.0% of total government revenues for the period of estimation leads us to anticipate the existence of a positive relationship between government expenditure and oil exports.

(d and e) GDPD on OPI and CPI and NGDPD on CPI

The GDP deflator is a weighted average of the oil GDP deflator and the non-oil GDP deflator. As the oil sector is dominated by refining activities, the refined petroleum price index in the United States is taking as a proxy for the Bahraini index.

In Bahrain a large proportion of non-oil GDP is directed toward consumption. For instance output of the construction, commerce and restaurants, transportation and communication, agriculture and fisheries, and water and electricity sectors are mainly consumption oriented. Of the CPI goods and services basket, the output of the above sectors encompass approximately 64.2% of the total basket weights. In other words the baskets of both price indices contain common goods and services.

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[1]This has been found for Kuwait. The economies of Bahrain and Kuwait have very similar structure, i.e. oil driven economies.

Appendix 2B

A List of The Quarterly Missing Observations

A list of the Missing Quarterly Observations

Quarter	GDP	NGDP	GDPD	NGDPD	G
1975					
I	99.2	56.5	43.0	47.6	28.4
II	88.7	57.6	43.6	50.3	25.3
III	88.6	51.8	47.6	51.7	26.6
IV	105.8	50.1	49.2	52.9	32.2
1976					
I	101.8	65.9	47.8	50.0	34.1
II	135.5	80.9	46.6	51.5	43.5
III	145.0	91.7	49.0	52.9	46.9
IV	167.9	98.1	49.9	54.5	52.6
1977					
I	179.4	134.9	51.7	60.1	55.9
II	189.7	123.7	54.8	59.8	58.9
III	154.2	88.2	55.3	61.4	56.5
IV	168.9	103.4	54.6	66.2	58.7
1978					
I	200.9	129.1	55.3	72.7	66.3
II	179.2	120.6	55.7	72.6	62.3
III	187.6	121.0	57.1	75.2	63.4
IV	206.6	147.0	58.9	76.8	65.6
1979					
I	197.9	142.4	48.0	78.1	56.2
II	186.7	144.2	56.9	76.4	52.9
III	231.5	135.9	71.3	75.5	72.0
IV	293.1	176.2	82.0	76.8	86.8
1980					
I	287.4	143.1	72.8	82.5	76.3
II	294.1	159.1	81.0	85.0	77.1
III	261.1	173.2	83.3	85.4	69.2
IV	315.6	174.9	83.7	87.2	83.3
1981					
I	312.1	179.0	92.2	93.7	78.4
II	339.8	178.7	100.3	93.9	89.6
III	300.0	170.0	95.7	100.8	77.2
IV	352.0	217.0	93.9	101.3	89.2
1982					
I	379.7	191.9	112.6	96.9	114.1
II	339.5	227.7	103.6	96.7	97.1
III	339.4	204.5	110.9	97.1	100.8
IV	312.1	234.6	107.5	98.0	90.1

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1983
  I      328.7    233.9    105.1    101.5    107.5
  II     305.6    248.7    100.4    101.3     99.6
  III    397.6    263.2    105.4    100.9    137.0
  IV     372.6    235.8    104.2    103.2    128.4

1984
  I      387.1    269.9    104.4    108.1    135.4
  II     380.6    279.5    105.0    107.3    135.1
  III    363.0    242.4    102.3    104.3    129.5
  IV     337.8    244.4    102.0    103.6    115.4

1985
  I      370.8    221.6     98.6    101.1    127.0
  II     316.4    256.7    101.8     99.5    111.1
  III    336.1    236.2     98.7    100.4    112.2
  IV     379.6    232.9    100.9     99.0    132.1

1986
  I      426.5    246.6    104.2     88.7    164.4
  II     282.3    235.0     84.8     88.3    103.5
  III    248.1    190.9     75.6     86.9     93.3
  IV     241.3    219.1     75.5     86.7     92.2

1987
  I      263.6    221.8     79.9     88.1     94.6
  II     271.7    203.9     84.5     88.2     98.1
  III    330.1    225.3     88.5     86.9    120.7
  IV     326.4    239.6     86.9     90.8    111.7

1988
  I      292.4    228.2     83.2     90.9    107.9
  II     337.9    244.3     86.3     90.9    128.2
  III    303.2    252.8     85.4     91.0    113.2
  IV     329.4    283.0     82.7     94.1     99.7

1989
  I      300.3    234.4     80.9     95.8    108.6
  II     314.1    232.7     93.8     95.6    113.7
  III    310.4    247.6     87.9     95.6    109.9
  IV     422.8    322.1     89.0     95.3    133.3
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