The Demand for Money, Asset Substitution and the Inflation Tax in a Liberalizing Economy: an Econometric Analysis for Kenya.

Christopher S. Adam

Nuffield College
Oxford

Thesis submitted in part fulfilment of the degree of
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ABSTRACT

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Christopher S. Adam

Nuffield College, Oxford

Thesis submitted in part fulfilment of the degree of Doctor of Philosophy in the Sub-Faculty of Economics, University of Oxford, Hilary Term 1992.

This thesis develops empirical econometric models of the private sector aggregate demand for real and financial assets in Kenya over the period 1973 to 1990. Single-equation error-correction models of the demand for money are estimated using systems cointegration methods developed by Johansen (1988). The models are found to be statistically stable functions throughout the period, and are capable of encompassing existing studies. Across a range of monetary aggregates, including a Divisia index aggregate for broad money, the models describe demand for money functions in which inflation and illegal foreign currency substitution are significant determinants of money holdings, and where the private sector adjusts rapidly to deviations from its stable long-run equilibrium real money demand.

The demand for money is then integrated within a neo-classical model of asset demands, which examines the behaviour of the aggregate private sector asset portfolio in response to changes in relative prices between assets and to external shocks to the economy, principally the 1976-77 coffee boom. A variant of the Almost Ideal Demand System model developed by Deaton and Muellbauer (1980) is estimated for a class of six assets: base money, banking system deposits, government securities, tradable capital, non-tradable capital and inventories. The asset substitution model, which also takes an error-correction form, and which allows for credit rationing, generates results which are consistent with the earlier demand for money models, where private agents are also denied access to foreign-denominated assets. Using this model, the maintenance of policies of financial repression are shown to cause the private sector to offset inflationary shocks through the accumulation of real assets, principally in the form of non-tradable capital in the construction and property sectors.

The evidence from the two models is used to analyze the fiscal effects of the inflation tax and financial repression measures. Policies of financial liberalization are shown to reduce the revenue maximizing rate of inflation (estimated to be 14% per annum) and the implicit tax on domestic holders of government liabilities. This dampens asset substitution in response to inflationary shocks and offsets the adverse effects of "construction-boom" investment on non-tradable capital prices.

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1

INTRODUCTION

1.1 Research Objectives

This thesis examines the nature and implications of private sector asset accumulation in Kenya over the period from 1973 to 1990. The research addresses itself principally to the econometric modelling of the sector's demand for real and financial assets, with a particular emphasis on the demand for money, and the implications of this demand behaviour for the conduct of monetary and financial policy. Since the mid-1980s the Government of Kenya has instituted a series of policy measures aimed at the liberalization of the domestic financial system. The objective of these policies has been to move from a monetary policy based on quantitative controls on credit and interest rates to one where the monetary authorities operate through price-based interventions in the money and bond markets. The effectiveness of these policy measures clearly depends on the structure of the underlying demand functions for financial and real assets.

The conduct of monetary policy in Kenya, both in terms of past operating procedures and current policy objectives, is broadly similar to many economies in sub-Saharan Africa. However, though Kenya has shared many of the characteristics of other sub-Saharan economies, such as the direct administration of interest rates, thin markets for government securities, and a prohibition on the accumulation of foreign-denominated financial assets, it differs from them in a number of important respects. First, Kenya has enjoyed a period of relative monetary stability since Independence which has been matched by very few other African economies outside the Rand and Franc monetary zones. Consequently, it has not been prone to the high levels of inflation experienced in, for example, Uganda, Zambia or Ghana during the 1980s. Second, though real domestic deposit rates have been negative throughout most of the period, they have been gradually moved in line with inflation and thus the phenomenon of strongly negative real interest rates has been avoided. Finally, active exchange rate policy has ensured that the parallel market for foreign exchange has remained relatively small. The economy has thus not experienced widespread currency substitution, or "dollarization", which has again characterised many other economies. Taken together these characteristics suggest that the Kenyan economy can offer a reasonably favourable environment in which to conduct econometric research of the form envisaged in this thesis.

Despite these differences, the Kenyan economy, and its financial system, has been subject to a number of shocks, starting with the so-called coffee boom of 1976-77 which saw world prices for Kenya's principal exports rise by 400 per cent. This boom reversed a period of sharp economic decline in the economy, while the reversion of world prices for Kenya's exports to more normal levels in the early 1980s saw the economy enter a period of disequilibrium, which was exacerbated by a series of adverse shocks from 1979 to 1984. A second but smaller coffee boom occurred in 1986, which was followed by a period of moderate real growth but worsening fiscal and external balances. This unsteady economic environment has had implications for the private sector demand for financial and real assets, and thus one of the principal objectives of the thesis is to examine whether robust behavioural models of asset demands can be recovered from this environment. Moreover, since Kenya does share a number of characteristics with other sub-Saharan economies, the analysis of the Kenyan economy in this thesis may also provide archetypical evidence of the effects of financial liberalization elsewhere on the continent.

1.2 Structure and Methodology

The analysis commences in Chapter 2 with an evaluation of the demand for different monetary aggregates by the non-bank private sector. From this analysis, a natural extension is to examine the fiscal implications of the private sector demand for money and other government liabilities. The private sector demand for government liabilities has important seigniorage and inflation tax implications which are examined in Chapter 3, which also provides an analysis of the fiscal effects of the maintenance of policies of financial repression.

One of the principal drawbacks of the approach adopted in Chapters 2 and 3 is that while the single equation models of asset demand provide useful and flexible forms for the analysis of the demand for individual assets, they preclude a more comprehensive analysis of the dynamic substitution effects between money and other financial and real assets. In Chapter 4 we attempt to analyze these substitution effects in detail, by developing a more general model of asset demands in which we characterize the process of asset substitution in response to changes in the structure of asset prices and the economic conditions. To do so in a tractable manner we are obliged to employ a more restrictive modelling structure, and we choose a version of the Almost-Ideal demand systems model developed by Deaton and Muellbauer (1980). We find that although a number of problems are associated with the model structure, it does serve to highlight the key features of the data over the period. Finally, in Chapter 5, we use this model to generate a series of scenarios which evaluate the impact of the policies of financial implementation currently being implemented in Kenya.

This thesis is primarily concerned with the development of robust econometric relationships for the Kenyan economy. The variables to be modelled are generally non-stationary time series, and therefore we employ single-equation and systems cointegration techniques to identify long-run relationships between these variables. In each case the models are developed using a two-stage process. Initially, the long-run characteristics of the data are derived using the Engle-Granger (1987) and Johansen (1988) techniques. These long-run theory-consistent solutions form the basis for dynamic error-correction models, which combine long-run theory-based relationships within short-run dynamic models of economic adjustment.

The models presented in Chapter 2 are derived from the standard conditional aggregate demand for money model popularized by Friedman (1956) and others. The implicit model identified in the data consists of a stable long-run demand for real balances, and the supply of money which is determined principally by the supply of domestic monetary liabilities issued by the government (through the Central Bank of Kenya). In the long-run it is assumed that the price level moves to clear the money market. The model presented in Chapter 2 is relatively general, but subsumes a number of important substitution effects between money and other assets within a restricted set of conditioning variables. In Chapter 4 our attempt to relax this restriction to examine the cross price effects in more detail is performed within a similar econometric framework, although using a more restricted functional form. The model employs the common neo-classical assumption that the flow of utility from holding any asset is monotonically proportional to its stock, which means that demand functions are defined in terms of the individual share of each asset in total wealth. In addition, the Almost-Ideal demand system model is based on a representative-agent utility function where the assumption of weak separability of preferences permits a two-stage budget process in which demand functions can be modelled solely in terms of relative prices within the group of assets, independently of movements in prices of commodities (including leisure) outside the group of assets. These two sets of assumptions allow demand behaviour to be inferred from a model in which the vector of relative prices, total expenditure, and total income are the sole conditioning variables.

1.3 Macroeconomic Background and the Development of Monetary Policy[1]

The macroeconomic history of post-independence Kenya falls quite neatly into five phases. The first phase extends from Independence in 1963 to the first oil shock a decade later. This was followed by a short, but exceptionally large, favourable trade shock referred to generally as the coffee boom. The third phase, which stretched from 1979 to 1983 was a period of severe macroeconomic imbalance and was characterised by failed stabilization efforts on the part of the government. The period from 1984 to 1986 saw the economy stabilize, and

[1] This description of the macroeconomic developments in Kenya draws heaving on Bevan *et al.* (1990), Mosley *et al.* (1991) and Adam *et al.* (1992).

culminated in a second short coffee boom - a boom which was followed by the collapse of the International Coffee Organization, while the final phase since 1986 has witnessed the combination of mixed economic performance combined with comprehensive moves towards trade, price and financial liberalization. Table 1.1 summarises the main macroeconomic aggregates over the period.

Table 1.1
Summary Macroeconomic Indicators

	1963-4	1975-9	1980-3	1984-6	1987-9
Population (millions)	12.3	14.8	17.6	20.1	22.4
Population Growth Rate (%)	3.6	3.9	3.9	3.8	3.7
GDP Growth Rate (%)	6.6	4.9	0.8	5.1	4.3
Per capita GDP growth (%)	3.0	1.0	-3.1	1.3	0.6
Current Account Deficit (% GDP)	-1.4	-2.6	-3.7	-1.2	-6.8
Budget Deficit (% GDP)	-0.6	-2.1	-3.7	-4.5	-5.1
Annual Inflation Rate (%)	7.7	14.1	14.4	9.1	7.7
Exchange Rate (Ksh/US$)	7.1	7.8	10.2	15.7	18.3
Average Terms of Trade	116.1	140.4	113.4	123.6	97.5

Source: Kenya Statistical Abstract (various years)

The decade following independence in Kenya in 1963 was one of rapid real growth in income, averaging 6.6 per cent per annum over the decade. This growth was supported principally by favourable terms of trade, high official and private capital inflows, and a budgetary stance which saw limited recourse to monetization of the deficit. By the time of the first oil shock in 1973, economic activity, principally export growth, was beginning to slow down, and the combination of sharp increase in oil and other import prices and the reversal of private capital flows, precipitated a severe balance of payments crisis. This crisis persisted through 1974 and 1975 and, as growth stagnated, the government deficit expanded to 6 per cent of GDP in 1974/5 and 7.3 per cent in 1975/6. Real capital formation declined sharply, falling by over 35 per cent between 1973 and 1975.

The government's response to the crisis consisted of a programme of adjustment measures aimed at reducing import dependence and promoting agricultural production, supported by tight wage and fiscal restraint. The government's programme was supported by an IMF Extended Fund facility, but these adjustment efforts were short lived following the realization in early 1976 that a severe frost had destroyed the Brazilian coffee crop. This marked the start of the second phase: Kenya (along with its East African Community neighbours) experienced a short, sharp, commodity boom. Coffee prices rose by over 400 per cent between 1975 and 1977, while the terms of trade gain was equivalent to approximately 24 per cent of GDP over its lifetime.[2]

Though short-lived, the effects of the boom lasted from 1976 until 1979 in the consumption and tradables sectors of the economy, and until as late as 1981 in the construction sector. Real GDP growth reached 9.4 per cent in 1977 and, with the liberalization of trade policy providing access to imported intermediate goods, investment growth rose rapidly, both in the private sector and, significantly, in the public sector. However, although there was no doubt that the boom was to be short-lived, there was only limited sterilization of the windfall income and the macroeconomic imbalances that had first emerged in 1974 and 1975 remained fundamentally unaddressed.

The period from 1979 to 1983 saw the economy enter a third phase in which it experienced a severe recession, caused both by adverse external shocks, particularly the second oil price boom in 1979, and drought in 1979 and 1980, and by the continued loss of domestic fiscal and monetary control. External borrowing grew sharply, and the budget deficit rose to almost 8 per cent of GDP in 1982. Repeated attempts at achieving stabilization met with failure: three separate IMF programmes were entered between 1979 and 1982, but in each case disbursement was suspended as the government failed to meet fiscal and monetary targets established by the IMF.

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[2] Bevan *et al.* ((1990) Chapter 5).

From 1984 onwards fiscal and monetary stabilization was re-established. Real growth recovered, and by 1986 had reached almost 6 per cent per annum. This was accompanied by the reduction of the budget deficit, which fell to approximately 5 per cent of GDP, and a concomitant fall in the rate of domestic inflation, from approximately 15 per cent per annum in the early 1980s to 10 per cent by 1984, and to less than 5 per cent in 1986. The improved management of aggregate demand was accompanied by a series of donor-supported liberalization and adjustment measures developed under the auspices of Sessional Paper No.1 of 1986 on *Economic Management for Renewed Growth*. World Bank sectoral adjustment loans were extended for the agricultural and industrial sectors in 1986, and for the financial sector in 1989, at which time the Capital Market Development Authority was established, and the monetary authorities instituted measured designed to complete the transition to a de-regulated financial sector.

Monetary Conditions and Policy 1971-90

Since the early 1970s the monetary authorities in Kenya have utilised five main sets of policy instruments: credit guidelines and controls; mandatory cash limits; mandatory liquid asset requirements; direct interest rate controls; and open market operations. The first four have been used in varying ways from 1971 to the present, while the latter has been developed only since the early 1990s.

The first years of the Central Bank of Kenya's operations[3] were characterised by domestic and external monetary stability. Net foreign assets remained virtually constant throughout the period, while inflation averaged less than 5 per cent per annum throughout the decade up to 1973. Active quantitative monetary policy was initiated in December 1971 with the introduction of a 5 per cent cash ratio for commercial banks and a corresponding 12½ per cent liquid

[3] The central bank was established in terms of the Central Bank of Kenya Act (1966).

asset ratio.[4] In neither case, however, did the restrictions bind: actual cash holdings by the commercial banks as at the end of 1971 were 12.3 per cent, and liquid assets 18 per cent of eligible liabilities respectively. Consequently the cash limit was rescinded two months after its introduction, although the liquid asset ratio was retained, increased to 15 per cent in 1972, and then extended to cover Non Bank Financial Instruments (NBFIs) in June 1974.

In June 1974, responding to the sharp rise in inflation since the end of 1972, the authorities moved away from their short-lived monetary base control policy towards an explicit policy of targeting total domestic credit. Domestic credit expansion (DCE) targets have been maintained throughout the period and since 1981 have been combined with explicit IMF credit expansion guidelines. The credit targets were set in aggregate terms, although were supplemented by guidelines emphasizing lending to agriculture, small scale enterprises and the consumer-good import substitution sector. Despite these guidelines, however, total domestic credit expanded very rapidly in 1973 (46 per cent year-on-year) and 1974 (28 per cent), principally as a result of strong growth in credit to the public sector, and domestic inflation continued to increase, from 16 per cent in 1974 to over 19 per cent in 1975.

The period 1976 to 1978 was dominated by the large monetary expansion which occurred during the coffee boom. With the increase in the terms of trade, the stock of net foreign assets increased by 120 per cent from December 1975 to December 1976, and by a further 150 per cent in the following year. The period began with an attempt (in July 1976) to limit total DCE to 21 per cent through the introduction of a specific restriction on public sector credit growth. This was combined with an increase in the liquid asset ratio (for both banks and NBFIs) to 18 per cent of eligible deposits. Domestic credit remained close to its target range, growing by 19 per cent in the year to December 1976 and by 23 per cent in the year to December 1977, although its controlled rate of expansion was not sufficient to offset the growth in net foreign assets and the sum of domestic credit

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[4] Liquid assets consist of: i) till cash; ii) Balances with the Central Bank of Kenya; iii) Holdings of Treasury Bills; and iv) net inter-bank assets.

plus net foreign assets (NFA) grew by 45 per cent in 1977. This was accompanied by a rapid increase in the rate of inflation which reached almost 23 per cent by the end of the year.

The dramatic increase in private sector incomes during the boom period was transmitted to the monetary system in two ways. First, because the private sector were not permitted to hold foreign assets, export earnings were converted into domestic assets and deposited with the banking system. This drove up eligible deposits of the banking system, and correspondingly lowered the banking systems cash ratio, which fell to below 5 per cent by the end on 1976. The second effect however was that the creation of these deposits by the banking system was not offset by any sterilization of the counterpart net foreign asset growth by the Central Bank and the government. Between December 1976 and December 1977 net foreign assets increased by Ksh 2 billion, net domestic credit to the private sector increased by Ksh 1.7 billion, yet there was no reduction in the net domestic credit to the public sector. Despite the rise in deposit liabilities, the banking system increased their total holdings of liquid assets (ie claims against the government) more than proportionally such that their liquid assets equalled 28 per cent of eligible liabilities (10 percentage points above the minimum statutory requirements). At the same time, however, the share of cash in that total dropped to below 5 per cent by the end of 1976. Concerned that the high level of liquid assets was a result of a constrained excess demand for credit, the minimum lending rate was abolished to encourage investment, while the cash ratio was re-introduced in response to the fall in commercial banks cash balances.

The abrupt termination of the coffee boom in 1978 was accompanied by a reduction in the terms of trade and a marked deterioration of the current account balance. Net foreign assets fell by Ksh1.5bn, but this was more than offset by a 35 per cent increase in total domestic credit (which included an 80 per cent increase in credit to the public sector, occasioned by the continuance of high levels of public spending). Monetary policy remained relatively neutral throughout 1979 and 1980: the liquid asset ratio was reduced to 16 per cent in June 1979 and credit guidelines, which remained at their previous levels of 12 per cent growth per annum, were met. Interest rates were raised slightly to 11 per cent.

The years from 1981 to 1983 saw the economy pass through a period where monetary and fiscal control collapsed. The loss of fiscal control in 1981 and 1982 saw a dramatic increase in domestic credit to the public sector of 87 per cent in the year to December 1981, and a further 65 per cent in the year to December 1982. Total credit expansion rose, but at a lower rate of 25 per cent and 29 per cent respectively, against specified credit limits of 15 per cent and 20 per cent respectively. Thus, after falling briefly from its peak in 1977, inflation rose rapidly following the second oil price shock in 1979, eventually reaching a peak of 24 per cent in 1982. The growth in credit to the private sector was matched by increases in deposit and loan rates which rose from 11 per cent to 16 per cent in nominal terms from the beginning of 1981 to the end of 1982, but with inflation rising even more rapidly, *ex post* real interest rates remained strongly negative.

Monetary and fiscal control was gradually re-established from 1983 to 1986 with the support of a series of IMF loans. Total domestic credit expansion was contained within its 15 per cent guidelines established for 1983 to 1985 (the growth rates for the three years being 0 per cent, 11 per cent and 13 per cent respectively), while a larger proportion of the government budget deficit was financed through domestic debt sales to the bank and non-bank private sector. Inflation fell rapidly from its peak in 1982, and by 1986 had fallen below 5 per cent per annum, heralding a period of positive *ex post* domestic interest rates. The failure to maintain fiscal control in the later 1980s however saw domestic inflation rise again, although in this period nominal interest rates rose concomitantly.

In general, the period since 1986 has been characterised by a more systematic approach to monetary policy, even in the face of variable fiscal conditions. The first evidence of this change was the pre-emptive measures adopted in 1986 to sterilize the anticipated balance of payments effects of the coffee boom of that year. Thus in June 1986 the cash ratio was again re-introduced at a level of 6 per cent (although again the actual cash ratio was considerably in excess of this amount), while the Central Bank marketed new "liquidity absorption" government securities of two and five year maturity. The purpose of these securities, which marked an important step towards developing an active market-based monetary policy, was to avoid the same build-up of excess liquidity in the banking system as had occurred at the time of the coffee boom a decade earlier. The bond issue, however, was not successful, either in absorbing the excess liquidity which did materialize, or in stimulating greater non-bank private sector participation in the market for government securities. The bulk of the new debt was acquired by public-sector institutions, and excess liquidity in the banking sector grew rapidly. Holdings of liquid assets exceeded 30 per cent of eligible deposits in the years 1986 and 1987, but fell back in 1988 and 1989 to their trend level of between 4 per cent to 6 per cent above the statutory requirement.

More recently, financial policy reforms have been more successful, and a number of steps have been taken to accelerate the process of financial liberalization and the development of indirect monetary control. In June 1990 the Central Bank purchased a large tranche of Treasury Bills for the purpose of establishing a trading stock with which to conduct open market operations with the banking system. In November 1990 it fully liberalised the Treasury Bill market, and finally in July 1991 it liberalised the domestic market by abolishing all remaining central controls on price setting in the domestic deposit and credit markets. Unfortunately because of lags in the production of official statistics it is not possible to assess the effect of these latter developments in this thesis directly, although in Chapter 5 we provide a partial analysis of the likely effects of the liberalization process.

2

THE DEMAND FOR MONEY IN KENYA

Introduction

The principal objective of this chapter is to specify and estimate models of the demand for money for Kenya for the period from 1973 to mid-1989.[5] The chapter is divided into a number of sub-sections as follows. We commence in Section 2.1 by reviewing the literature on the demand for money, with particular emphasis on small open developing economies, and conclude with a survey of three studies specifically examining the demand for money in Kenya. Section 2.2 describes the data series to be used for modelling the demand for money. Two particularly important data issues emerge from this section. The first is that as with many developing economies, Kenya does not produce quarterly national accounts or income data and it is therefore necessary to interpolate this series over the missing quarterly observations. Section 2.3 reviews various approaches to data interpolation, and reports the results of the interpolation carried out for measures of income in Kenya. In addition this section examines the implicit seasonality imposed by the interpolation method. The second data issue concerns the definition of monetary aggregates. In general, research in this field, in both developed and developing economies, has concentrated on the simple-sum aggregates such as M0 and M1. However there is a strand of research (stemming from Barnett (1980)) which argues for the construction of alternative monetary aggregates -deriving from Diewert's (1976) superlative class of index and referred to as Divisia monetary aggregates. The Divisia index, by construction, reflects the imperfect substitutability between the components of money aggregates (for example, cash, demand deposits and savings deposits) and consequently is a more

[5] Reliable monetary data does not exist prior to 1973 in Kenya.

accurate measure of agents' aggregate demand for money, especially for broad-based aggregates which embrace a number of individual monetary assets. In Section 2.4 we construct Divisia indices for Kenya.

Having established the data series to be used we then proceed to examine the time-series characteristics of the data (Section 2.5) and consider the nature of the long-run cointegrating relationships between the variables of the model (Section 2.6). Section 2.7 reports and analyses dynamic error-correction models for each of the aggregates, and offers an interpretation of the results. Section 2.8 seeks to address an important issue concerning the exogeneity of the explanatory variables in these models of the demand for money, and Section 2.9 concludes.

2.1 The Theory of the Demand for Money: Overview and Implications for Small Open Economies with Capital Constraints and Parallel Markets

The demand for money is one of the pre-eminent aspects of demand analysis, and has undergone considerable empirical testing, principally in developed economies, but also amongst developing economies. The research programme combines two main components, the first being the macroeconomic analysis of the determinants of aggregate holdings of money, and the second, the microeconomic foundations of the demand function. Theoretical microeconomic research developed in the 1950s and 1960s within a Keynesian framework stressing the constituent motives for holding money. For example: Baumol (1952) Tobin (1956) on the determinants of the transactions demand for money; Tobin (1958) on liquidity preference and portfolio selection; and, more recently, extensions of the transactions model by Miller and Orr (1966), Akerlof and Milbourne (1980) and Sprenkle and Miller (1980) to introduce uncertainty and precautionary motives for holding money. Parallel to this research programme was the macroeconomic analysis of the demand for money popularised by Friedman (1956) but stemming from Fisher's quantity theory of money. Goodhart (1975) and (1984), Laidler (1985) and Judd and Scadding (1982) provide detailed reviews of the extensive developed economy research into the demand for money.

In general the empirical work in this area up to the mid-1970s seemed to support Friedman's hypothesis that the demand for real money balances was a stable function of income and the interest rate, and, by extension, that this stability could be exploited through money stock management as a policy-instrument in pursuit of inflation control (see Laidler and Parkin (1971), Goodhart (1975) and Goldfeld (1973)). The general conclusion was that, at the aggregate level, the familiar generic multiplicative long-run model could be estimated which nests the microeconomic theories of money demand of the form:

(2.1) $M^d = kPy(1+\pi)^{\alpha}(1+r)^{\beta}$.

P is the price level, y the level of real income, π the rate of inflation, r the (net) interest rate on other financial assets, and k a constant. Generally, long-run price homogeneity is assumed, such that real money balances are expected to be increasing in real income (the transactions demand), and decreasing in inflation and the interest rate (the precautionary and asset-market motives). This specification is discussed in more detail below. Following the oil-shock of 1973, however, many hitherto empirically robust economic relationships broke down, with existing models persistently over-predicting actual real money holdings (see Goldfeld (1976)). The failure of demand for money functions to adequately capture these movements in real money balances, in particular the dramatic rise in the velocity of circulation in the mid 1970s (referred to as the period of "missing money") elicited two main responses. The first concerned the search for a more comprehensive specification of the impact of asset market structures on the demand for money, while the second concerned the issue of dynamic specification in econometric models of money demand.

Financial Innovation and a New Vector of Explanatory Variables

Initial responses to the failure of the aggregate demand for money functions focused on possible omitted-variable biases arising as a result of innovations and institutional change in financial systems. Attention was paid to the specification of domestic interest-rate effects and the consideration of the impact of currency substitution effects (see *inter alia* Judd and Scadding (1982) and Baba *et al.* (1985) for the US, Goodhart (1986), Rose (1986), Podolski (1986) Hendry (1985) and Adam (1991) for the UK, and Arango and Nadiri (1981) and Blejer (1978) on the open economy aspects of the demand for money).[6] The effect of this response clearly indicated that this form of model re-specification proved to be a necessary but not sufficient condition to resurrect the stability of the aggregate demand for money. As a consequence greater attention has be paid to the issue of dynamic specification.

Costs of Adjustment and Dynamic Specification

The debate on appropriate dynamic specification in time-series models draws heavily on the view that though equation (2.1) characterises the long-run or static implications of the theory of the demand for money it does not provide any insight into the behaviour of agents out of equilibrium. The appropriate specification of the relationship between the long-run theory and short-run dynamics has dominated much of the time series econometric research in the 1980s and represents the principal response to the collapse of many of the aggregate macro-economic relationships in the 1970s (*inter alia* Davidson *et al.* (1978), Hendry (1980, 1983, 1985), Hendry and Richard (1983)). The econometrics of dynamic specification, and in particular the issue of cointegration and error-correction, have led to important revisions to the modelling of macroeconomic relationships in recent years, including the demand for money.

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[6] Baba *et al.* (1985) examine the impact of the introduction of interest-bearing current accounts; Goodhart (1986), Rose (1986) and Podolski (1986) consider variously the erosion of the distinction between commercial banks and building societies in the UK, the removal of Bank of England quantitative controls on the banking sector, and the introduction of electronic technologies in the banking industry; Johnson (1984) and Adam (1991) examines the implications of the abolition of exchange controls and the operation of the Euro-currency markets.

(See, for example, Granger (1986), Engle and Granger (1987), Hendry (1986), Banerjee *et al.* (1986) and (1992), Johansen and Juselius (1990).)

Within the debate on the demand for money before the mid 1980s, the issue of out-of-equilibrium behaviour, and thus dynamic specification, was broadly represented by the partial adjustment mechanism (see Chow (1966)) which in terms of a simple bivariate model can be represented as

$$(2.2)\quad m_t = \alpha_0 + \alpha_1 z_t + \alpha_2 m_{t-1} + \epsilon_t,$$

where m is the real money stock, z a vector of explanatory variables, and all variables are in natural logs. While this model of adjustment may indeed be a true characterization of the actual adjustment process, evidence has shown that such partial-adjustment models face a host of problems when the series m and z are non-stationary (as is likely in many macroeconomic time-series models). First, the likely presence of spurious regression results is high in view of the trending nature in the levels of the variables (see Granger and Newbold (1974)); second they experience high levels of multicollinearity amongst the regressors z_t and m_{t-1}; third they tend to exhibit high levels of first-order autocorrelation (a symptom of the presence of spurious-regression); and finally, as α_2 tends towards unity (which occurs as the series becomes progressively non-stationary), the implicit rate of adjustment towards the equilibrium becomes inordinately slow.[7] As a result of these features, the partial adjustment specification is generally dominated by the non-stationary time-series characteristics of m_t, so that it may fail adequately to capture the structural relationship between m and z.

Research on cointegration in time-series data has suggested the relatively widespread presence of cointegrated combinations between macroeconomic variables,[8] and in view of the Engle-Granger Representation theorem (1987),[9]

[7] The mean lag is $\alpha_2/(1-\alpha_2)$, so that as α_2 tends to unity $\alpha_2/(1-\alpha_2)$ tends to infinity.

[8] A series is said to be integrated of order d if it becomes stationary after differencing d times, but not d-1 times. Such a series is denoted as $x_t \sim I(d)$. Using this terminology, a stationary series is an I(0) series, and a non-stationary series with a single unit root is I(1). Many (logarithmic) macroeconomic variables are I(1) (Engle and Granger (1987)), but some non-stationary series are of order 2 or even higher, in which case the first difference or growth rate of the series may be I(1). In

empirical analysis of the demand for money in the 1980s has consequently converged on a generic error-correction model of dynamic specification of the general (logarithmic) form

$$(2.3)\quad A(L)\Delta m_t = B(L)\Delta z_t - \gamma(m-kz)_{t-1} + \epsilon_t$$

where A(L) and B(L) are lag polynomials and z is again a vector of explanatory variables. The second term on the right-hand side of (2.3) is the error correction term which is the stationary linear (cointegrating) combination of the non-stationary levels of the variables m and z, where k is a scalar.[10] The earliest

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general, linear combinations of I(1) series are themselves non-stationary, but an exception is in the case of cointegration. Formally, if $y_t \sim I(d)$ and $x_t \sim I(b)$ and the linear combination of the two, namely, $z_t = y_t - kx_t \sim I(d-b)$ then x_t and y_t are cointegrated of order (d-b). The statistical properties of cointegrating combinations allow long-run information (ie on the relationship between the levels of the variables) to be combined with short-run information on their dynamic behaviour within a stationary error-correction framework.

[9] Engle and Granger establish the isomorphism between the presence of a cointegrating relationship between variables and the error correction dynamic specification. Thus if data are cointegrated then the error correction specification will be the dominant dynamic parameterization of the model.

[10] The standard theoretical approach relating the long run equilibrium conditions to short-run dynamics assumes that agents seek to minimize the costs of adjustment from their actual to their desired positions. Nickell (1985) and Domowitz and Hakkio (1985) consider the simplest case where agents minimize the multi-period quadratic loss function of the form:

$$L = \Sigma\alpha^s[\beta_1(M_{t+s} - M^*_{t+s})^2 + (M_{t+s} - M_{t+s-1})^2 - 2\beta_2(M_{t+s} - M_{t+s-1})(M^*_{t+s} - M^*_{t+s-1})].$$

M is the actual value of the control variable, M^* its target value, α the rate of discount, and $\beta_1, \beta_2, > 0$. In the case of the demand for money M^* can be thought of as a vector of explanatory variables $M^* = g(P,Y,R)$, where P is prices, Y income and R some measure of the rate of interest. Minimizing this loss function with respect to M_{t+s} results in first-order conditions which generate a second order difference equation of the form

$$\alpha M_{t+s+1} - (1+\alpha+\beta_1)M_{t+s} + M_{t+s-1} = \alpha\beta_2 M^*_{t+s+1} - (\alpha\beta_2 + \beta_2 + \beta_1)M^*_{t+s} + \beta_2 M^*_{t+s-1}$$

Bringing the M and M^* terms together this can be re-written as

$$\alpha y_{t+s+1} - (1+\alpha+\beta_1)y_{t+s} + y_{t+s-1} = -\beta_1(1-\beta_2)M^*_{t+s}$$

where $y_{t+s} = M_{t+s} - \beta_2 M^*_{t+s}$.

Factorising and solving, this difference equation solves out to

$$\Delta M_t = \beta_2\Delta M^*_t + (1-\mu)\{\beta_2 M^*_{t-1} + (1-\beta_2)(1-\alpha\mu)\Sigma(\alpha\mu)^s M^*_{t+s} - M_{t-1}\}$$

where μ is the stable root of the difference equation. This equation thus relates changes in the actual value of M to the change in the target value M^* and to the error in the previous period (ie the deviation of M_{t-1} from the growth trajectory for M^*). This is then the direct analogue to the error-correction studies focused on bivariate relationships, and found that only real money balances and income or financial wealth were cointegrated (Hendry (1985)), but more recent work examining cointegration relationships spanning a broader number of variables including inflation and interest rates (Johansen and Juselius (1989) for Finland and Denmark M1; Hendry and Mizon (1991) for UK M1, Adam (1991) for UK M3).

The re-examination of the dynamic specification of the money demand function in conjunction with revisions of asset market effects to account for the impact of financial innovation has resulted in the estimation of statistically robust and theoretically consistent models of the demand for money, in developed economies.

Finally, it may be noted that the issue of dynamic specification also featured strongly in the development of buffer-stock or "disequilibrium" theories of money demand. Most closely associated with Artis and Lewis (1976), Laidler (1980) and (1985), Carr and Darby (1981), buffer-stock models provide a link between the rational expectations research programme and empirical models of the demand for money. Money, in particular narrow money, is used as a buffer against unanticipated shocks and since there are costs involved in the adjustment of actual balances to their long-run optimal level, the effects from monetary shocks will be transmitted via real-balance effects. Extensions of buffer-stock models, for example Cuthbertson (1988), have attempted to illustrate the superiority of an expectations-augmented, forward-looking, buffer-stock model of money demand over the error-correction and partial-adjustment models which are feedback models, Hendry (1988) however illustrates how the feedback model in fact encompasses the former. We return to this latter issue in Section 2.7 below.

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specification (2.3) where $(1-\mu)$ is equivalent to the feedback coefficient γ. It may be noted that if β_2 is set to zero in the loss function, then the solution reverts to a forward-looking partial adjustment model.

The Demand for Money in Africa

Empirical analysis of the demand for money in developing economies has been dominated by research on Latin America and Asia (see Adelkunle (1968), and Coates and Khatkhate (1980)), and work on Sub-Saharan Africa is relatively limited. Exceptions are a number of papers for Kenya (see below) and an important study of the Sudan by Domowitz and Elbadawi (1987). A number of specific issues arise in the transition to empirical analysis of the demand for money in Africa. First, money held with the commercial banking system exists as the principal financial asset in most Sub-Saharan economies. Alternative financial assets are scarce while equity and bond markets are thin. The bulk of government paper is generally held by public-sector institutions and there is rarely any secondary bond market. Opportunities for substitution between money and other financial assets are therefore more limited than in developed economies. However there remain important substitution effects between money and real assets which in addition to their own intrinsic income flows may substitute for money holdings for speculative and precautionary motives. In most empirical work the return on real assets is proxied by the rate of domestic inflation.[11] Second, borrowing and deposit interest rates have traditionally been administered by the monetary authorities and, for much of the period since the 1960s, domestic interest rates have been maintained at low or negative levels in real terms. Third, however, in many cases there are thriving parallel markets in foreign exchange and agents' demand functions for money may involve currency substitution considerations (see, for example, Blejer (1978) and Calvo and Rodriguez (1978)). Failure to incorporate these effects may induce an omitted variable bias and overstate the substitution from money into domestic real assets. The specific nature of such currency substitution in the demand for money will, of course, depend *inter alia* on the nature of the macroeconomic control regime. In a number of economies the parallel market thrives and foreign currency holdings constitute

[11] This assumes that money is non-interest bearing: in the situation where the components of money earn interest it is necessary to define the rate of return on real assets in terms of the differential between the rate of inflation and the (weighted) nominal rate of interest on money.

a significant proportion of private sector wealth (for example the Sudan and Uganda), while in others, notably Kenya, the parallel market in foreign exchange is illegal and more limited in scale.

Domowitz and Elbadawi's (1987) dynamic error-correction model for the Sudan from 1956 to 1982 is perhaps the most robust of the studies on Africa. Estimated on annual data, real money and real income are taken to be cointegrated and thus define the error correction term, while in the short run a significant role is found for the US dollar exchange rate and the rate of domestic inflation. No role is found for the domestic interest rates which, as the authors note, was altered only twice during the entire 26 year period of the study. Overall the model was found to be stable over the estimation period.

The Demand for Money in Kenya

There are three published studies which estimate demand for money functions for the post-independence Kenyan economy. These are by Darrat (1985), Killick and Mwega (1989) and Mwega (1990) (the latter two report the same model, hereafter referred to as Mwega), and Pathak (1981). Darrat and Mwega estimate the quarterly demand for money[12] for the period 1969 Q1 to 1978 Q4, and 1973 Q3 to 1988 Q4 respectively. Pathak uses only annual data for the period 1968-78.[13]

Using quarterly data both Darrat and Mwega are obliged to interpolate income data from an annual to quarterly series. Mwega constructs the income series (nominal GDP) on the basis of quarterly exports and government expenditure, while Darrat employs a time series interpolation on GNP.[14] As shall be seen below there is a significant variation between the models in terms of the

[12] Darrat estimates models for M1 and M2, Mwega for M1, M2, and M3.

[13] Consequently, the reported regressions show only 5 degrees of freedom which invalidates any serious inference.

[14] Only in the case of Mwega was sufficient detail provided to allow the interpolated series to be reconstructed, and the model reproduced in the course of this research.

income elasticity of demand, which may in part be caused by the different interpolation techniques.

Mwega imposes a partial adjustment structure for the lagged dependent variable, while Darrat admits no short-term dynamic effect of money itself, although the explanatory variables are all estimated on the basis of a third order Almon lag structure. Pathak's study estimates only a static regression. Measures of income (Pathak and Mwega use GDP, Darrat GNP) and inflation are included in all the models, but the specification of the asset market variables seems somewhat arbitrary. For example, though Mwega and Pathak follow standard practice by including a short-term Treasury bill rate to proxy the yield on financial assets, Darrat argues that

> "because the above argument [about the thinness of Kenyan asset markets] seems applicable to Kenya, the interest variable is dropped from the money demand equation. Yet one must further note that contemporary economies are more or less open to each other. In such economies, international opportunity costs of holding domestic money should also be considered. A foreign interest rate variable is therefore included in the money demand equation." (page 1164)

Despite overlapping sample periods and a relatively congruent set of explanatory variables, the models report widely differing elasticities for the main variables, and a wide range in their statistical significance. The most striking deviations between the models lies with the long run income elasticity of demand for money. Mwega finds that for all three monetary aggregates the impact income elasticity was not significant, and was very low. The long run income elasticity of demand ranged from 0.25 for M1, 0.78 for M2, to 0.56 for M3. These compare with M1 and M2 elasticities of 1.843 and 1.912 respectively from the Darrat model and 1.061 and 1.138 in Pathak. Secondly, whilst Mwega reports a significant role for the domestic asset market, this is discounted *a priori* by Darrat who finds a significant external asset market effect. Pathak's M1 model reports an insignificant interest elasticity, although in his M2 model the interest elasticity in significant, while similar short-run inflation elasticities are reported by Mwega and Darrat, although the long run results differ markedly. Pathak's model does not however admit a role for domestic price inflation. These three models of the demand for money provide a benchmark for this study, although in practical terms the Mwega (1990) model is the dominant specification and it is this work which we shall attempt to encompass in Section 2.7 below.

Drawing on this review of the theoretical literature we define the vector of variables of interest in determining the demand for money in Kenya, **X**, as

$$(2.4) \qquad \mathbf{X} = ((m\text{-}p), (y\text{-}p), r, r^{*}, \pi)$$

where m-p is real money balances[15] variously defined, y is some measure of nominal income, r is the domestic rate of interest, r^{*} a measure of the rate of return on holdings of foreign currency, and π the rate of inflation. All the variables will be defined in the following section. The conditional model can be expressed as

$$(2.5) \qquad D(m\text{-}p_t \mid z_t, \mathbf{X}_{t-1}, \lambda).$$

where $\mathbf{z} = ((y\text{-}p), r, r^{*}, \pi)$ is the vector of current dated explanatory variables, $\mathbf{X}_{t-1}$ the history of the data, and λ the parameter vector. In Section 2.6 we estimate the conditional model for the Kenyan economy over the period from 1973 to 1990. Before doing so we commence by defining the variables in detail and analyzing the time series characteristics of each series to be modelled.

2.2 The Data

A number of important issues arise when considering the appropriate data measures to be used as empirical proxies for the variables of the model. The first concerns the definitions of money. In this chapter we estimate models for the

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[15] The demand for real balances is assumed to be homogeneous of degree 1 in prices. This neutrality restriction has been pre-tested and is accepted by the data for Kenya. However we do not assume that real balances are neutral in terms of inflation.

money aggregates reported by the Central Bank of Kenya, namely: M0 (defined as notes and coin in circulation outside the banking system); M1 (M0 plus demand deposits with commercial banks); and M2 (M1 plus time and savings deposits). In addition we examine the demand for the broader measure of money, M3, which is defined as M2 plus the deposit liabilities of the non-bank financial institutions. In respect of this latter aggregate we examine both its simple-sum and its Divisia representations (see Section 2.4).

The second issue concerns the choice of income series. Traditionally some measure of GDP is employed as a proxy for income in models of the demand for money. However in the case of an open economy such as Kenya the volatility in the terms of trade means that taking GDP as a measure of income will fail accurately to reflect the transactions demand for money. We therefore choose two alternative measures of income, gross national income (GNY), equal to the Gross National Product adjusted for changes in the terms of trade, and total final expenditure (TFE), the latter being commonly found in most developing country models. Both series are reported only annually and an interpolation exercise is required to create suitable quarterly data. Details on the construction of these two series, and the analysis of the implied seasonality, are reported in Section 2.3.

The third issue concerns the price series. The ideal price deflator would be an expenditure deflator in which the weights reflected the components of expenditure for which money is used. This deflator is, however, not available in Kenya. Whereas most models of the demand for money in developed economies use the GDP or GNP deflator, we choose to use the consumer price index (CPI). In an open economy such as Kenya the GDP deflator is not appropriate since it is constructed as a value-added deflator which includes exports (which domestic residents do not purchase), but excludes imports (which they do). The CPI deflator, on the other hand, avoids this particular problem since it includes imports and excludes exports, but being a consumption deflator it excludes expenditure on investment goods. Since, however, the majority of total expenditure is on consumption the CPI provides a reasonable first-order approximation to the true price deflator. Moreover, although the choice of the CPI is determined to an extent by the fact that it is the only consistent quarterly price data series available for Kenya, using a CPI measure can also be justified since, unlike many other African economies where the official CPI weighting is inappropriate because a significant proportion of total transactions are conducted at parallel market prices, evidence for Kenya suggests that the CPI is a reasonable approximation of the true vector of consumer prices facing private sector agents.

Fourth, concerning interest rates we note that there is only a small number of interest-bearing assets held by the private sector. Throughout most of the period under examination domestic interest rates have been controlled by the authorities. However all interest rates have generally been adjusted in a consistent manner over the period such that despite the absence of an active market mechanism through which interest rate changes are transmitted, all the main rates of interest have tended to move together (see figure (2.1)).[16] Consequently using the discount rate for Treasury Bills by the Central Bank of Kenya is a reasonable approximation to the true interest rate.[17]

Finally, in measuring the effect of currency substitution we face a number of difficult empirical issues. The expected return to holding foreign currency is defined as a function of the rate of interest on foreign currency holdings plus the expected depreciation of the home currency. In an open economy with no capital controls and assuming rationality in the foreign exchange market the return on currency substitution would equal expected depreciation of the exchange rate plus, say, the dollar interest rate in the US or on the Eurocurrency markets (see Adam (1991)).

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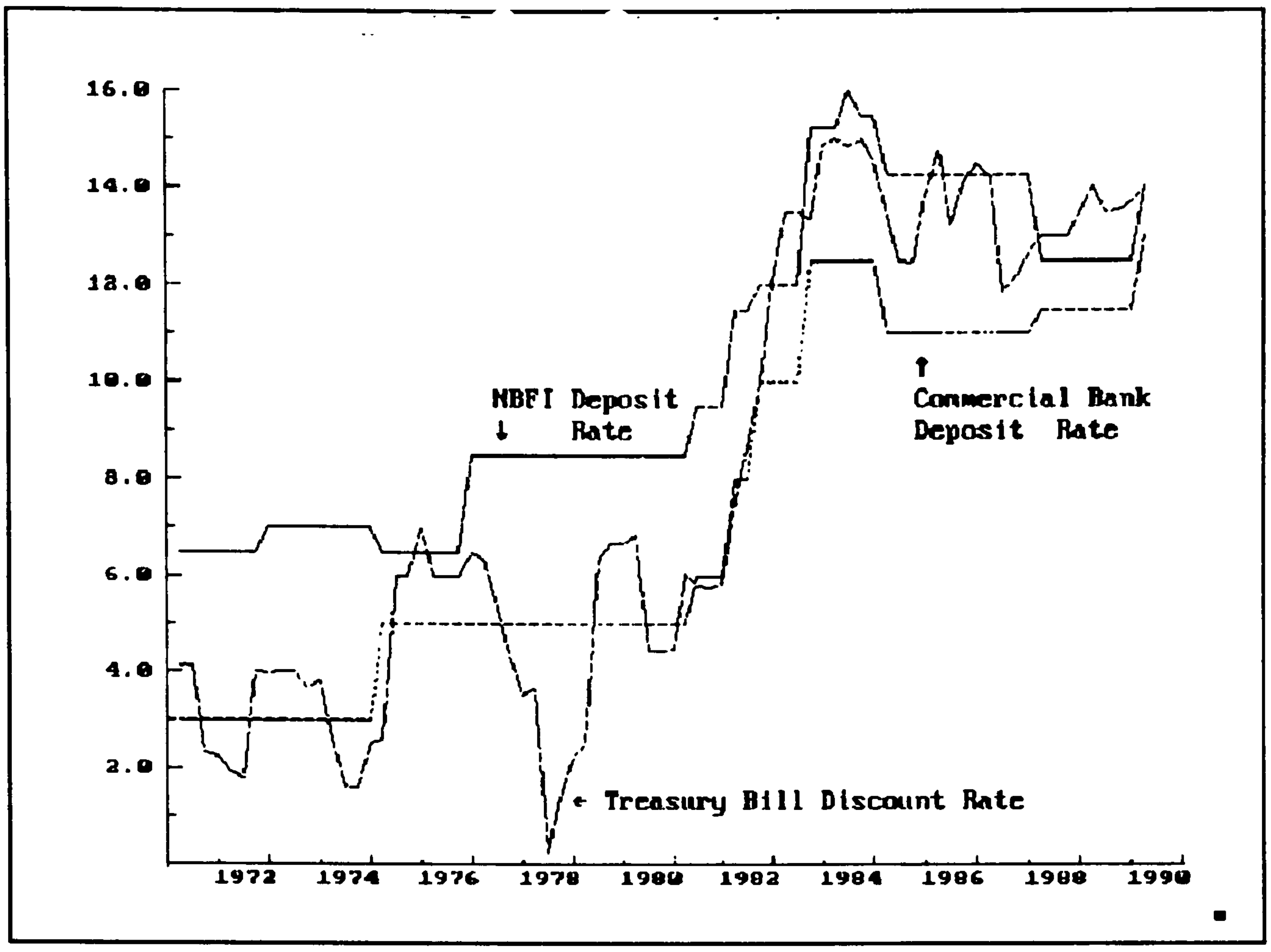
[16] The fall in the Treasury Bill rate in 1977 and 1978 reflects the excess liquidity of the banking sector at the height of the boom. The non-bank private sector was in a net credit position and the banks were unable to increase their lending. The minimum lending rate was abolished at this time, and the authorities lowered the rate on treasury bills in an attempt to adjust the relative return on Bills to that prevailing in the market for loans.

[17] However, throughout the pre-analysis of the data and the models reported in this thesis, alternative interest rate definitions have been used. For reasons of space these are not reported, in general have not improved the performance of the model, nor have they altered any inferences drawn from it.

Figure 2.1
Annual Domestic Interest Rates (%)



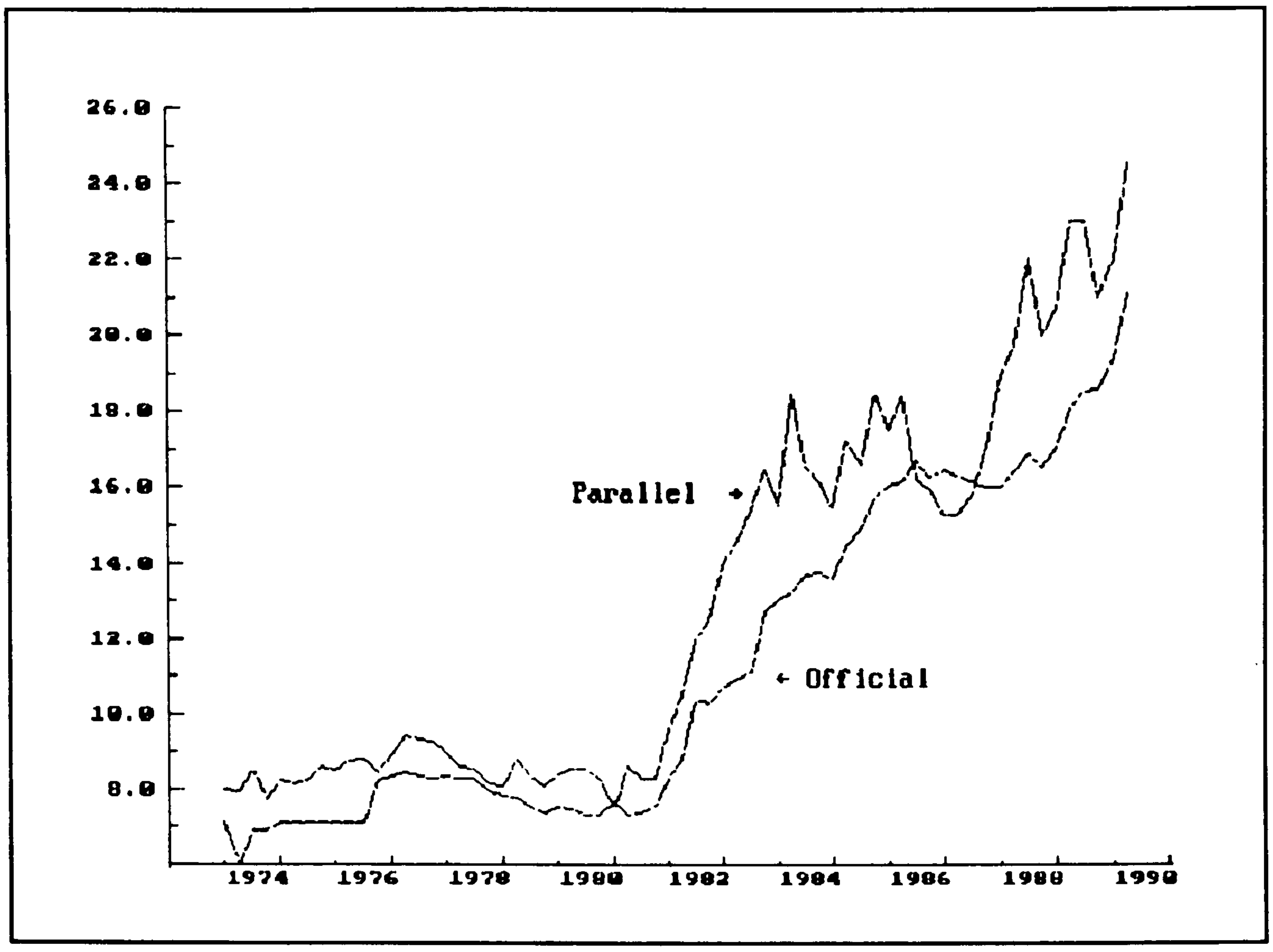
However when considering illegal foreign currency holdings, it is likely that interest rate considerations are less important and that currency substitution is less determined by the interest rate component, but more so by the devaluation effect.[18] Thus in an economy such as Kenya where domestic agents are prohibited from holding foreign currency balances the appropriate rate would be the expected depreciation of the parallel market rate of exchange.[19] In the absence of the observability of this forward looking rate we take the *ex post* actual parallel market exchange rate depreciation to proxy the *ex ante* expected rate (see Figure 2.2).

[18] Pick's International Currency Yearbook (1990) suggest that the black market in Kenya "has been a rather limited and concentrated affair...in recent years air shipments and "courier" transport to London and New York or unsurrendered hard-currency bank notes have blossomed...[while] contraband traffic with Somalia (and Uganda) has also kept the black Shilling active". (p. 104).

[19] This assumes that if the parallel market exchange rate is freely determined, it will fully reflect expected inflation differential between the domestic and world economy. (Blejer (1978)).

Figure 2.2

Official vs Parallel Market Exchange Rates (Ksh/$)



2.3 Interpolation of the Income Variables for Kenya

We turn now to the issue of specifying a quarterly income series for Kenya. We noted earlier that we shall focus exclusively on two alternative measures, Total Final Expenditure and Gross National Income. While there is no universally accepted method for generating data series through methods of interpolation, we employ a variant of Friedman's (1962) interpolation method, although in practice the most common technique employed in most empirical work on Kenya, and elsewhere, follows the method used by Aghevli (1978), which uses a simple linear interpolation of the annual series, subject to adding-up constraints.[20] In either case the interpolation method imposes an arbitrary seasonality to the data and

[20] Mwega (1990) uses a hybrid method which applied the estimated coefficients from an annual regression model to the quarterly values of the explanatory variables, but without imposing any direct adding-up conditions on the estimates.

therefore, having created the interpolated series, we proceed to examine its seasonal properties.

The Friedman (1962) interpolation method is as follows. Let Y^A be the annual series which is to be interpolated to a quarterly frequency, $\mathbf{X}^A$ be the *annual* observations on the vector of j explanatory variables $X_1 \ldots X_j$, and $\mathbf{X}^Q$ the vector of quarterly observations on the same X variables (all data are in logs). The interpolation procedure then augments a linear interpolation between the observations of Y^A by the known error between the actual values of the $\mathbf{X}^Q$ variables and the linear interpolation between the *annual* observations of $\mathbf{X}^A$. The errors in interpolation are then weighted by the regression coefficients of each X_j^A variable in the regression model of Y^A on $\mathbf{X}^A$.

The mean of the linear interpolation for both Y and X_j are defined as $T_y = \frac{1}{4}(Y_{t+4} - Y_t)$ and $T_{xj} = \frac{1}{4}(X_{jt+4} - X_t)$. The corresponding linear interpolation are thus calculated as $Y^*_{t+i} = Y_t + iT_y$ and $X^*_{jt+i} = X_{jt} + iT_{xj}$ where i = 1,2,3, and the * indicates the linear interpolation.

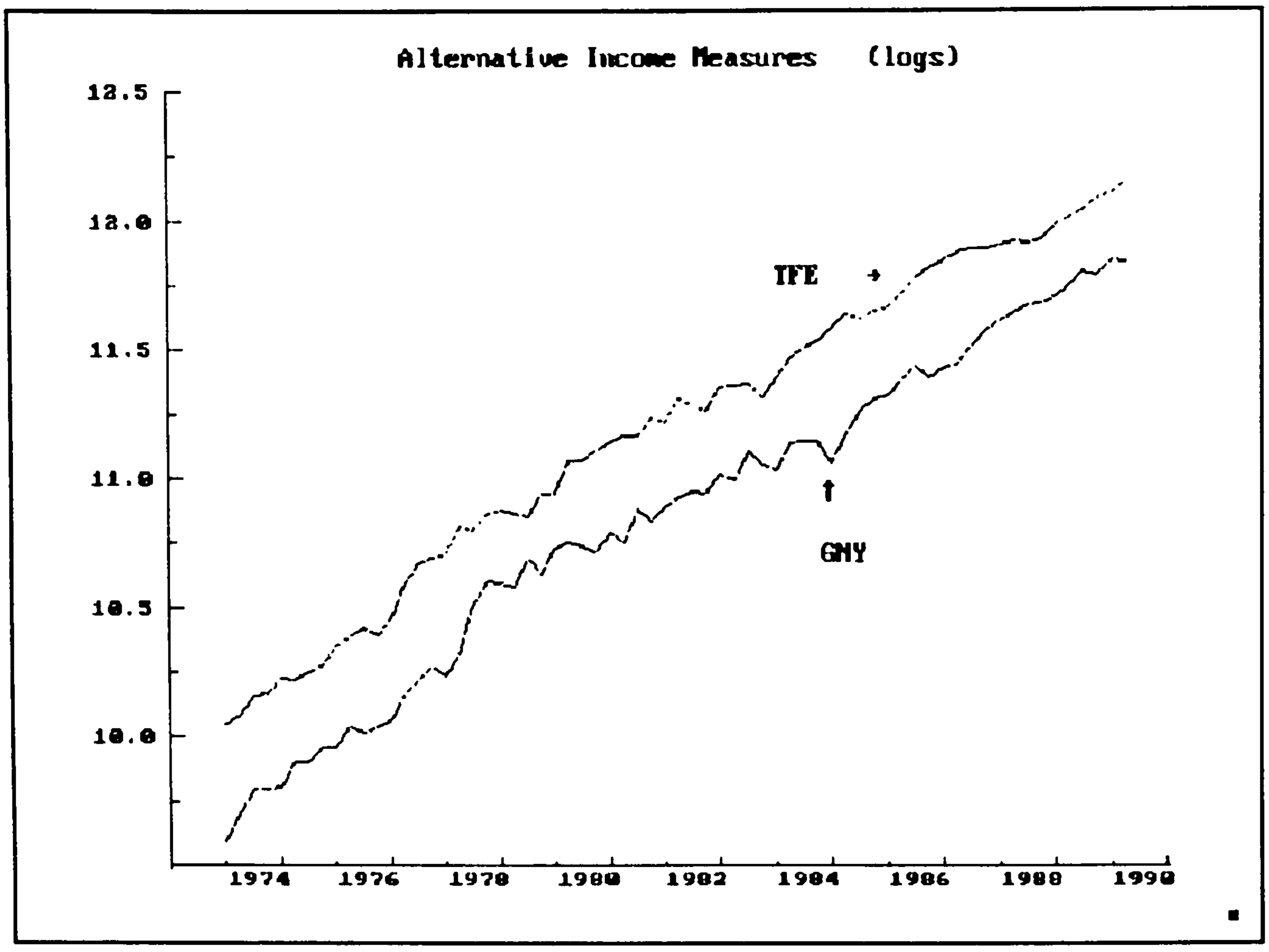
The error in the trend interpolation for the X_j variables, defined as $\delta_j = (X^*_{jt+i} - X^Q_{jt+i})$, where X^Q_{jt+i} is the known quarterly observation on X_j is then used to adjust the simple linear trend interpolation for Y. Hence the final estimate for Y is:

$$Y^Q_{t+i} = Y^*_{t+i} + \Sigma\beta_{Aj}\delta_j$$

where β_{Aj} are derived from the annual regression $Y^A = \mathbf{X}^{A\prime}\beta_A$.

The interpolated series Y are respectively Total Final Expenditure and Gross National Income, and X, the vector of explanatory variables from which the β vector of weights is derived, includes quarterly export and terms of trade data, and data derived from the Central Bureau of Statistics Business Expectations Enquiry. The annual regression models for the two series, and full details of the data series are presented in Appendix 2(A) and the resulting plots of the two quarterly interpolated series are presented in Figures (2.3).

Figure 2.3
Interpolated Nominal Income Series



Interpolation and the Implications for Seasonality in Income Data

The method adopted to create the quarterly income series raises a concern that the process will by design bias downwards the variance of the created series and thereby improve goodness of fit statistics. However two factors mitigate this problem. The first is that the interpolation has been carried out using data series which are not used elsewhere in the model. Second, and more importantly, since by design the interpolated series are consistent with known annual observations for GNY and TFE then the interpolation process serves only to impose a seasonal component on the data, but does not alter the long-run dynamics of the data. Consequently any inference on the long-run relationships between the interpolated series and other data series will be invariant to the exact nature of the interpolation.

These long-run characteristics notwithstanding, a concern remains that the interpolated quarterly observations exhibit an artificial pattern of seasonality which may be inconsistent with their true (but unknown) seasonality. This section attempts to address this problem by constructing and comparing season filters for both interpolated series and the other principal macro-economic aggregates in the Kenyan economy.

The seasonal component of the series is that part which, when extrapolated, repeats itself over any one-year period, but which averages out to zero over that period. Thus, as noted, the seasonal function (ie the seasonal filter) contains no information on the direction, or underlying characteristics of the series in either the short or long run. Most analyses of seasonality in macroeconomic time-series data occurs as a component of a more comprehensive decomposition of an ARIMA process into trend, cyclical, seasonal and white-noise components (Harvey (1990)). Generally it is assumed that the seasonal component is stationary, regardless of the time series characteristics of the underlying data, but recently interest has focused on the analysis of the order of integration of seasonal components. In particular Osborn *et al.* (1988), Osborn (1990) and Hylleberg *et al.* (1990) have tested for the presence of non-stationarity in both the non-seasonal and the seasonal components of macroeconomic time series. They conclude, however, that for most macroeconomic aggregates, although the non-seasonal component is invariably non-stationary, the seasonality is stochastic around the non-seasonal series. In this situation seasonality can be efficiently analyzed in terms of a dummy-variable regression model around the first-difference of the non-stationary series. Kenyan macroeconomic aggregates are in the main non-stationary in nominal terms, and although we do not formally test for the stationarity of the seasonal component, we employ a simple version of the dummy-variable approach, which may be viewed as a fair first-order approximation to the true seasonality component of a series.[21]

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[21] Various further complexities can be introduced into seasonality by allowing for trigonometric seasonal functions, the evolution of seasonality over time, and by introducing Bayesian processes to the seasonal component. Such developments characterise the detailed seasonal filters constructed for large scale policy-model (as in the US Bureau of Census X-11 procedure), but for the purpose of the current exercise these methods are excessively complex and time consuming.

All the aggregates we examine here are non-stationary (see Section 2.5),[22] and we therefore take the first-difference of each series to remove the I(1) or trend component of the series. The seasonal filters are thus constructed around the quarterly growth rate of each series. The seasonal filter is estimated from the model:

(2.6) $\Delta y_t = \alpha_0 + \Sigma\beta_i S_i + \epsilon_t \; (i = 1,2,3).$

The adding-up constraint for fourth quarter seasonal ensures that

(2.7) $\Sigma(\beta_i - \alpha_0) = 0 \;\; (i = 1..4).$

In other words the seasonal dummies sum to zero around the constant. Since all variables are in natural logs the values of the seasonal components can be interpreted as percentages.[23]

Results

Table (2.1) provides a summary of the estimated seasonal filters. The first block reports the estimated coefficients from equation (2.6), their individual significance (in terms of the t statistic) and their joint significance under the null that there is no seasonal component to the series.

Using the reported significance of the F test, we would accept, for example, the null that there is a significant seasonal component at a five percent

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[22] All series are in natural logs.

[23] Once the filter has been estimated for each series we test that it is indeed valid by testing the hypothesis H_0: $(\gamma_1 = \gamma_2 = \gamma_3 = 0)$ in the model

$A(L)\Delta y^*_t = \nu_0 + \Sigma\gamma_i S_i + \epsilon_t \; (i = 1,2,3),$

where A(L) is a lag polynomial in y^*_t and y^*_t is the de-seasonalized series. Clearly if the seasonal filter is accurate then there will be no seasonal component in the de-seasonalized series and $\nu_0 = \gamma_i = 0$ for all i. In the case of all the variables reported above this null could not be rejected.

significance level in the series for gross national income (LGNY) and for total sales reported in the Business Expectations Enquiry (LBEES), but reject the existence of a seasonal component for government expenditure (LEXP) and total inventories (LBEEI). The second block of the table reports the components of the filter in terms of their seasonal percentage deviation from the mean of the series (as per equation (2.7)).

Table 2.1
Analysis of Seasonal Components of Macroeconomic Aggregates

Variable [1]	Seasonal Filter (around constant) Mean	Q1	Q2	Q3	Q4	Joint Sig F (Prob)[2]
Interpolated Series						
LGNY	0.035	-0.008	-0.032	-0.047	0.087	0.0178
t statistic		(0.057)	(0.843)	(2.255)	(2.984)	
LTFE	0.032	0.006	-0.005	0.027	-0.028	0.0515
t statistic		(2.461)	(1.267)	(2.150)	(0.381)	
Macro-Aggregates						
LBEES	0.038	0.050	0.086	0.084	-0.220	0.0015
t statistic		(6.568)	(0.299)	(2.899)	(2.657)	
LBEEI	0.039	0.068	0.083	0.098	-0.249	0.1229
t statistic		(4.574)	(0.564)	(1.453)	(2.280)	
LREV	0.045	0.260	0.022	0.709	-0.990	0.0000
t statistic		(3.028)	(1.230)	(1.885)	(7.065)	
LEXP	0.048	0.027	-0.067	0.013	0.026	0.6943
t statistic		(0.352)	(0.045)	(0.989)	(0.102)	
LCPI	0.031	0.013	0.019	0.025	-0.057	0.2339
t statistic		(5.281)	(1.867)	(0.948)	(0.162)	
LX	0.029	0.037	0.127	0.188	-0.352	0.0372
t statistic		(1.754)	(0.558)	(1.101)	(2.235)	
LM	0.035	-0.032	0.087	0.020	-0.075	0.2548
t statistic		(0.766)	(1.079)	(0.967)	(0.189)	
LTOT	-0.024	0.289	0.208	0.370	-0.868	0.2875
t statistic		(1.116)	(1.290)	(0.717)	(1.870)	
LIPX	0.011	0.173	0.128	0.017	-0.317	0.0000
t statistic		(2.662)	(4.449)	(2.945)	(1.251)	
LGFKFT	0.038	-0.098	0.048	0.014	0.037	0.3974
t statistic		(0.280)	(1.291)	(0.343)	(0.041)	
LGFKFN	-0.024	1.528	1.520	1.159	-4.207	0.0250
t statistic		(2.430)	(2.730)	(2.760)	(1.690)	

Monetary Aggregates

LNCC	0.036	0.246	0.266	0.190	-0.702	0.000
t statistic		(12.206)	(9.071)	(10.644)	(5.054)	
LM1	0.031	0.108	0.129	0.087	-0.325	0.0049
t statistic		(4.935)	(2.388)	(3.598)	(1.258)	
LM2	0.035	0.080	0.096	0.063	-0.238	0.0160
t statistic		(5.592)	(1.859)	(3.065)	(0.616)	
LM3	0.039	0.069	0.087	0.061	-0.217	0.0375
t statistic		(6.223)	(1.269)	(2.829)	(0.589)	

Implicit Seasonal Filters [%]

LGNY* [3]	-0.061	-0.078	-0.129	0.268
LTFE* [3]	0.014	0.063	0.078	-0.155

Notes:

[1] All variables are in logs and have been differenced once and are quarterly (1973 Q1 to 1989 Q2). The mean is thus the average quarterly growth rate. Quarter 1 is January to March; Q2 April to June; Q3 July to September; Q4 October to December. Seasonal Dummies do not sum to 1 because filter estimated with constant: the deviations of the seasonal components from the constant sum to zero

[2] Indicates the probability that the joint significance of the seasonal dummies is zero. Also interpretable as the significance level.

[3] See text for explanation.

The first noticeable feature is that though the variation in seasonality is considerable, it does seem to accord with expectations. For example there is a very clear seasonality in reported government revenues (LREV). This is to be expected since there are clear seasons in the collection of trade-taxes (especially from non-traditional exports) and also from the pattern of income tax assessment and payments. On the other hand, we notice that there is virtually no seasonality in government expenditure (LEXP). The predominance of wages and salaries and debt service costs in total expenditure, both of which exhibit only limited seasonality[24] seems to have offset any seasonality in other items such as fixed capital formation. It may be noted that, again in accordance with priors, private sector fixed capital formation exhibits different seasonality between non-traded capital formation (GFKFN, principally transport, infrastructure and construction) and traded capital formation (GFKFT) where the former has a more marked seasonal pattern. Finally we also note the existence of a significant seasonality in total production as measured by the index of production (LIPX). Since the index only covers the period from 1979 (Q1) to 1985 (Q4) it therefore cannot be afforded the same statistical accuracy as for the other series which run from 1973(Q1) to 1990(Q2). A similar pattern emerges in the trade balance where exports are much more strongly seasonal than imports.

Finally, the analysis of the various monetary aggregates indicates how the seasonality in all the monetary aggregates (M1, M2, and M3) is caused by the extremely high seasonality in the stock of notes and coin in circulation outside the banking system (LNCC). Notably the seasonality is consistent with the pattern observed in government revenue and export earnings. Though no firm conclusions can be drawn from this observation, it is consistent both with a notion of agents adopting a buffer-stock or "target-threshold" approach to determining their money holdings, but that the management of the buffer stock is achieved through changes in holdings of cash rather than demand deposits. We return to this issue later.

This bring us to the issue of whether the seasonality imposed on the interpolated series for LGNY and LTFE is consistent with other patterns of seasonality in the economy. We can assess this in two ways. The first condition is that the variance of the interpolated income/expenditure aggregates should equal the sum of the variances of the components plus their cross-products. Since not all of the component series are known (hence the need for interpolation), we can suggest, as an alternative, that the variance of the seasonality of the constructed series ought to be bounded above and below by the maxima and minima of the variances of the components of that series. We have direct quarterly observations

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[24] Payment of bonuses and retention payments to public sector employees may induce some small monthly seasonality in this item, but domestic debt service is smoothed through overlapping issues of 90 day Treasury Bills, and a smooth schedule of external debt service payments.

on a number of the components of these two series, namely government expenditure, imports and exports, and private sector investment, and proxies for the unobserved consumption component by way of BEE sales. The relative variance of the seasonal filters for the series are shown in Table 2.2.

Table 2.2
Variance of Seasonal Filters

Variable	Variance
LGNY	2.14%
LTFE	1.32%
LBEES	1.70%
LEXP	3.93%
LX	5.88%
LM	4.22%
GFKFT	5.45%
GFKFN	39.55%

In the case of GNY the variance of the seasonal filter is bounded by that of its components, but it does seem that the interpolation procedure may have slightly over-smoothed the TFE series, unless the true seasonality of the unobserved components (specifically consumption) is less than that of their proxies, or unless the true TFE series is strongly negatively correlated with its observed components.

The second procedure adopted to examine the interpolation process attempts to match the pattern of the seasonality of the interpolated series with that of the independent known components of the income series, but which have not been used in the interpolation exercise. These are referred to as the implicit seasonal filters, where the weights used reflect the actual share of each independent series in the total income series.[25] The implicit filters are reported in Table 2.3 along with the filters derived in Table 2.1.

Table 2.3
Implicit versus Actual Seasonality

Series	Q1	Q2	Q3	Q4
GNY* (= line 1 of table 2.1)	-.008	-.032	-.047	.087
GNY (implicit)	-.061	-.078	-.129	.268
TFE* (= line 2 of table 2.1)	.006	-.005	.027	-.028
TFE (implicit)	.014	.036	.078	-.155

Although the absolute magnitudes differ quite considerably, the signs and relative magnitude of the seasonality suggest that the interpolated LGNY series is consistent with the known behaviour of at least some of its components. The same close correspondence does not hold for the LTFE series, where there is some degree of counter-cyclicity. On the basis of this evidence we can accept that the interpolation of the income series, especially for the GNY series, has not resulted in the imposition of any egregious seasonality which is at variance with other macroeconomic aggregates, and we therefore use these series in the quarterly demand for money models presented in the remainder of this chapter.

2.4 Monetary Aggregation and the Divisia Index

Finally we turn to the issue of monetary aggregation. Generally monetary aggregates such as M1, M2 and M3 are constructed as a simple sum of their

[25] The GNY and TFE series were constructed using the total sales data from the Business Expectations Enquiry. The excluded variables used in the construction of the implicit deflators are then investment , government expenditure, exports and imports.

components where the weights associated with each component is unity. A simple-sum aggregate is thus defined as

$$(2.8)\quad M_s = \Sigma w_i m_i \text{ where } w_i = 1 \ \forall \ i,$$

where M_s is the monetary aggregate, m_i the component assets and w_i its share weight. However, for such aggregates to have economically valid micro-foundations then it follows that the aggregate must be able to be interpreted as the quantity of a single good and that agents can make resource allocation decisions conditional on that good regardless of its composition. This requires that the components of the aggregate, m_i, are perfect substitutes, so that the utility of a monetary aggregate is independent of its composition. In reality, however, perfect substitutability does not hold (cash, demand deposits, savings deposits and NBFI deposits, for example, differ in terms of their rate of return, liquidity and risk), and thus the simple sum aggregate is non-neutral with respect to the composition of the aggregate. Work undertaken in the early 1980s has attempted to address this deficiency by constructing monetary aggregates in which the weights, w_i, reflect the relative marginal liquidity of the component assets. Drawing on the statistical index theory of Diewert (1976), Barnett (1980), (1982) and others have suggested the Thornquist-Theil Divisia Index as an appropriate aggregate for discrete time analysis.[26] The Divisia Monetary Index, Q, is defined

$$(2.9)\quad \log Q_t - \log Q_{t-1} = \Sigma s^*_{it} (\log m_{it} - \log m_{it-1})$$

where the share weights $s^*_{it} = ½(s_{it} + s_{it-1})$ and $s_{it} = \varpi_{it} m_{it}/\Sigma \varpi_{kt} m_{kt}$. m_i, $i = 1...k$ are the asset components and ϖ, the user cost of each asset is defined as

$$(2.10)\quad \varpi_{it} = p^*(R_t - r_{it})/(1+R_t),$$

[26] Strictly, the Divisia index is an exact index (ie it is always equal to the underlying implicit aggregator function when the data are generated by microeconomic maximizing behaviour) on in continuous time. There are no known exact indices in discrete time, although Diewert's (1976) superlative indices provide second-order approximations to any weakly separable aggregator function. The Thornquist-Theil Divisia index belongs to this class of indices.

where p^* is the general price level, r_{it} the (tax adjusted) current period yield on the component m_i, and R the "maximum available holding yield in the economy for that period" (Barnett (1982) p 689). The Divisia thus uses the relative interest rate between assets to define their relative liquidity, the intuition being that higher interest rates are required to compensate the holder for lower liquidity (or lower "moneyness") of a component asset. In an economy where relative interest rates are market-determined this method is likely to produce a reasonable approximation to the true aggregator function. Barnett's (1980 *et seq.*) work on US aggregates and to a lesser extent work on Canada (Cockerline and Murray (1981)) and the UK (Mills (1983)), indicate that simple-sum aggregates and the Divisia can deviate significantly, especially in periods of rapid financial innovation. More recently Ford *et al.* (1992) have argued that the Divisia index actually reflects movements in the "true" monetary aggregate in the presence of financial innovation only if the financial technology is neutral across the component assets (that is if technological change alters the relative liquidity of each asset equally). In a less monetized economy where money market interest rates are more clearly administered by fiat, the share-weighting metric of the Divisia may constitute only a poor approximation to the true relative liquidity of the component assets. Moreover, in economies where there are sizeable parallel markets in foreign currency, or where unrecorded trade represents a significant proportion of economic activity, the liquidity, or utility, of cash be higher relative to equivalent non-interest bearing demand deposits than would be indicated by the Divisia index based on official interest rate differentials. Moreover, in the case where demand (or sight) deposits do not attract interest, the Divisia index will indicate a perfect substitutability between cash and demand deposits since both are non-interest bearing. Clements and Nguyen (1980) in a comment on the original Barnett (1980) paper suggest that the elasticity of substitution between cash and demand deposits may be derived from auxiliary estimates of the elasticity of substitution and then replaced in the Divisia Index. In general this is not done and most indices ignore this specific form of substitution.

While Kenya does exhibit a number of these characteristics which may render the Divisia imprecise their gravity is less severe than elsewhere in Sub-

Saharan Africa. For example, as noted, the parallel market is relatively small, and although money market rates were administered until July 1990, a discernible relationship was maintained between different monetary instruments. Thus the Divisia index for Kenya may prove to be of some value, not least in the light of the rapid increase in the activities of the Non-Bank Financial Institutions from 1976 onwards.

Divisia indices have been computed for the three monetary aggregates, M1, M2, and M3, and their time series behaviour relative to the simple-sum aggregates is shown in Figures (2.4) to (2.6). The M1 and M2 aggregates, as expected, deviate very little from their simple-sum equivalents, but there is a significant deviation on the part of the M3 and M3 Divisia aggregates. The reason for this is that though in absolute terms there has been a dramatic rise in the volume of NBFI deposits over the period, their relatively illiquidity *vis a vis* other forms of deposit ensures that this volume increase is offset by their relatively low user-cost share weight in the Divisia index.[27] In view of the above in the subsequent analysis of the demand for money in Kenya we consider the Divisia M3 aggregate (denoted M3d) as well as the simple sum aggregates M0, M1, M2, and M3.

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[27] Non-bank financial institutions are unable to offer checking facilities and withdrawal of deposits is by passbook only, in many cases requiring advance notice. See Mwega and Killick (1990).

Figure 2.4
M1 vs M1 Divisia Money Aggregates

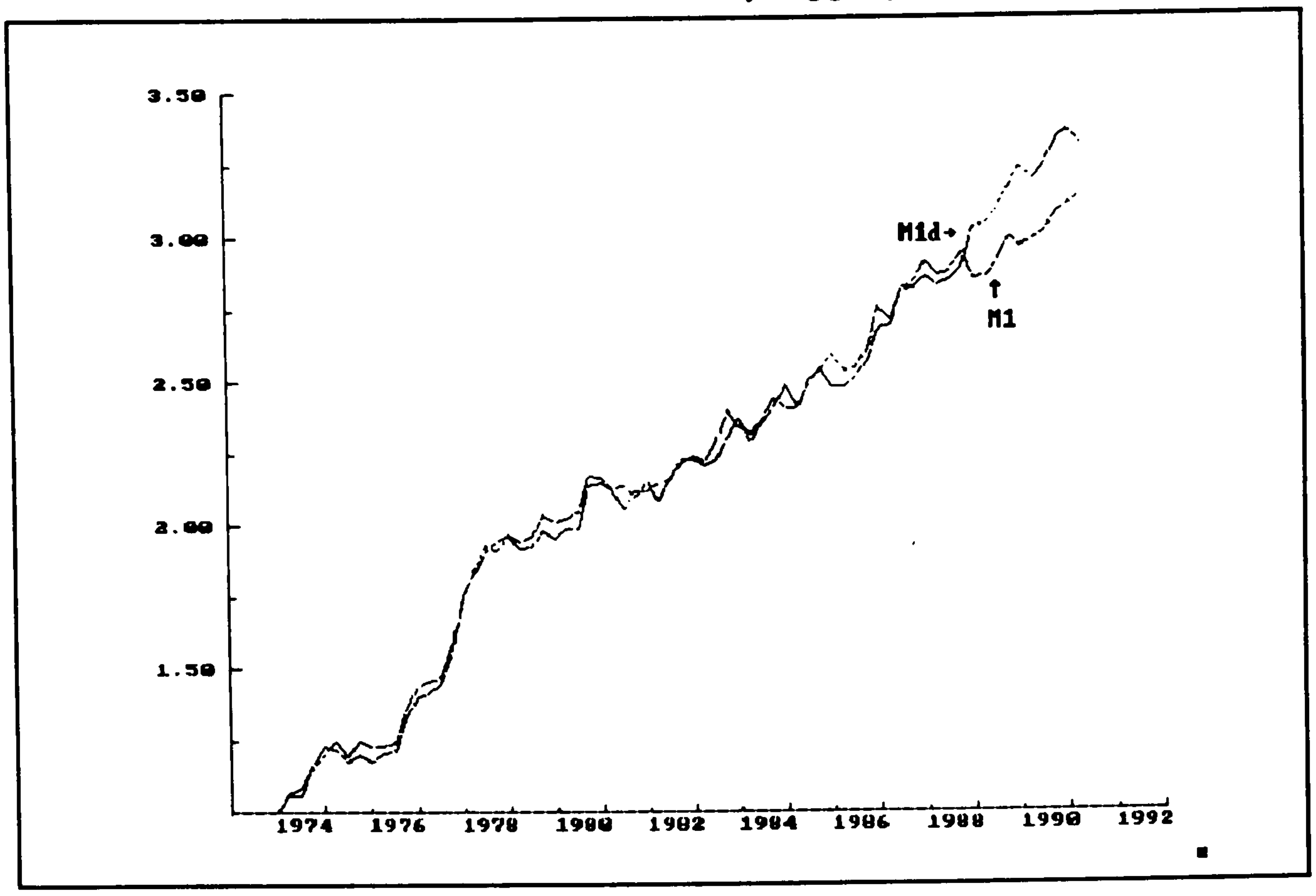


Figure 2.5
M2 vs M2 Divisia Aggregates

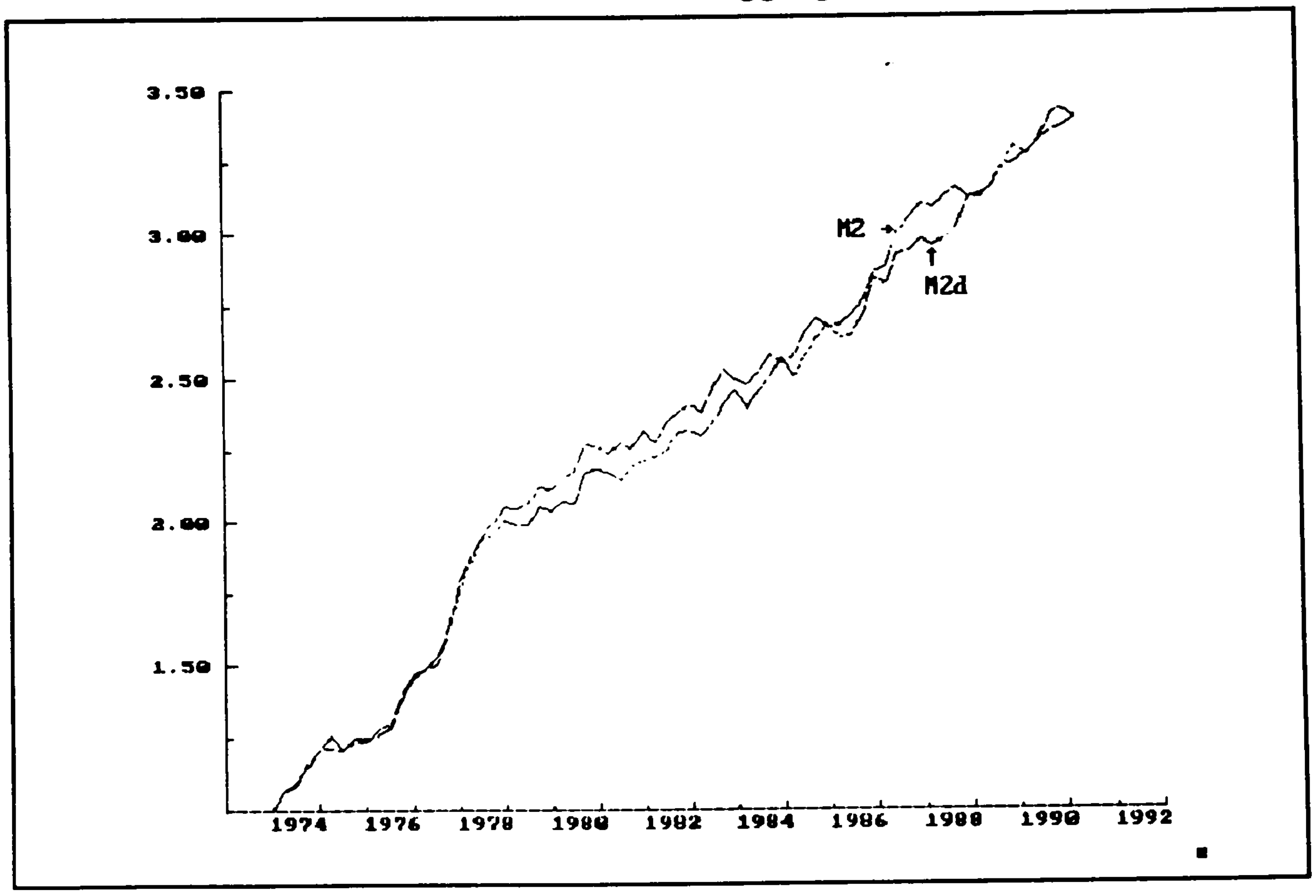
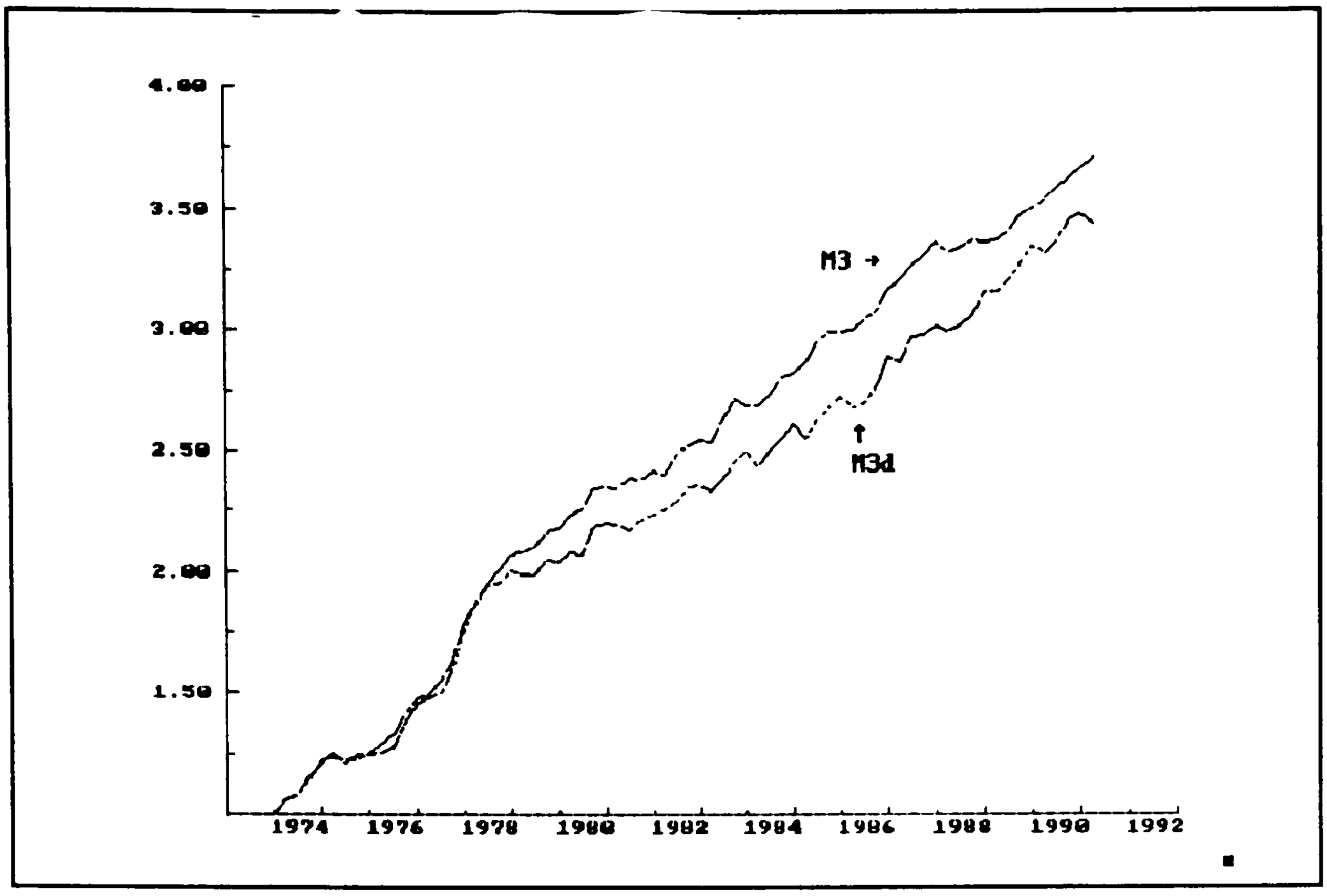


Figure 2.6
M3 vs M2 Divisia Aggregates



2.5 Time Series Characteristics of the Data

In this section we investigate their time-series characteristics of the data so as to ensure consistency in subsequent econometric modelling. We commence with tests for the relevant order of integration of each series and in the next section we examine the nature of the cointegrating relationships between the variables. We use the Dickey-Fuller and Sargan-Bhargava classes of unit root tests to evaluate the time series of each variable. Because of known weaknesses in these tests (see for example Banerjee *et al.* (1992)), we conduct the tests initially for the full sample, but also examine their behaviour at each point in the sample by using a recursive estimator.

The Dickey-Fuller test evaluate the size of the coefficient ρ in the equation

(2.11) $\quad y_t = \alpha_0 + \rho y_{t-1} + u_t \; ; \; u_t \sim (0, \sigma^2); \; y_0 = 0$

against the null H_0: $\rho = 1$, such that y_t is non-stationary. The test is constructed in the form

$$(2.12) \quad \Delta y_t = \beta_0 + \beta_1 y_{t-1} + \epsilon_t$$

where $\beta_1 = (1-\rho)$, such that H_0: $\beta_1 = 0$. The distribution of the test statistic is a non-standard 't'. Fuller (1976) has tabulated the distribution of the statistic, which, however, varies depending on whether the model is estimated with a constant and trend. The tests reported here are against the null that the model (2.11) has a constant, and consequently the 5 per cent critical value (ie for rejection of the null in favour of the alternative that $\rho < 1$) with a sample of 50 is -2.93 (see Banerjee *et al.* (1992)). One of the drawbacks of the Dickey-Fuller test, however, is that it necessarily assumes the DGP is an AR(1) process as above under the null. If it is not then autocorrelation in the error term in (2.12) will bias the test. In order to overcome this problem the Augmented Dickey-Fuller (ADF) test can be used. The ADF is identical to the standard DF test but is embedded within a regression model of the form

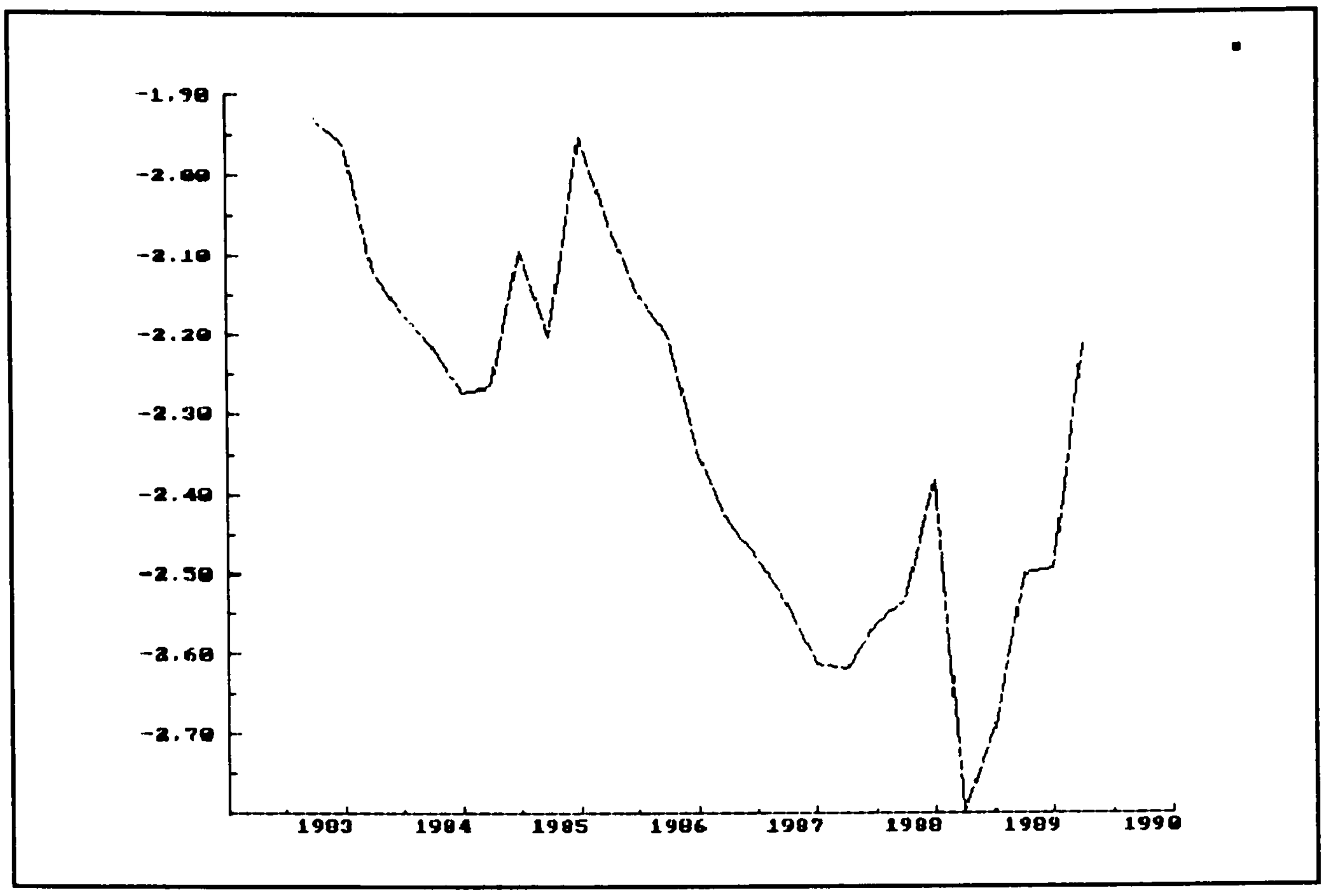
$$(2.13) \qquad \Delta y_t = \beta_0 + \beta_1 y_{t-1} + \Sigma\gamma_j \Delta y_{t-j} + u_t.$$

where the lag length j is set so as to ensure that any autocorrelation in Δy_t is absorbed, and the error term is distributed as white noise.[28] We shall report the full-sample results of these tests only, but Figure 2.7 plots the "t"-values on β_1 for the recursive ADF test, thus allowing us to assess whether the null can be maintained over the sample as a whole.

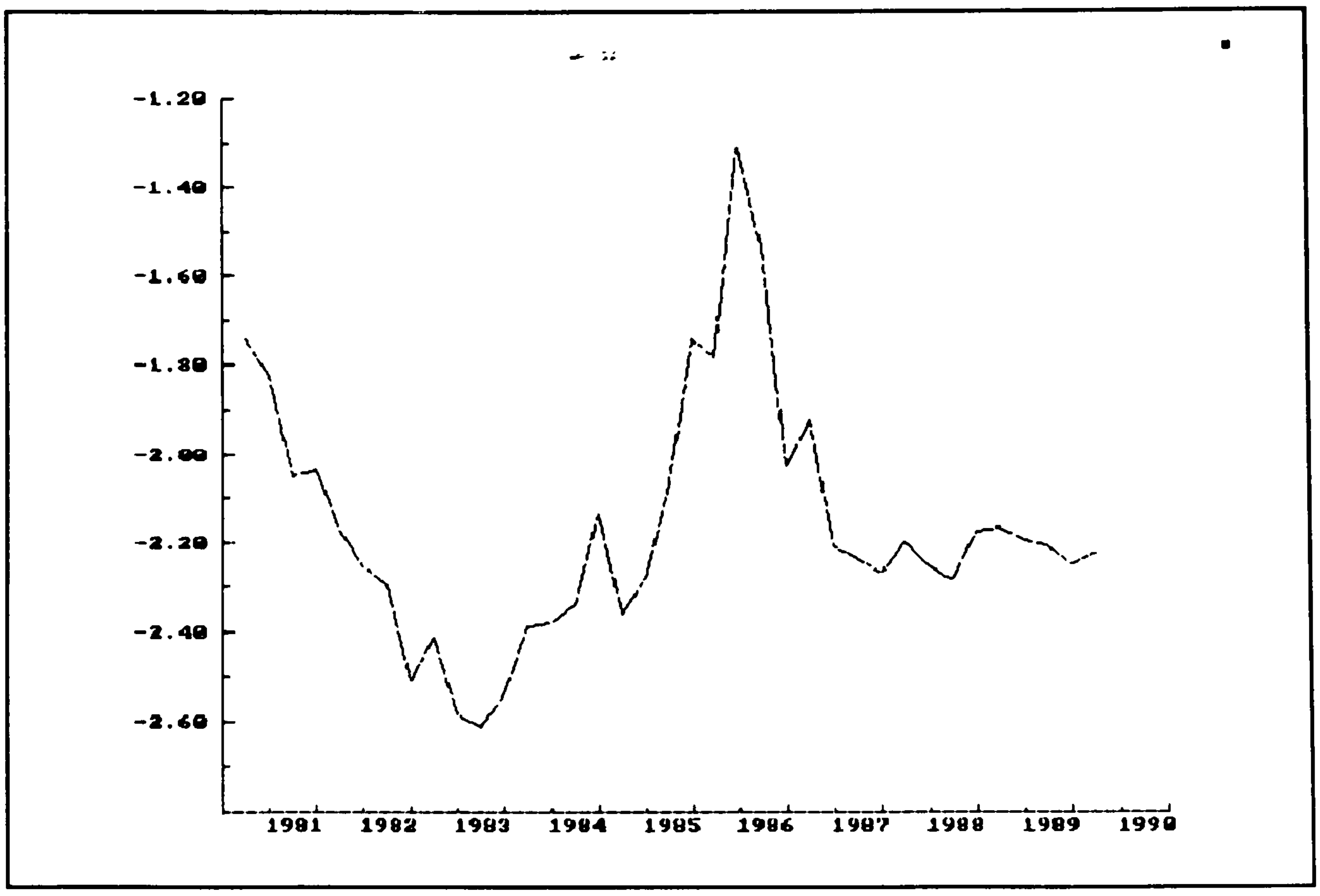
[28] This notion is generalised further in the Said-Dickey test which augments the ADF by allowing for a general ARMA process in (2.13), but in view of the increased computational problems (ie the ARMA is non-linear), this latter class of test is not performed here.

Figure 2.7
Recursive Dickey-Fuller Tests

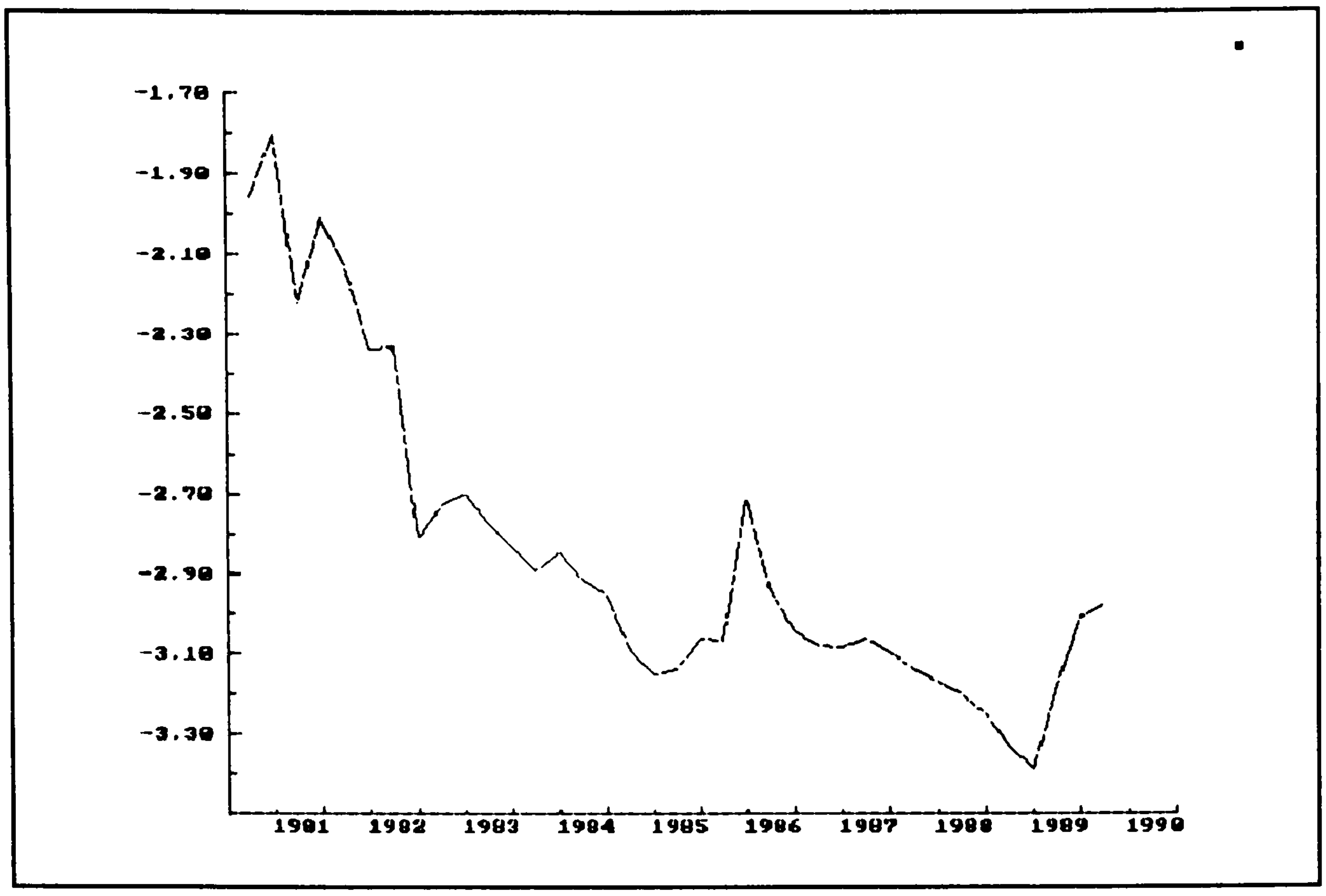
Recursive "t" value in ADF Unit Root Test (m0-p)



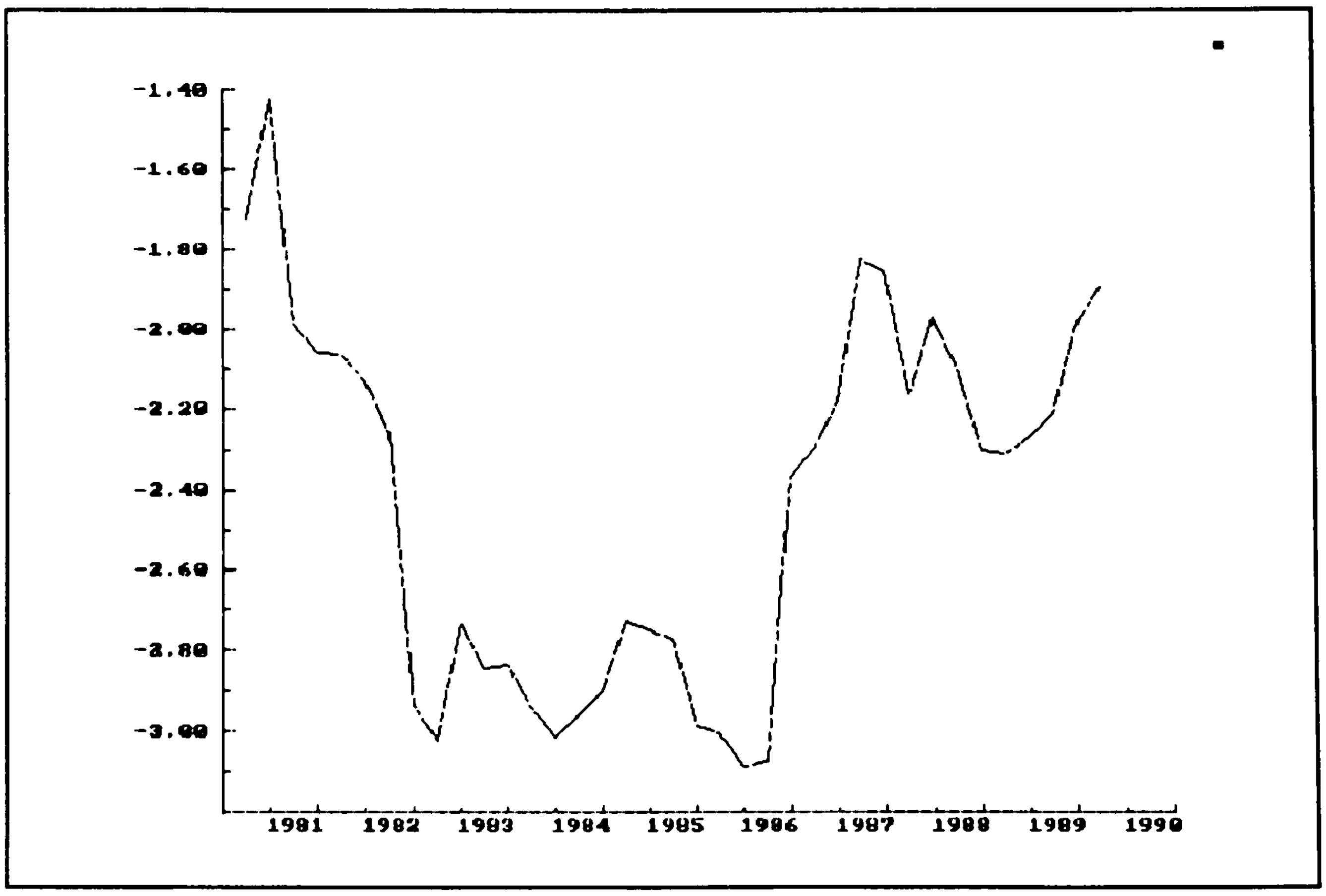
Recursive "t" value in ADF Unit Root Test (m1-p)



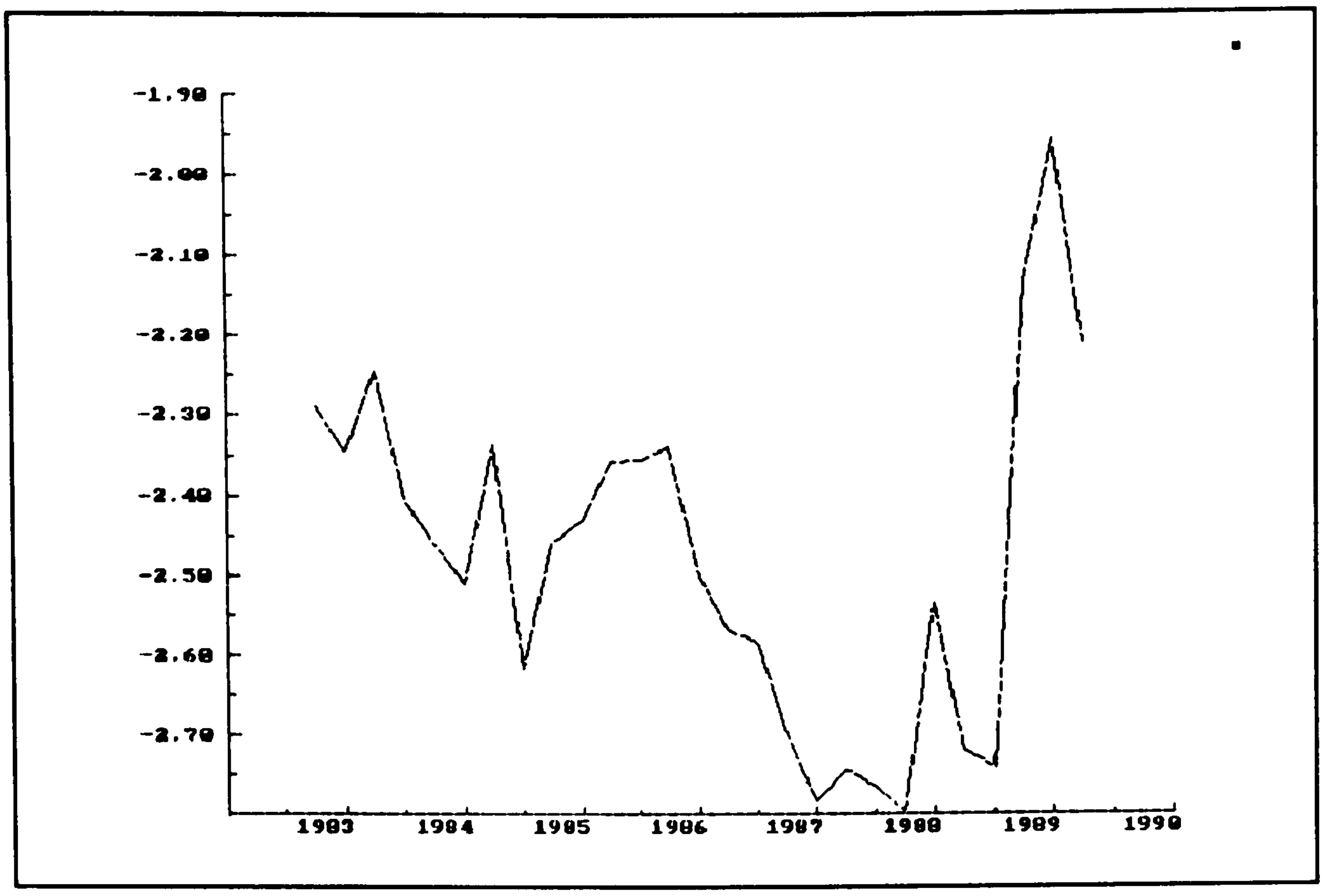
Recursive "t" value in ADF Unit Root Test (m2-p)



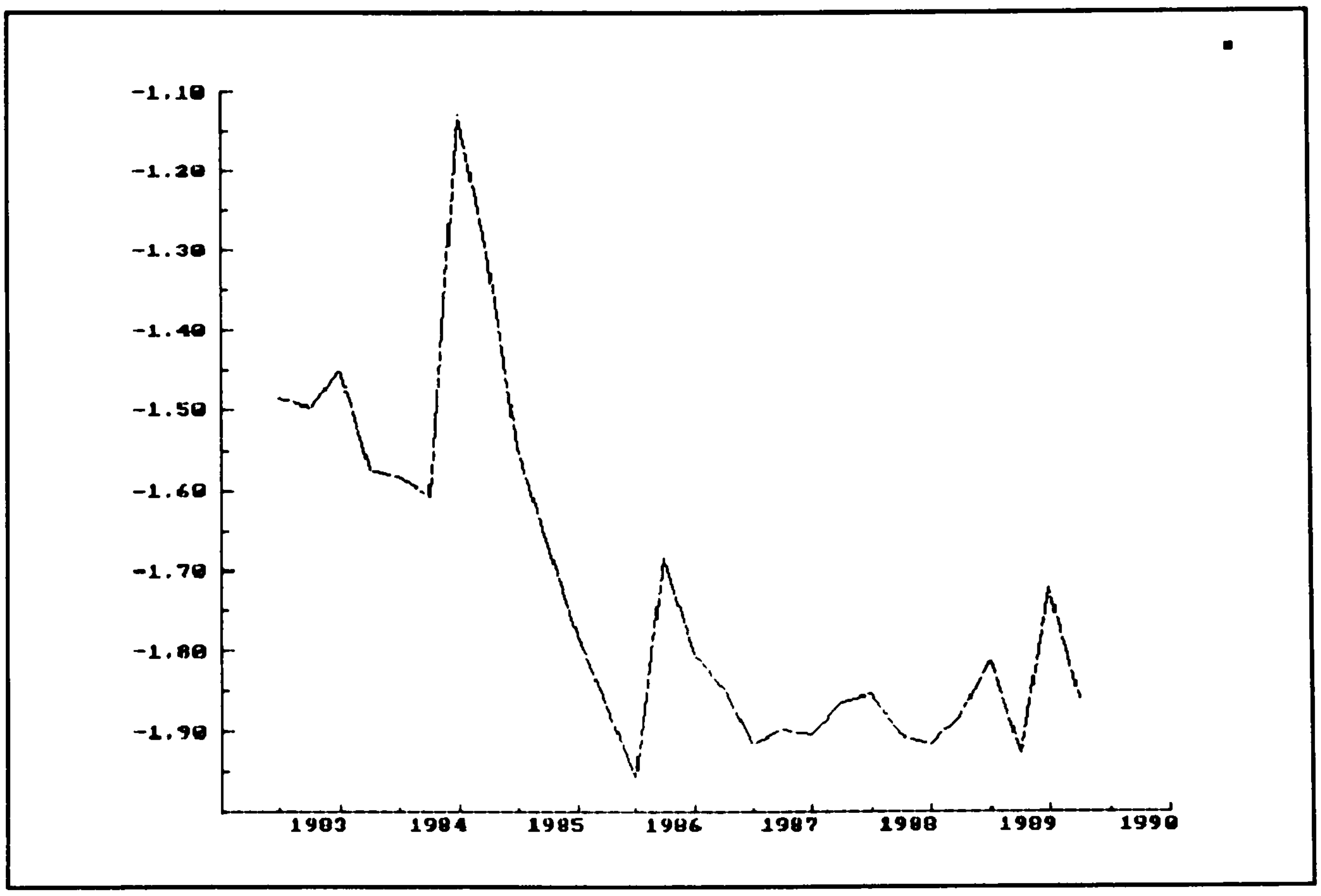
Recursive "t" value in ADF Unit Root Test (m3-p)



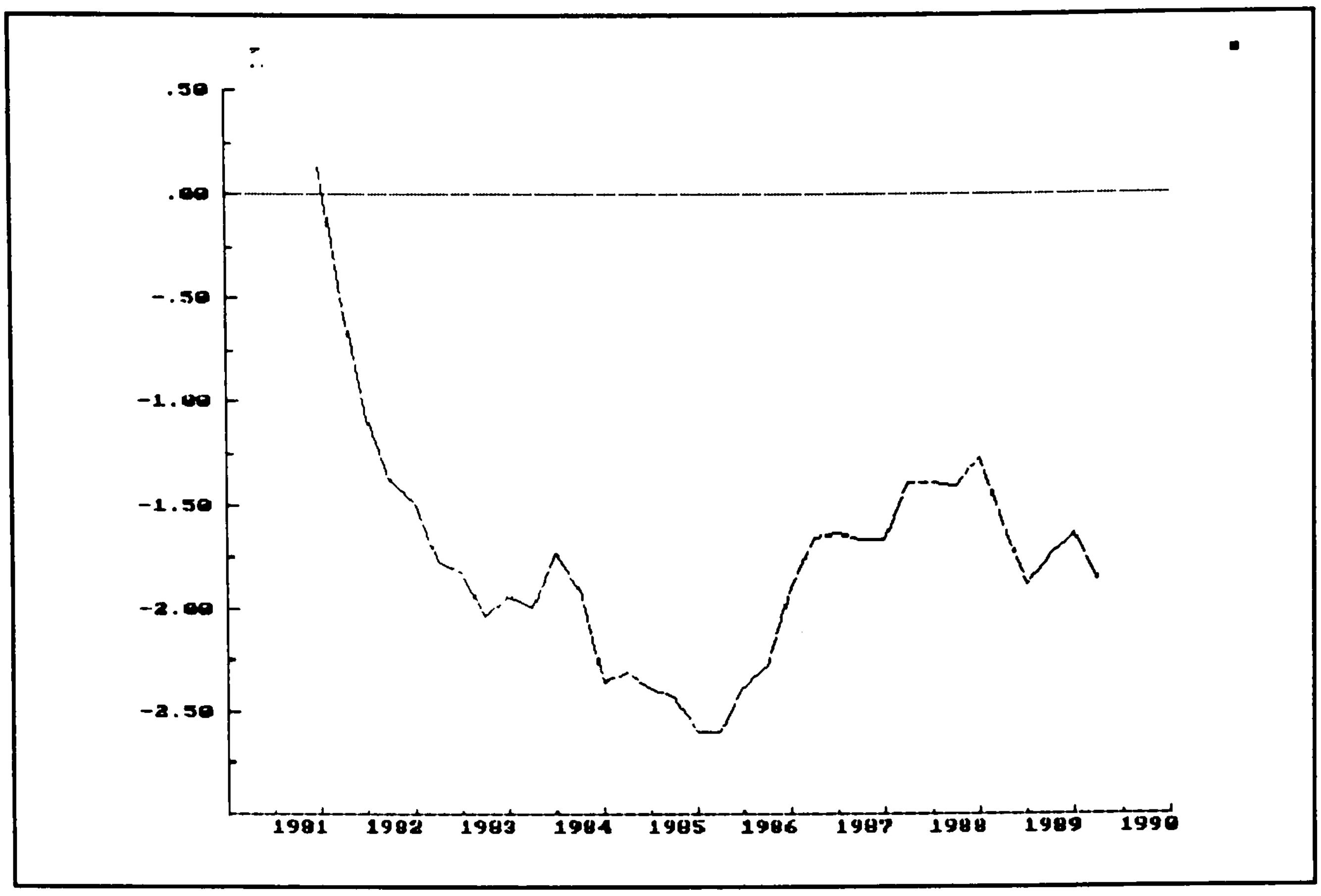
Recursive "t" value in ADF Unit Root Test (m3d-p)



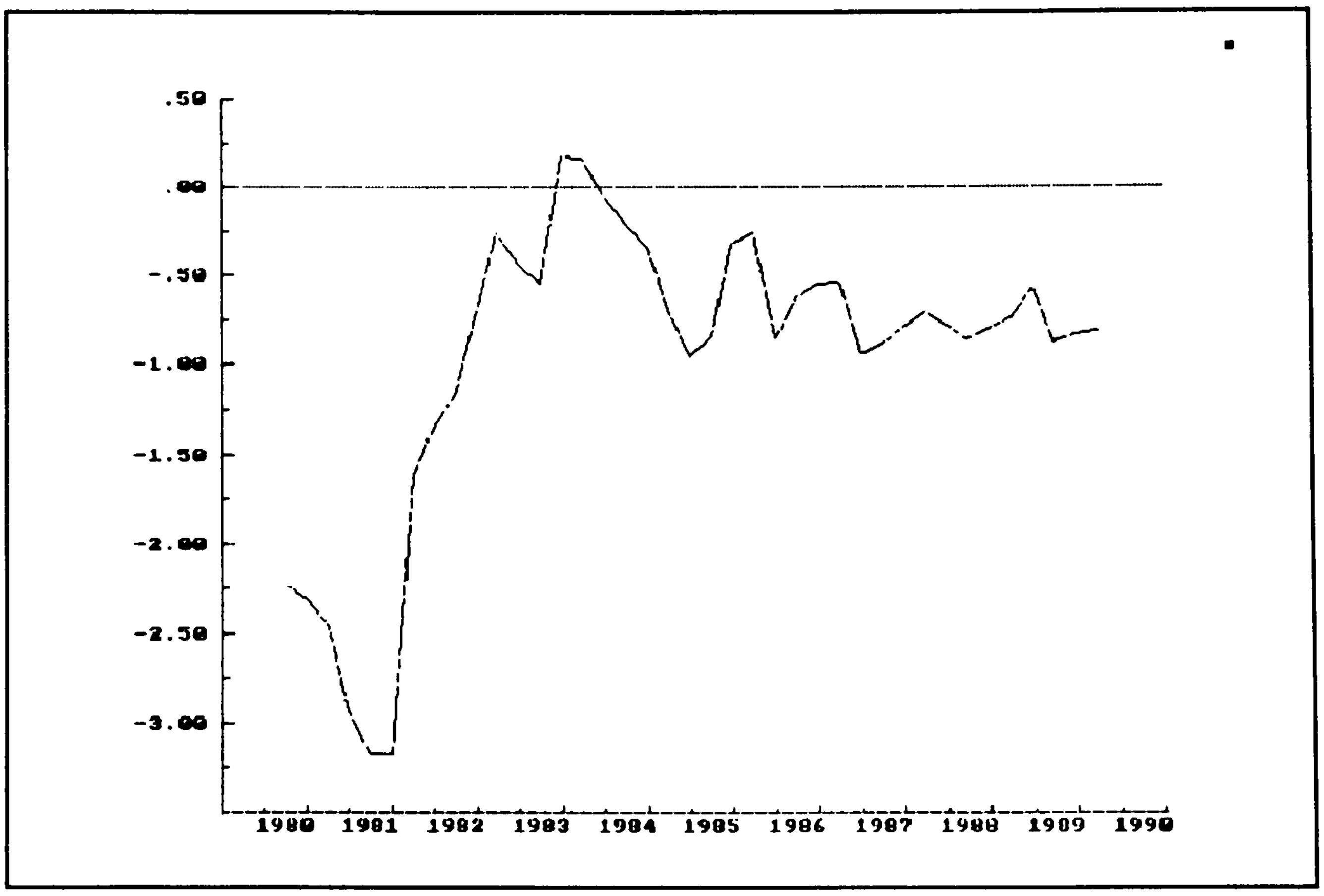
Recursive "t" value in ADF Unit Root Test (gny-p)



Recursive "t" value in ADF Unit Root Test (π)



Recursive "t" value in ADF Unit Root Test (rtb)



A second form of testing for the presence of unit roots is the Sargan - Bhargava Durbin-Watson Test. This test is based on the standard Durbin Watson statistic, but the test is applied not to the residuals of the regression as usual, but on the level of each individual series. The test is defined as

$$(2.16) \qquad DW(y) = \Sigma(y_t - y_{t-1})^2 / \Sigma(y_t - \bar{y})^2.$$

Unlike the Dickey-Fuller tests, the test is against the null that the series is I(0), in which case the value of the DW statistic will tend towards a value of 2. If the statistic is low then this is evidence of an I(1) series.[29] The 5 per cent critical values for the statistic, with a sample of 50 is 0.78, although the critical value is highly sensitive to the sample size, virtually halving with a doubling of the sample. With a sample of around 60 we may expect a critical value of 0.65. Tests for unit roots are reported in Table 2.4.[30,31]

The results reported here are typical of many problems in time-series econometrics, namely that although the SBDW statistics strongly reject stationarity, the DF and ADF test statistics are relatively close to their critical values. The plots in Figure 2.7 re-emphasize this view by showing the extent to which the "t" value moves over the period. With the exception however of a small number of points in the sample space it is not possible to comprehensively reject the null of non-stationarity for any of the series. Thus we can interpret these results as indicating that money, the two measures of income, inflation and all the interest rates are indeed I(1), or non-stationary, and proceed to test for the presence of cointegration between the variables.

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[29] The correspondence with the normal interpretation of the DW statistic is clear. A low value of the traditional DW statistic is taken as evidence of positive first-order autocorrelation. Such high (non-stationary) autocorrelation is exactly what defines a non-stationary series.

[30] Tests for unit roots are frequently biased, and have low power in distinguishing stationary series, ie those where $|\alpha|$ is close to but less than 1 and those series which genuinely have a unit root (Banerjee *et al.* (1986) for a discussion of biases in tests).

[31] All series are in natural logs, with interest rates expressed as LR = Ln(1+RQ) where RQ is the rate of interest per quarter.

Table 2.4
Unit Root Tests on Quarterly Data

Variable	DW	DF	ADF	Longest Lag	Order of Integration
(m0-p)	0.324	-1.98	-1.32	4	1
(m1-p)	0.254	-1.92	-2.42	8	1
(m2-p)	0.139	-1.49	-2.91	8	1
(m3-p)	0.055	-1.28	-2.07	8	1
(m3d-p)	0.182	-1.27	-1.75	8	1
(gny-p)	0.366	-2.19	-1.95	4	1
(tfe-p)	0.336	-2.17	-1.85	-	1
π	0.285	-2.19	-1.89	4	1
rtb	0.061	-0.81	-0.83	-	1
ex	0.014	0.52	-0.11	-	1
exb	0.034	0.03	0.83	-	1

2.6 Cointegration Analysis

At the heart of the analysis of cointegration is the stylised fact that though the bulk of macro-economic time series are non-stationary, there are certain cointegrating combinations of these non-stationary series which are themselves stationary. The identification of these cointegrating combinations of variables allows information concerning the long-run relationship between such non-stationary variables to be embedded in stationary econometric models, through the well-established error-correction model (see Engle and Granger (1987)). However the Engle-Granger approach to cointegration analysis does not readily allow for the analysis of a multiplicity of cointegrating relationships between variables. Recent work by Johansen (1988) and Johansen and Juselius (1990) has developed an alternative method for the analysis of cointegrating vectors, which nests the Engle-Granger approach as a special case. This approach is employed here.

We commence from a standard vector autoregression (VAR) of the form:

$$(2.15) \qquad \mathbf{X}_t = \mathbf{\Pi}_1\mathbf{X}_{t-1} + \ldots + \mathbf{\Pi}_k\mathbf{X}_{t-k} + \mu + \mathbf{\Theta}\mathbf{D}_t + \varepsilon_t$$

where $\mathbf{X}$ is a p x 1 vector of the I(1) variables of interest, μ is a vector of constants, $\mathbf{D}$ is a vector of centred seasonal dummies, and $\varepsilon_1 \ldots \varepsilon_T$ are $\mathbf{IN}(\mathbf{0}, \mathbf{\Lambda})$ error terms. Using the difference operator, Δ, (2.15) can be reparameterized as:

$$(2.16) \quad \Delta\mathbf{X}_t = \mathbf{\Gamma}_1\Delta\mathbf{X}_{t-1} + \ldots + \mathbf{\Gamma}_{k-1}\Delta\mathbf{X}_{t-k-1} + \mathbf{\Pi}\mathbf{X}_{t-k} + \mu + \mathbf{\Theta}\mathbf{D}_t + \varepsilon_t$$

where $\mathbf{\Gamma}_i = -(\mathbf{I} - \mathbf{\Pi}_1 - \ldots - \mathbf{\Pi}_i)$ (i= 1,...,k-1),

and $\mathbf{\Pi} = -(\mathbf{I} - \mathbf{\Pi}_1 - \ldots - \mathbf{\Pi}_k)$

Model (2.16) is a standard first-differences VAR augmented by the term $\mathbf{\Pi}\mathbf{X}_{t-k}$. It is this latter term which contains information on the long-run (levels) relationship between the variables in the VAR. By extension from the bivariate cointegration case, this term will be consistent with the stationary VAR only if it is also stationary, and this will occur if the elements of $\mathbf{X}$ are cointegrated. The number of cointegrating vectors, ν, between the elements of $\mathbf{X}$ will therefore determine the rank of the vector $\mathbf{\Pi}$. There are three alternative situations depending on the rank of $\mathbf{\Pi}$ (ie the number of independent linear combinations spanning the I(1) vector space). If $\mathbf{\Pi}$ is of full rank p, then the matrix is stationary, and the data in vector $\mathbf{X}$ are not, in fact, I(1). If the rank is zero, then the variables are all individually I(1) but not cointegrated, in which case the error-correction isomorphism cannot be employed. Finally, if the rank, ν, is greater than zero but less than p, this means that there are ν cointegrated vectors which can be identified and can be embedded in an error-correction model.

When $0 < \nu < p$, $\mathbf{\Pi}$ can be factorised as $\mathbf{\Pi} = -\alpha\beta'$ where α and β are ν x p, with β containing the ν cointegrating vectors, and α their corresponding adjustment, or feedback parameters. The matrix β' contains the parameters of economic interest in the VAR, and its vectors constitute the long-run (levels) relationships between the variables. The rank of the matrix Π is established using the eigenvalues μ_i derived from the minimization of the product matrix of the concentrated likelihood of (2.15) in the form of tests based on the value of -

$T\log(1-\mu_i)$, where T is the sample size. The critical values of the statistic are computed in Johansen and Juselius (1990 Appendix A3).[32]

The VAR corresponding to (2.16) above for Kenya consists of the five variables in (2.4). Thus $\mathbf{X} = ((m-p), (y-p), r, r^*, \pi)$. Initially we considered 10 separate non-nested VARs, namely for each of the five money aggregates and the two different measure of income, although it was quickly evident that the appropriate income variable for all money aggregates was gross national income (GNY) rather than total final expenditure (TFE).[33] In the following tables we report only the results for the vector including GNY as the income variable. The sample period extends from 1973(1) to 1988(2), which though containing 66 observations, is relatively short and, as is characteristic of high frequency data estimated over short historical periods, renders signal extraction problematic and thus requires careful interpretation of the statistics.

Following Johansen and Juselius we estimate the VARs of the form (2.16) without a linear trend, but with a constant and three centred seasonal dummies. The VAR is estimated with seven lags on each variable, using a concentrated likelihood method to isolate the parameters and structure of the $\mathbf{\Pi}$ matrix so as to investigate whether the matrix contains any information concerning the long-run relationships between the variables.[34] Table 2.5 reports the maximal eigenvalue statistics, $-T(1-\mu_i)$, derived from the minimization of the concentrated likelihood function.[35]

In each case the I(1) vector space is spanned by at least one cointegrating vector (the maximal eigenvalues for p=5 are all greater than the critical value), although there is evidence that there may also be two cointegrating combinations between the variables. Examination of the normalized β' matrix of eigenvectors,

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[32] Johansen and Juselius also compute the value of $-T\Sigma\log(1-\mu_i)$ as sum of the maximal eigenvalue statistics (referred to as the trace).

[33] This was revealed in the consistently lower significance of the cointegrating vector with TFE rather than GNY, although it can also be simply ascertained in terms of the fit of simple bivariate regressions.

[34] All estimation is carried out using the PC-GIVE and PC-FIML routines within PC-GIVE v6.01 (1989).

[35] See Johansen and Juselius (1990) pp174-180.

and the corresponding loadings, α, (reported in Appendix 2(B)) indicates that for all the aggregates except M0, the first cointegrating vector is dominated by the relationship between rtb and π variables, whose linear combination is virtually stationary relative to the other variables, and seems to be capturing the known rise in administered interest rates in absolute terms (relative to the falling rate of inflation over the period). The second vector, however, is more clearly interpretable in terms of a money demand function which is consistent with theoretical priors such that for all aggregates other than M0, the demand for money is a positive function of income and the own rate of interest (proxied by rtb, the Treasury Bill rate), and a negative function of the rate of inflation and the expected devaluation of the parallel market exchange rate. In the case of the narrow money measure it was found that the order of the significance of the two vectors was reversed, with the money demand relationship being identified in the first vector and the interest rate relationship in the second. The interest rate relationship is virtually identical across all the aggregates, while the long run solutions to the demand for money functions (ie the second row of the β' vectors) are all intuitively plausible. Because the β' matrix is not uniquely identified we are obliged to impose identifying restrictions on the matrix so as to define unique cointegrating relationships (which may include linear combinations of the independent matrices). In this case identification is facilitated by the fact that the interest rate and inflation relationship can be approximated as

(2.17)	(m-p)	(y-p)	π	rtb	exp
	0	0	0.4	1	0

which reflects the convergence towards a constant positive real domestic interest rate (see Chapter 1). The imposition of this restriction can be tested by calculating the fall in the likelihood under the imposition relative to the unrestricted estimate of the relationship, although in this case is seems clear that the restriction would be accepted.[36] Taking this approximation we can then derive a linear combination

[36] Current editions of the PC-GIVE software only provide for the direct testing of zero-one restrictions.

of the first and second relationships to define economically interpretable demand for money vectors for the five aggregates. This allows us to uniquely identify two cointegrating vectors which exactly span the vector space of the β' matrix. In Appendix 2(B) we report the full vectors along with the details of the linear combination chosen to identify the unique cointegrating vectors. In Table 2.6 we report only the revised demand for money vector for each money aggregate, along with its feedback vector α. Two features need to be noted. First, it was found that for the model in (m0-p) only by excluding the black market exchange rate term *ex ante* could an interpretable money demand cointegrating vector be determined. The interpretation of this exclusion is discussed below. Moreover, since narrow money is, by definition, outside money, it was found that the linear combination which eliminated the rtb term between the two vectors provided the most intuitive interpretation of the data.[37] Second, a similar sort of argument was found plausible for the Divisia index. Since the own rate of interest had already been captured within the construction of the aggregate, it was found that the linear combination of the vectors which yielded the most plausible relationships was that which netted out the rtb term.

Table 2.5
Maximal Eigenvalues and Critical Values for five-variable VAR

Rank of Π	(m0-p)	(m1-p)	(m2-p)	(m3-p)	(m3d-p)	5% Critical Value
1	2.37	2.68	0.89	0.30	2.45	9.04
2	5.58	5.79	5.55	5.37	6.54	15.72
3	12.34	10.56	10.51	10.03	8.26	21.89
4	36.50	30.39	19.13	26.38	26.20	28.16
5	46.28	46.75	50.15	57.91	49.91	34.39

[37] Note that we could have equally taken a linear combination of the vectors to eliminate to the inflation term, π. In either case the demand for money function in which both interest rates and inflation appear is recoverable by substitution.

Table 2.6
Final Cointegrating Vectors and Loadings

(2.18) (m0-p) Revised ß' Eigenvectors

Variable	(m0-p)	(gny-p)	π
(1)	1.000	-1.005	6.148

Standardized α Coefficients

Variable	(1)
(m0-p)	-.1918
(gny-p)	.0708
π	-.0302

(2.19) (m1-p) Revised ß' Eigenvectors

Variable	(m1-p)	(gny-p)	π	rtb	exb
(1)	1.000	-0.898	5.468	-0.518	0.165

Standardized α Coefficients

Variable	(1)
(m1-p)	-.3687
(gny-p)	.0783
π	-.0448
rtb	.2043
exb	-.0442

(2.20) (m2-p) Revised ß' Eigenvectors

Variable	(m2-p)	(gny-p)	π	rtb	exb
(1)	1.000	-0.844	6.736	-2.255	0.113

Standardized α Coefficients

Variable	(1)
(m2-p)	-.2271
(gny-p)	.0383
π	-.0612
rtb	.3372
exb	-.0322

(2.21) (m3-p) Revised ß' Eigenvectors

Variable	(m3-p)	(gny-p)	π	rtb	exb
(1)	1.000	-1.106	6.199	-18.143	-0.094

Standardized α Coefficients

Variable	(1)
(m3-p)	-.0907
(gny-p)	-.0652
π	-.0572
rtb	.3462
exb	-.0186

(2.22) (m3d-p) Revised ß' Eigenvectors

Variable	(m3d-p)	(gny-p)	π	exb
(1)	1.000	-0.842	5.512	0.074

Standardized α Coefficients

Variable	(1)
(m3d-p)	-.0770
(gny-p)	.2232
π	-.1032
exb	-.0193

Interpreting the Long-Run Solutions

These cointegrating vectors define the long-run demand for money in Kenya.[38] Despite the relatively short sample over which they are estimated, they are statistically well defined, and accord with our theoretical priors. The equilibrium, or long-run, demand for money has an income elasticity equal to unity in the case of cash balances, but as the aggregate widens the income elasticity of demand falls slightly to approximately 0.8 (excluding the M3 measure). This fall reflects the

[38] Note that the constant and seasonal effects have not been reported.

relative shift from transactions to portfolio considerations in holdings of money balances, and is correspondingly reflected in the stronger portfolio considerations, as proxied by the inflation, interest rate and currency substitution price effects, as the aggregates widen. These elasticities are significantly lower than those reported by Darrat, are similar to Pathak's results, and, with the exception of the M1 aggregate, are extremely close to the results of Mwega. In general however the inflation elasticity, which -6.0, is significantly lower than Mwega's results, but is very much in line with Hendry and Mizon's (1991) estimates for the UK (1991).[39] This quarterly elasticity is equivalent to an annual inflation elasticity of approximately -1.5 which is entirely plausible. Finally it may be noted that the magnitude of the currency substitution effect is relatively slight, but seems to rise in importance in the M3 aggregate. In all cases, however, this effect is consistently signed: a depreciation in the black market exchange rate (represented by a rise in exb) leads to a shift out of domestic money balances.[40]

Of particular note is in the comparison of the simple-sum and Divisia aggregates for M3. In terms of the eigenvalues the Divisia aggregate is more strongly significant, and while both measures reveal intuitive inflation elasticities, the M3 aggregate reports an improbably high own interest rate elasticity of demand. Moreover the lower income elasticity for the Divisia-based M3 is consistent with Barnett's (1980) assertion that the simple-sum aggregate will overstate the income elasticity of demand.

In each case the feedback effects (as represented by the loadings vector α) indicate that the main effect of the cointegrating vector is through their feedback onto (m-p), ie real money holdings, and to a lesser extent onto inflation. Moreover the direction of the feedback on all the equations is consistent with a stable, error-correcting model of the demand for money.

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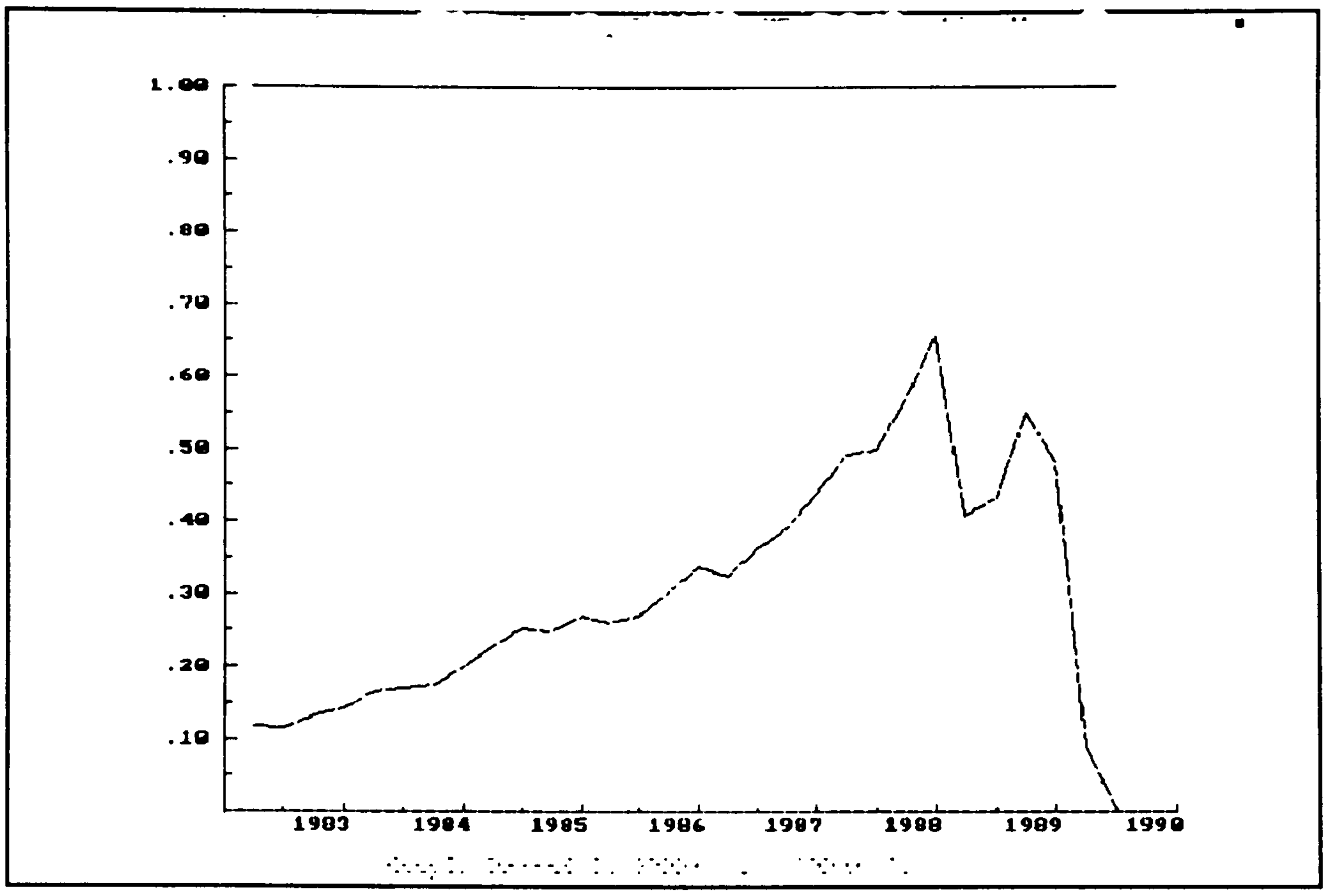
[39] They report an income elasticity of 0.97 and an inflation elasticity of -6.9.

[40] In specifying the cointegrating vectors (and also in the analysis of the dynamic models in the next section) we examined a variety of specifications of the currency substitution effect including the use of official rather than parallel market rates and also the premium on the parallel market rather than the level. Of the alternatives the actual parallel market rate was most significant and best characterised both the levels and the differences of the data.

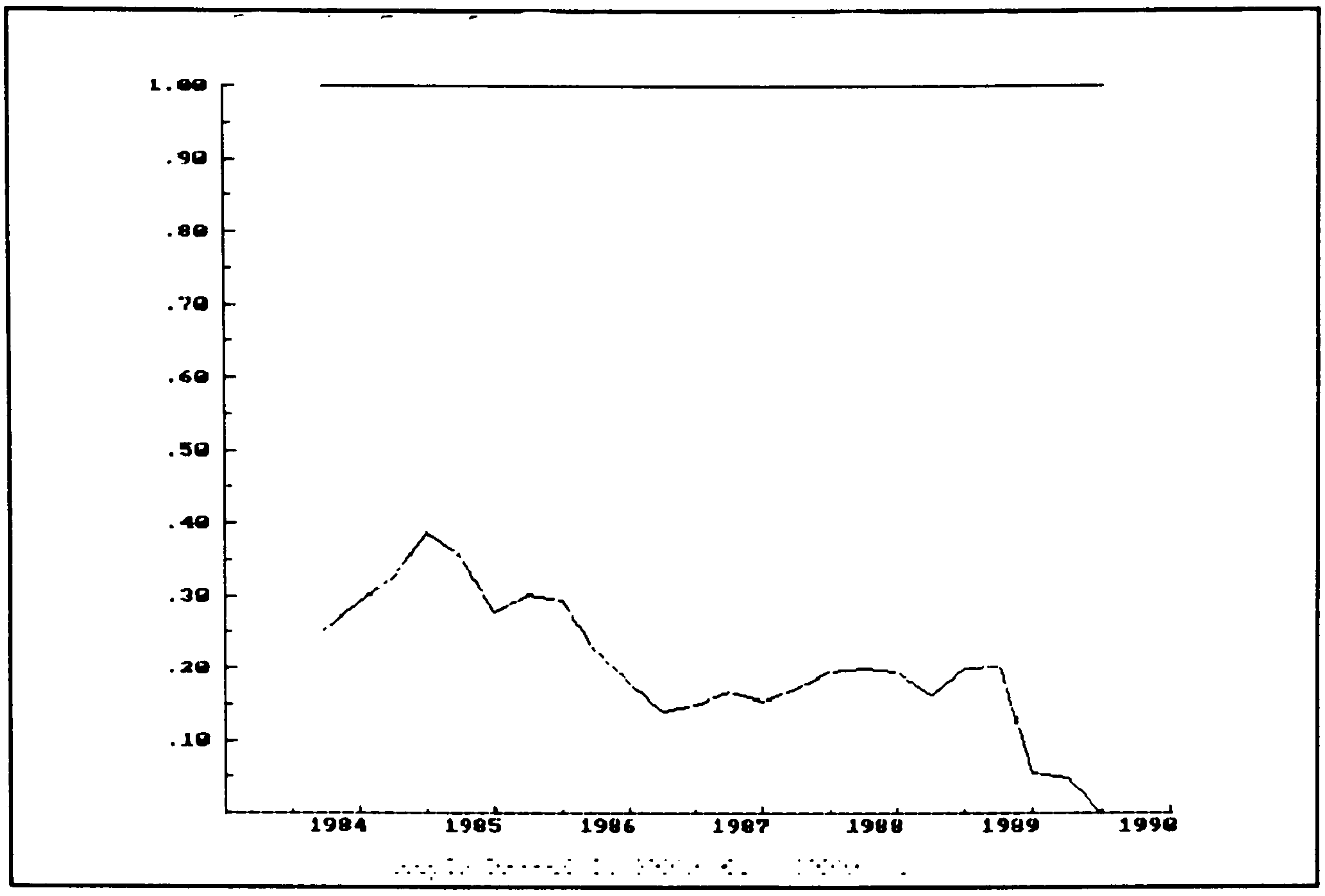
Finally, although the Johansen-type cointegrating vectors are defined over the full sample we can obtain some idea of their overall within-sample stability by examining the series of recursive split-sample Chow tests for each cointegrating vector. These are plotted in Figure 2.8 (and scaled against the 5 per cent critical value) and in each case it is impossible to reject the null of stability regardless of where the break point is taken.

Figure 2.8

(a) Recursive Split-Sample Chow Test for M0 Cointegrating Vector



(b) Recursive Split-Sample Chow Test for M1 Cointegrating Vector



(c) Recursive Split-Sample Chow Test for M2 Cointegrating Vector

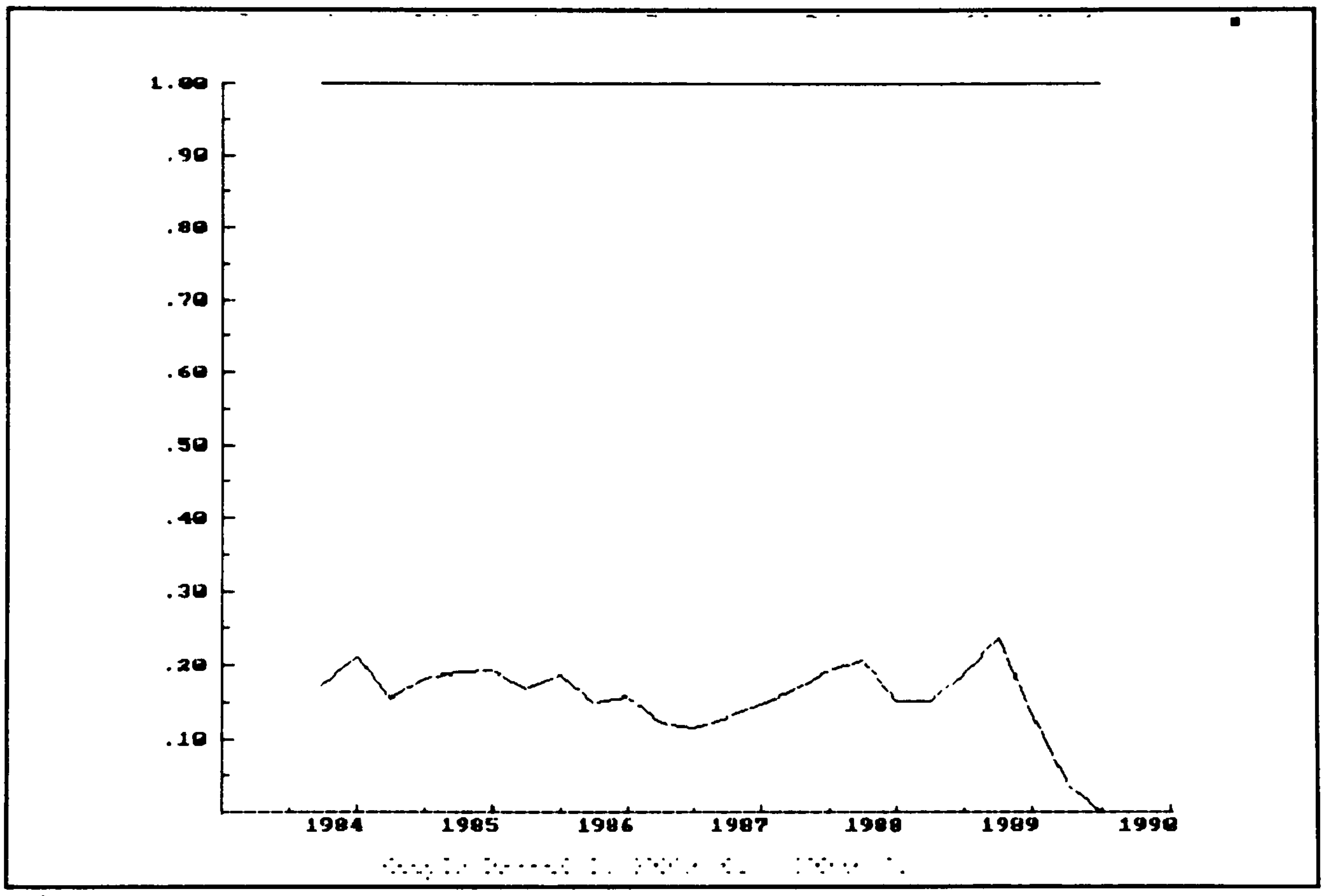
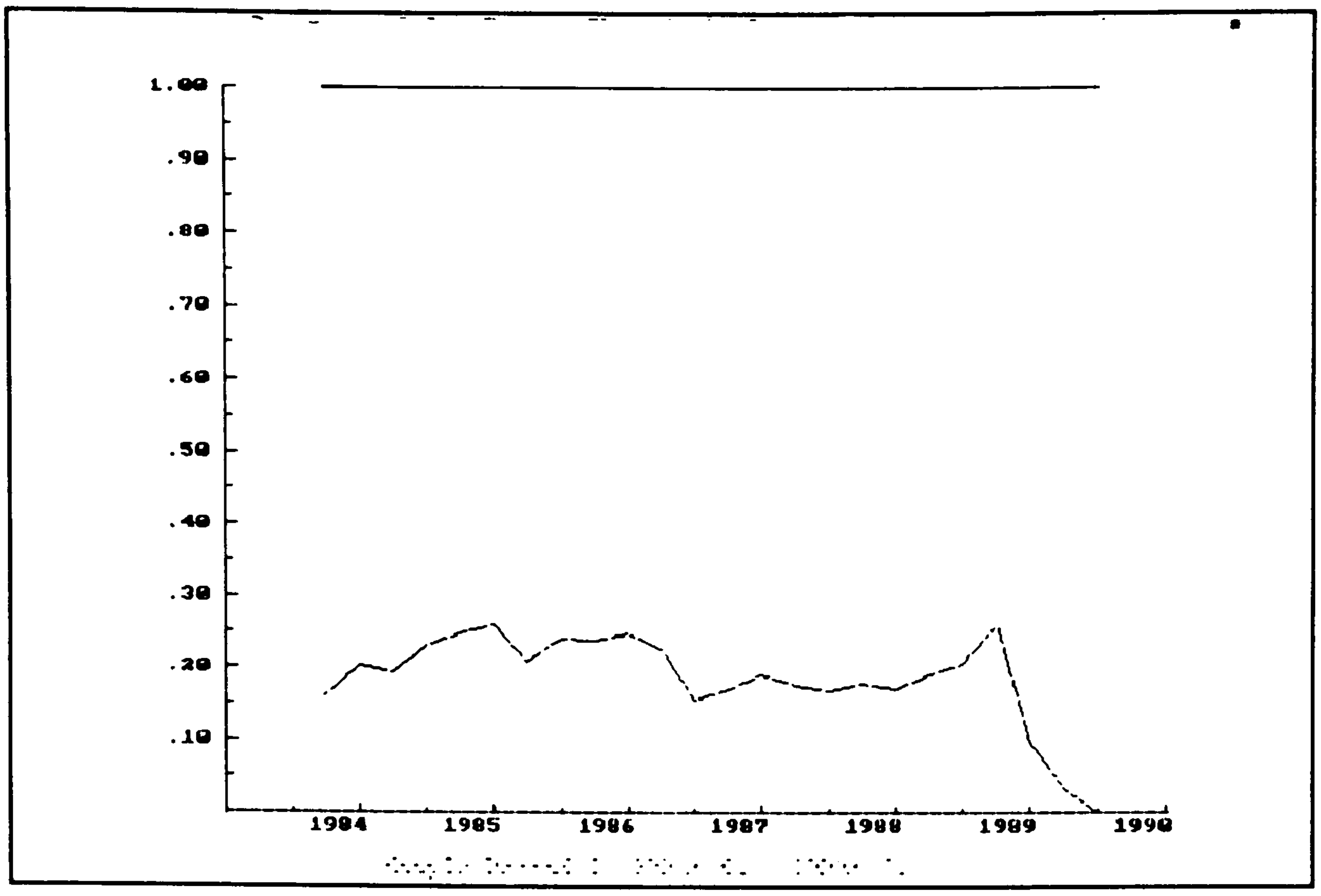


Figure 17

(d) Recursive Split-Sample Chow Test for M3 Cointegrating Vector



(e) Recursive Split-Sample Chow Test for M3d Cointegrating Vector

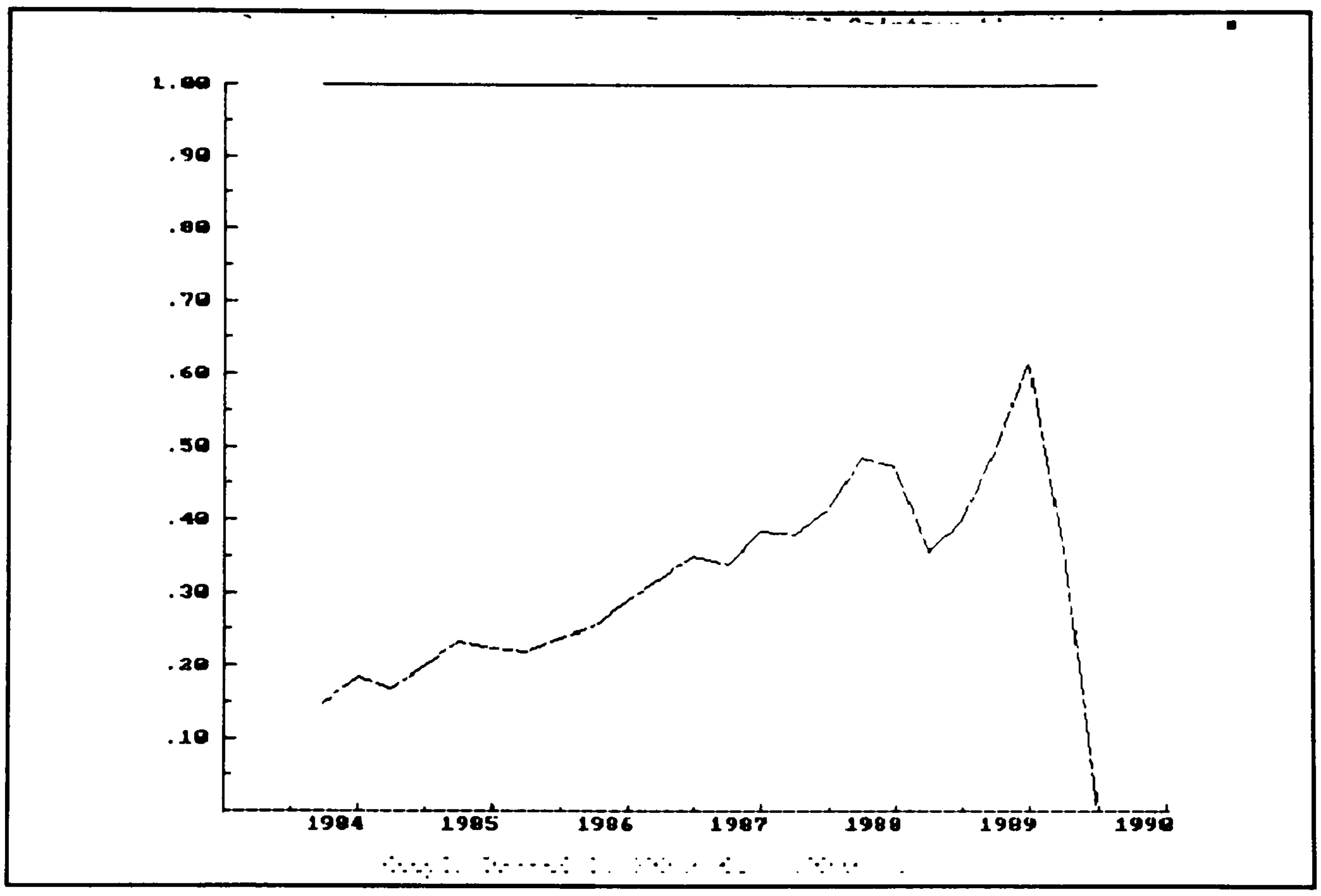


Table 2.7
Cointegrating Vectors used in Dynamic Models[41]

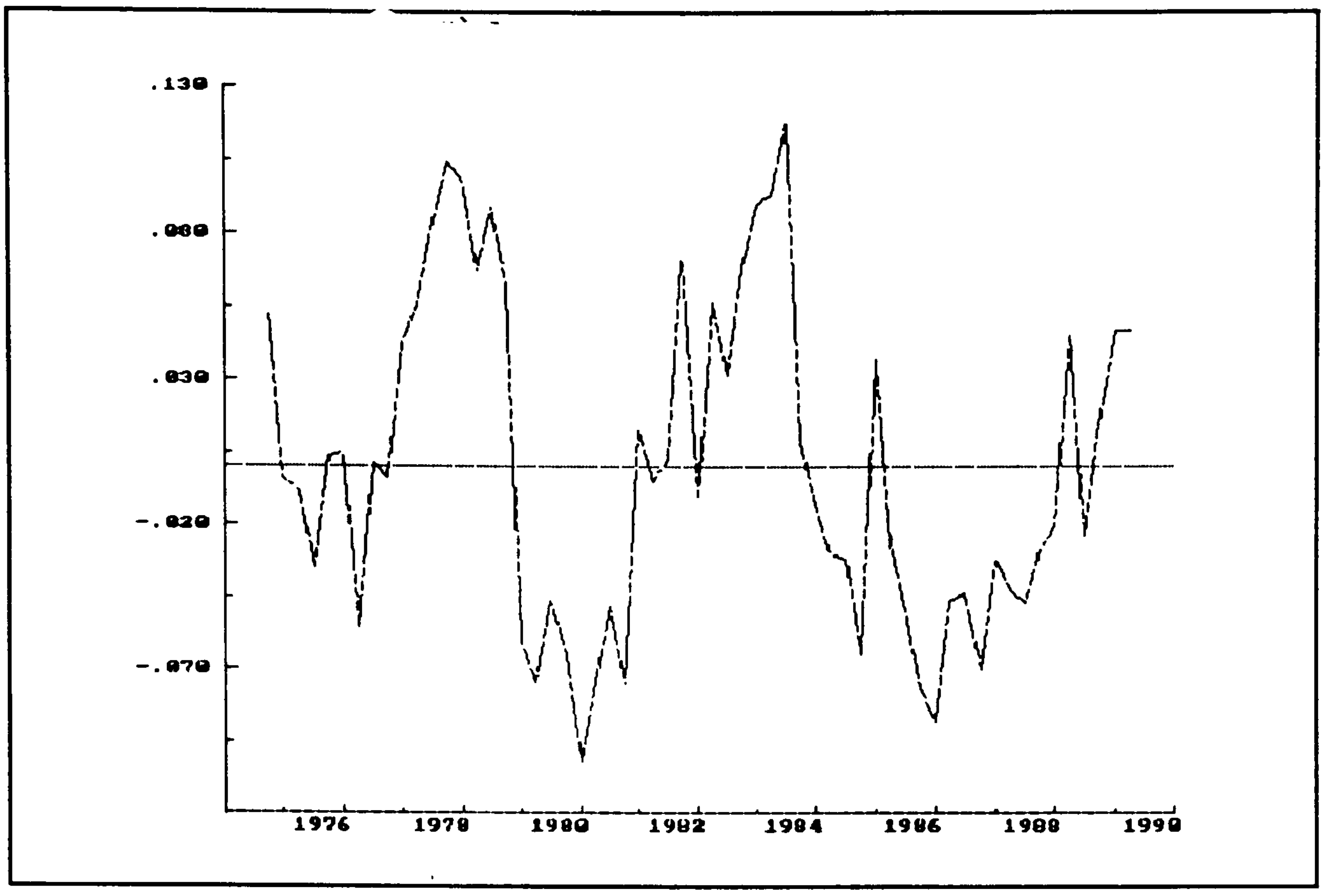
(2.23)	π	= -2.5 rtb			
(2.24)	(ncc-p)	= 1.0 (y-p)	- 6.5π		
(2.25)	(m1-p)	= 0.9 (y-p)	- 5.5π	+ 0.52 rtb	- 0.22exb
(2.26)	(m2-p)	= 0.8 (y-p)	- 6.7π	+ 2.25 rtb	- 0.11exb
(2.27)	(m3-p)	= 1.1 (y-p)	- 6.2π	+ 18.14 rtb	- 0.32exb
(2.28)	(m3d-p)	= 0.8 (y-p)	- 5.5π		- 0.07exb

In general, then, the long-run cointegrating relationships are consistent with the data and provide the basis for a coherent economic interpretation of the underlying relationships determining the demand for money. They are consistent with the limited comparable evidence from other applied studies using this methodology, and at the same time are explicable in terms of other applied work on Kenya. Consequently this enables us to accept the Engle-Granger Representation Theorem (1987) and proceed directly to an error-correction specification, and it is these cointegrating vectors, which are defined in Table 2.7, and plotted in Figure 2.9, which will represent the long-run demand for money relationships modelled within the dynamic error-correction models of money demand presented in the following section.

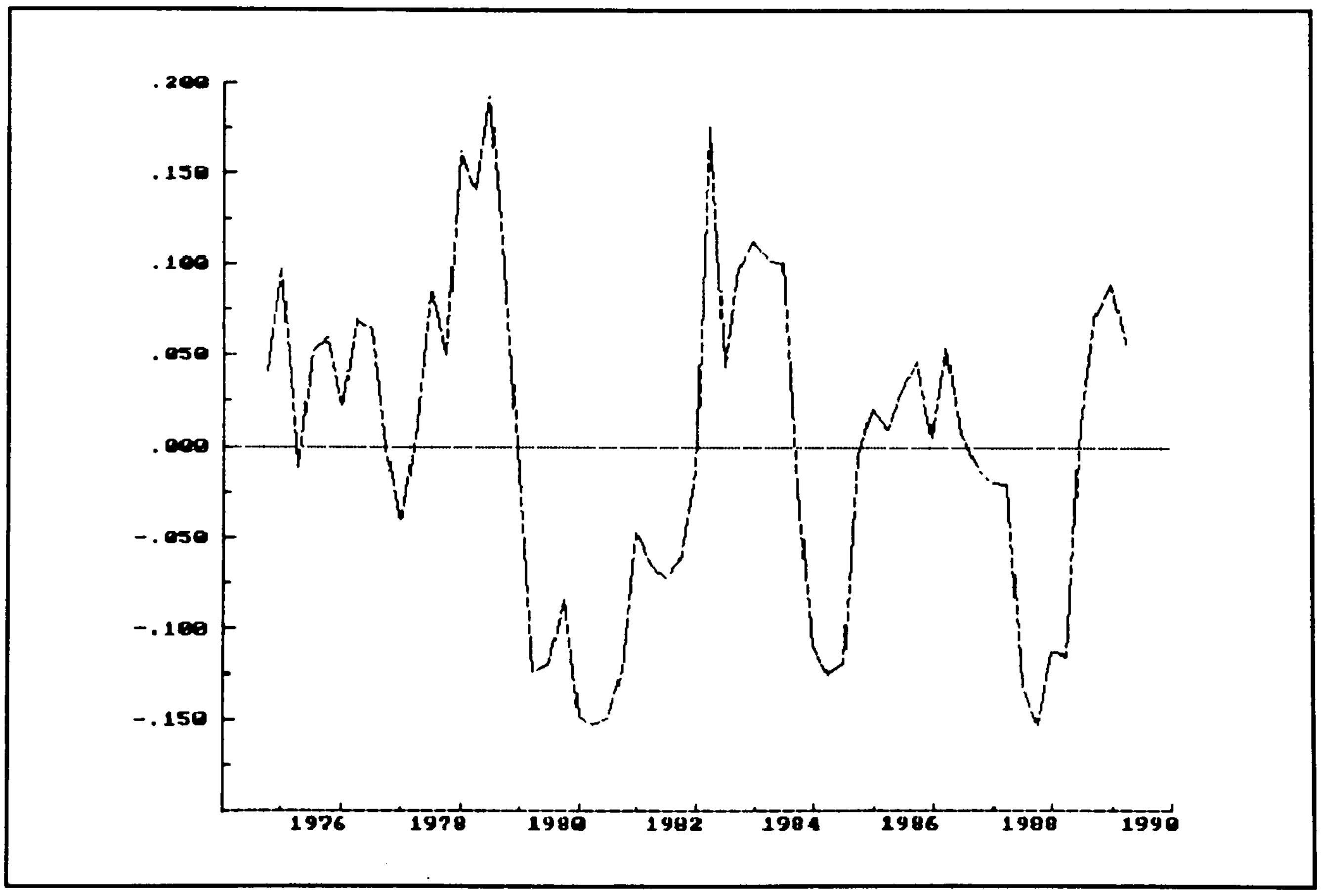
[41] Defined after removal of centred seasonal effects.

Figure 2.9
Demand for Money Vectors Cointegrating

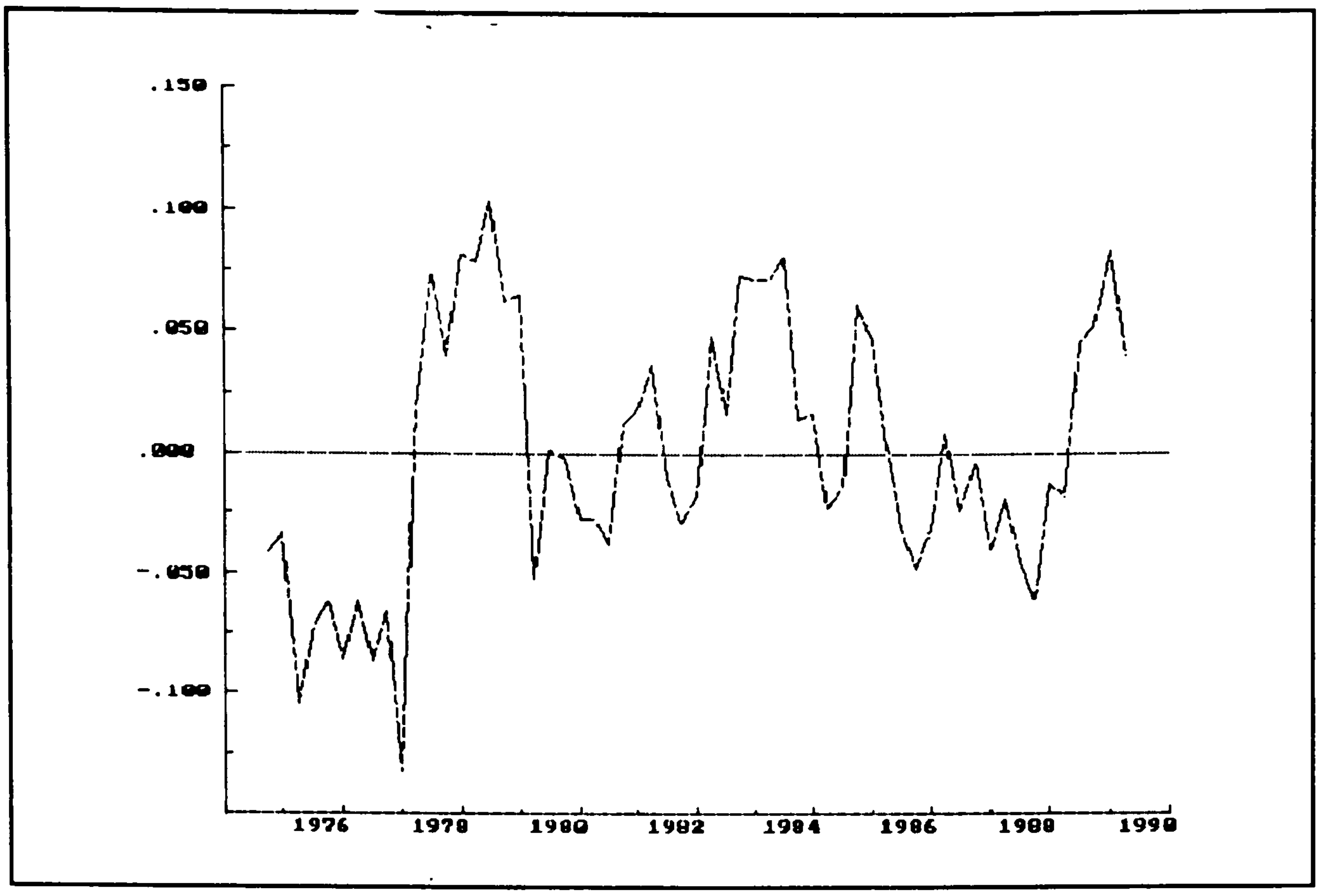
(a) M0



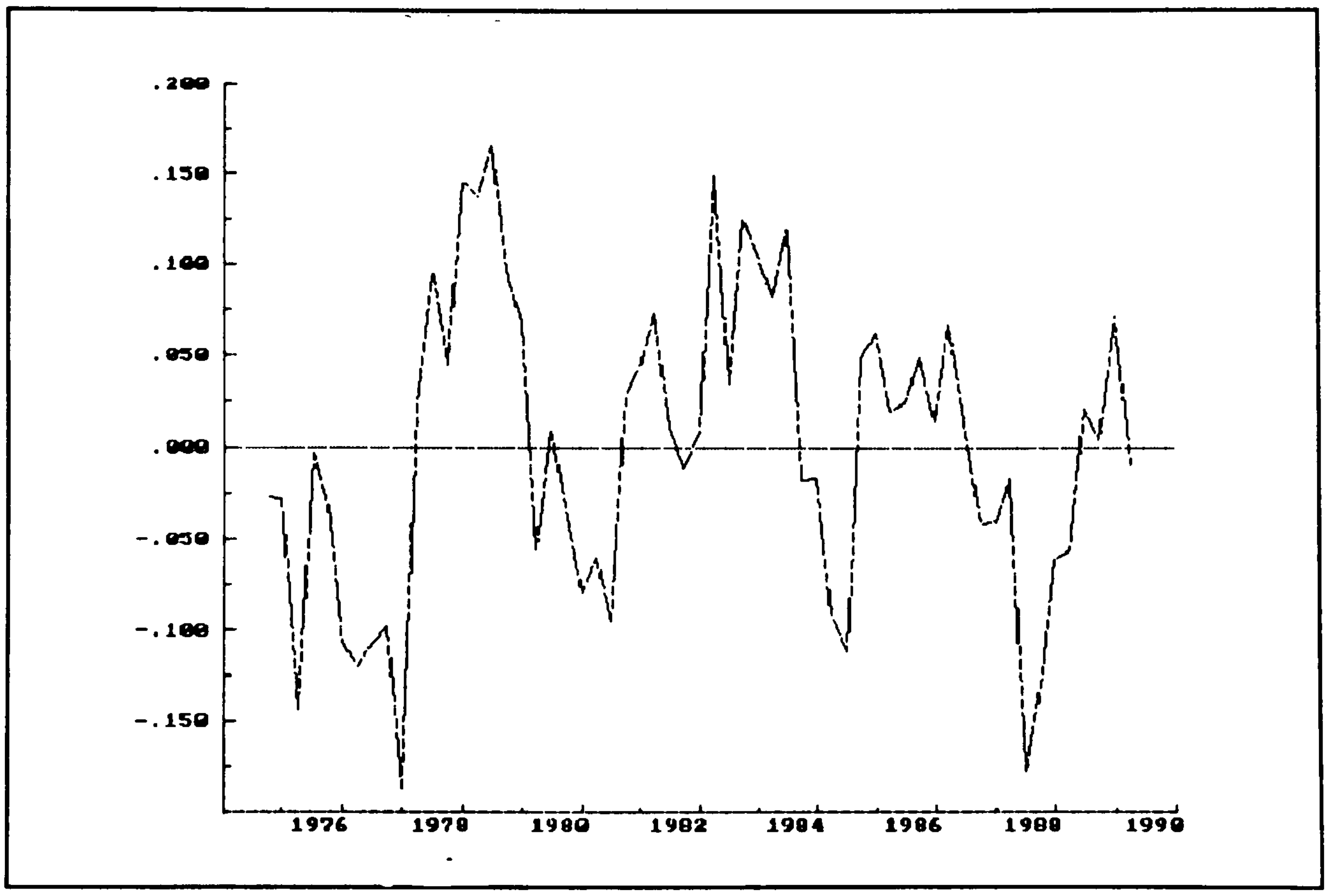
(b) M1



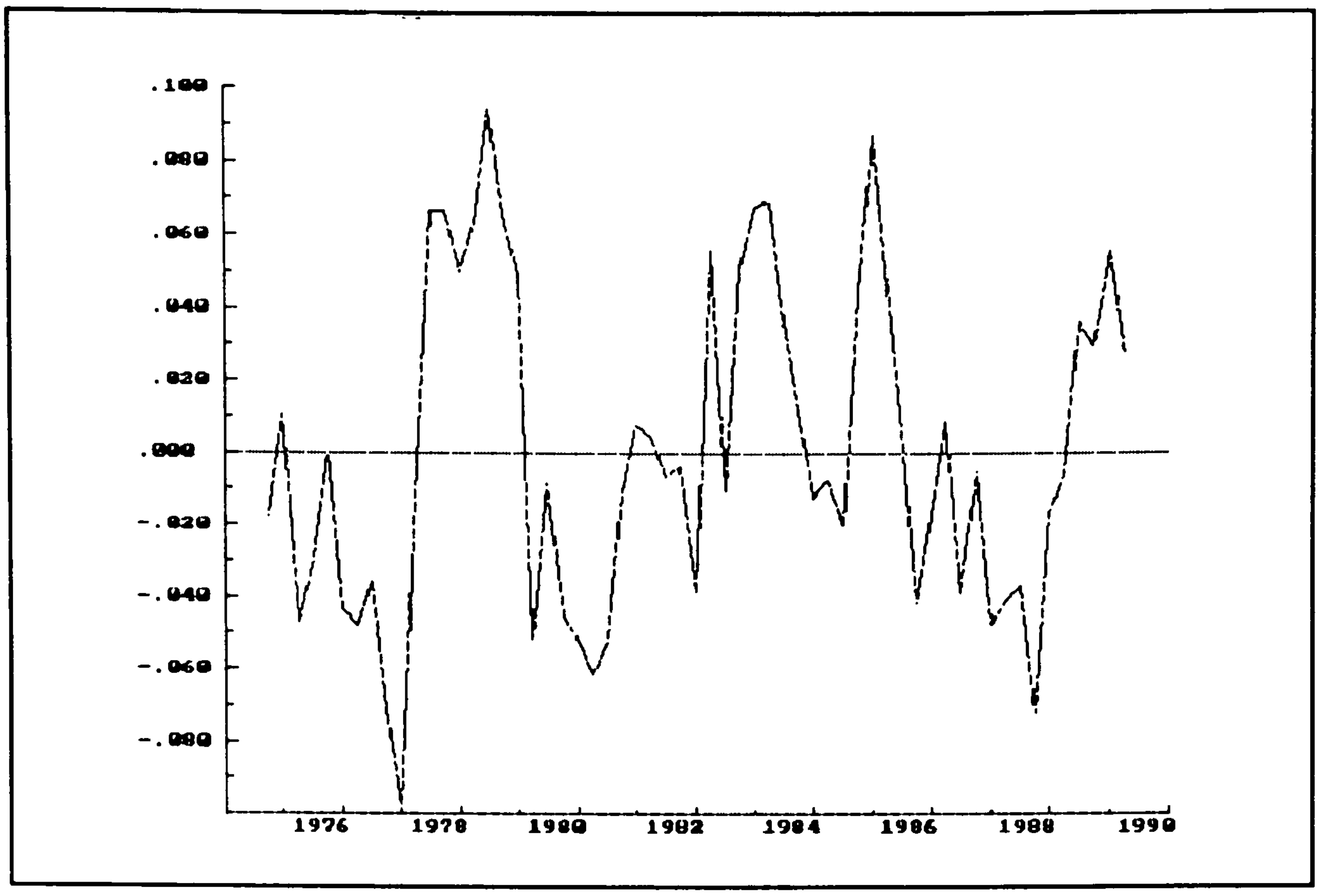
(c) M2


.150
.100
.050
.000
-.050
-.100
1976
1978
1980
1982
1984
1986
1988
1990

(d) M3


.200
.150
.100
.050
.000
-.050
-.100
-.150
1976
1978
1980
1982
1984
1986
1988
1990

(e) M3d



2.7 Dynamic Demand for Money Functions for the Kenyan Economy.

Adopting a general-to-specific procedure we estimate a series of dynamic error correction models for each money aggregate based around the cointegrating vectors reported in the preceding table. Each model is of the general form

$$(2.29)\ A(L)\Delta(m\text{-}p)_t = \alpha_0 + B(L)\Delta(y\text{-}p)_t + C(L)\Delta\pi_t + D(L)\Delta rtb_t + E(L)\Delta exb_t + F(L)Ecm_{t-1} + \Sigma\gamma_i S_i + \epsilon_t$$

where A(L)...F(L) are polynomials of the form $A(L) = \Sigma\alpha_i L^i$ in which L is the lag operator such that $L^r x_t = x_{t-r}$, and S_i are seasonal dummies. Throughout the reduction sequence various parameterizations of the variables were considered. In particular alternative specifications of the currency substitution effect were examined (using the actual and anticipated[42] depreciation of the parallel market rate, the actual and anticipated official rate of depreciation, and also the premium

[42] As proxied by the lead of the *ex post* actual depreciation of the exchange rate.

on the official rate). The results of these alternative specifications are not reported here, but it was found that for all aggregates a model specification in terms of the actual parallel market exchange rate encompassed (i.e. variance dominated) alternative specifications. It is important to note that this may lead to endogeneity problems in the data which we address in Section 2.8. We therefore report only the results from the latter models. Moreover we only report the final specifications in full although Table 2.10 indicates, by means of the Schwarz statistic,[43] the reduction achieved from the initial over-parameterized error-correction model (2.29).

Table 2.10

General to Specific Reductions of Over-Parameterized ADL

	M0	M1	M2	M3	M3d
Initial Specification					
Number of Parameters	35	35	35	35	35
Eqn Standard Error	2.8%	4.5%	3.8%	3.4%	4.1%
Schwarz Criterion	-5.62	-4.69	-5.06	-5.24	-4.90
Final Model					
Number of Parameters	9	10	10	8	9
Eqn Standard Error	3.2%	4.2%	3.3%	2.8%	3.3%
Schwarz Criterion	-6.42	-5.81	-6.32	-6.67	-6.31

The process of reduction has thus resulted in a series of parsimonious models which uniformly have increased efficiency over their nesting model (2.29), and allow for a clearer specification of the dynamic processes. The steps required to achieve these final models are not reported, although in general it was found that the short run dynamics effects were felt within a relatively short period (in no

[43] The Schwarz statistic is a measure of likely forecast efficiency. It is defined as $SC = \ln\sigma^2 + k\ln T/T$ where σ^2 is a degree-of-freedom adjusted equation standard error, k the number of parameters, and T the sample size. SC is thus increasing in σ^2 and in k: a fall in the value of SC is an indication of undominated "parsimony"

case were there significant lagged effects beyond four quarters). However, as shall be seen, the dynamic structures which most efficiently captured the data were often complex, but nonetheless interpretable. The final full sample equations spanning the period from 1974 to 1989 are reported in Appendix 2(C), but to facilitate an economic analysis of the results a stylised summary of the results is presented in Table (2.11), where for convenience we do not report the seasonality on the models and we suppress the details of the individual short-run dynamics of the models. Thus, for example, while in the Appendix we note that for the M0 and M1 models the short run dynamics of the dependent variable are best captured by a four-period (0 to 3) moving average process, those for the M2 are captured by a two period (0 to 1) process. In Table 2.11 we report both these under the line $\Sigma\Delta(m\text{-}p)$.

Table 2.11

Summary Demand for Money Models: OLS Estimates [1974(4)-1989(2)]

	Monetary Aggregate				
Explanatory Variables	Δ(m0-p)	Δ(m1-p)	Δ(m2-p)	Δ(m3-p)	Δ(m3d-p)
$\Sigma\Delta$(m-p)	0.54	0.57	0.40	-0.23	-0.30
	(2.98)	(2.11)	(1.79)	(2.61)	(2.83)
$\Sigma\Delta$(y-p)	-	-0.17	-0.11	-	0.42
		(2.24)	(1.95)		(2.29)
$\Delta\pi$	-1.20	-0.52	-0.93	-0.93	-0.74
	(6.61)	(2.23)	(3.42)	(3.87)	(4.09)
$\Sigma\Delta$rtb	-3.01	-6.77	-7.81	-5.46	-11.06
	(2.56)	(1.78)	(2.68)	(2.17)	(4.13)
Δexb	0.19	-0.17	0.11	-0.09	-0.06
	(2.58)	(2.78)	(2.02)	(1.26)	(0.99)
Ecm	-0.19	-0.32	-0.20	-0.07	-0.09
	(3.21)	(4.15)	(4.70)	(2.63)	(2.16)
R_2	0.853	0.594	0.599	0.560	0.643
s.d	0.078	0.061	0.047	0.041	0.055
σ	0.032	0.042	0.032	0.029	0.032
DW	1.946	2.016	2.083	2.024	1.981
ζ_1 (6)	0.68	0.86	1.07	1.16	0.83
ζ_2 (6)	0.79	0.44	0.25	0.27	1.08
ζ_3	0.77	1.17	1.24	0.94	0.96
ζ_4	1.54	7.18*	4.84*	10.85*	1.54
ζ_5	0.63	0.43	0.53	0.69	1.41

* indicates rejection of null.

Notes:

1: t statistics are reported in parenthesis; s.d is the standard error of the dependent variable; σ the corresponding equation standard error; DW is the first-order error autocorrelation Durbin-Watson statistic.

2: ζ_1 (6) is the sixth order Lagrange Multiplier test for autocorrelation; ζ_2 (6) the sixth order Lagrange Multiplier test for autoregressive conditional heteroscedasticity; ζ_3 is White's (1980) test for unconditional heteroscedasticity; ζ_4 the Jarque-Bera (1983) test for the normality of the error distribution; and ζ_5 a measure of 16-period (1985 Q3 to 1989 Q2) forecast stability (see Hendry (1989)). Tests ζ_1, ζ_2, and ζ_3 are reported as sample-adjusted F-Tests (see Kiviet (1985)): ζ_4 and ζ_5 are distributed as χ_2 with two degrees of freedom.

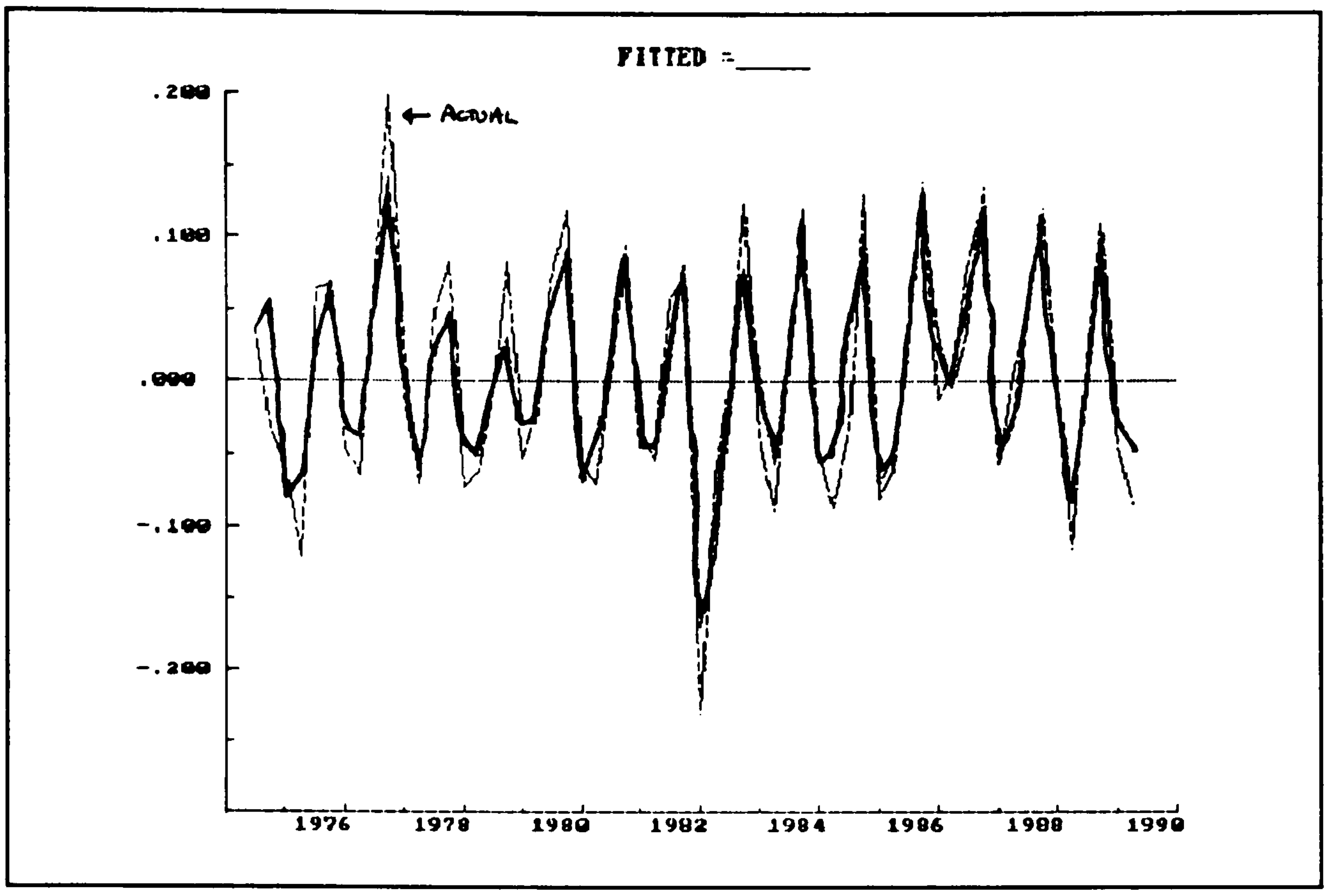
Analysis of Results

The statistical characteristics of the dynamic equations are good and all broadly accept the null that the error term is normally and homoscedastically distributed and exhibits no significant first- or higher-order autocorrelation. In the case of M1, M2, and M3, however, the null of normality is rejected by the Jarque-Bera test. This is due entirely to the presence of a significant outlier in 1977 Q1: for all aggregates the model significantly under-predicted the rise in money holdings in this quarter. This was due to the effect of the rapid increase in unsterilized income from coffee exports. The compulsory surrender of coffee earnings (which accrued directly to the non-bank private sector and which were not sterilized by the government) combined with the lags in the implementation of investment projects, forced the private sector off its demand function. This disequilibrium was also reflected in the rapid rise in the liabilities of the banking sector, which experienced severe excess liquidity at the period. It was this rise in excess liquidity (liquid assets were equivalent to almost 40 per cent of eligible liabilities) which prompted the abolition in the minimum lending rate in 1977. In the case of M0 however the strong seasonality in that aggregate seems to have captured the first quarter surge, while the built-in elasticity of substitution effects in the Divisia-based aggregate meant that the cash-surge in that quarter carried less weight in the Divisia aggregate than in the simple sum aggregates M2 and M3. Fitting a dummy variable for this quarter *ex post* to the M1, M2, and M3 equations improves their overall fit quite substantially in terms of R^2 while leaving the other equation coefficients unchanged. However in order to facilitate direct comparison between the aggregates we have chosen not to include any *ex post* dummy variables of this kind.

A clear pattern emerges in terms of the overall goodness-of-fit of the aggregates. Due to the strong seasonal component in the M0 model, R^2 is high at around 0.85, but this falls off sharply to around 0.60 when the aggregates are widened to include inside-money deposits with the financial sector. Noting that the dependent variables in each case are in terms of a quarterly first difference, this level of fit is relatively high, and compares well with comparable money demand studies elsewhere (eg Hendry (1985), (1988), Adam (1991)). It may also be noted that the Divisia-based aggregate has a slightly higher R^2 statistic than the simple-sum M3.[44]. Plots of the actual money holdings versus the fitted values from the full sample model are presented in Figures 2.10 (a) through (e), where the data features just noted can be clearly identified.

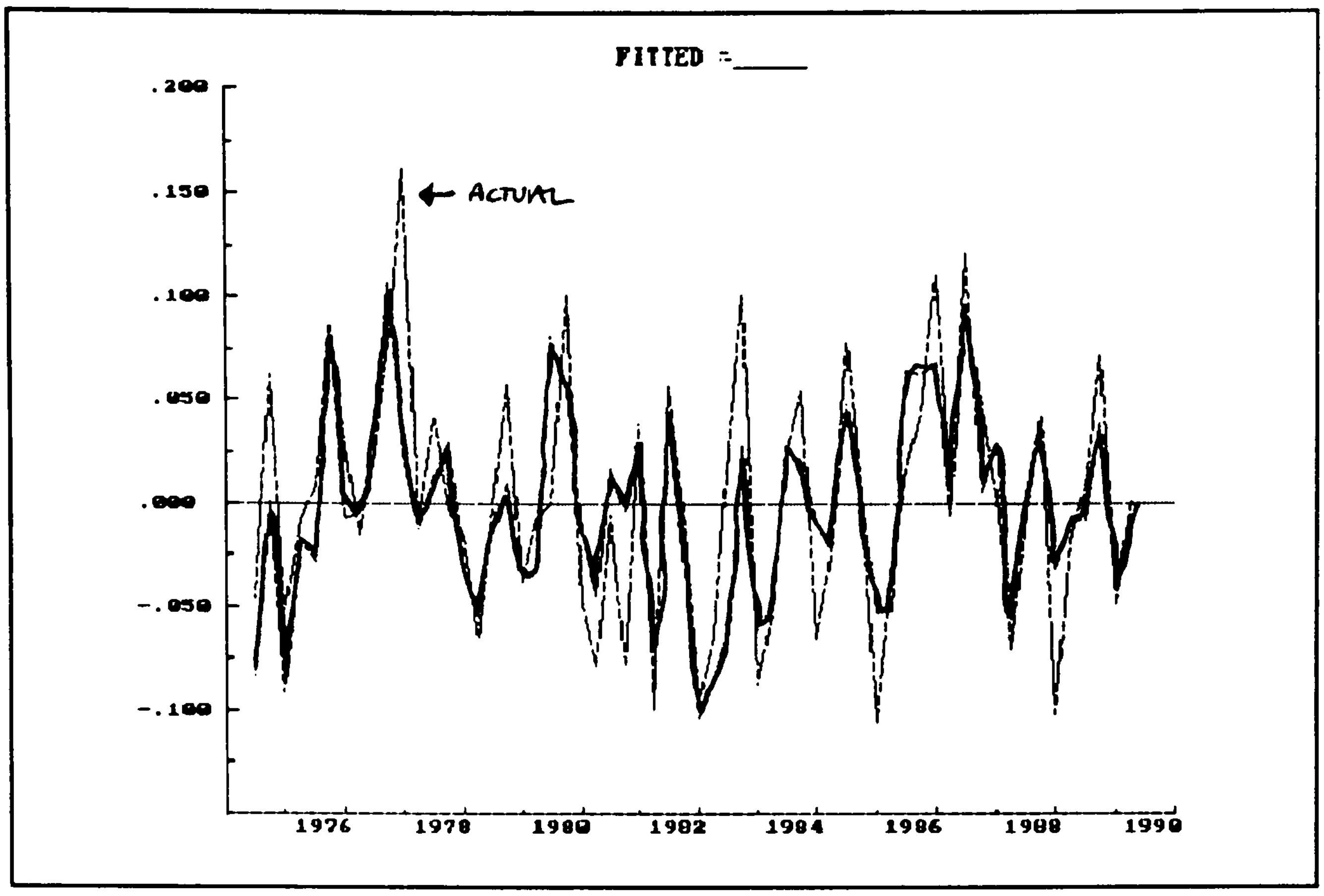
Figure 2.10
Actual vs Fitted Full Sample Estimates

$\Delta(m0\text{-}p)$

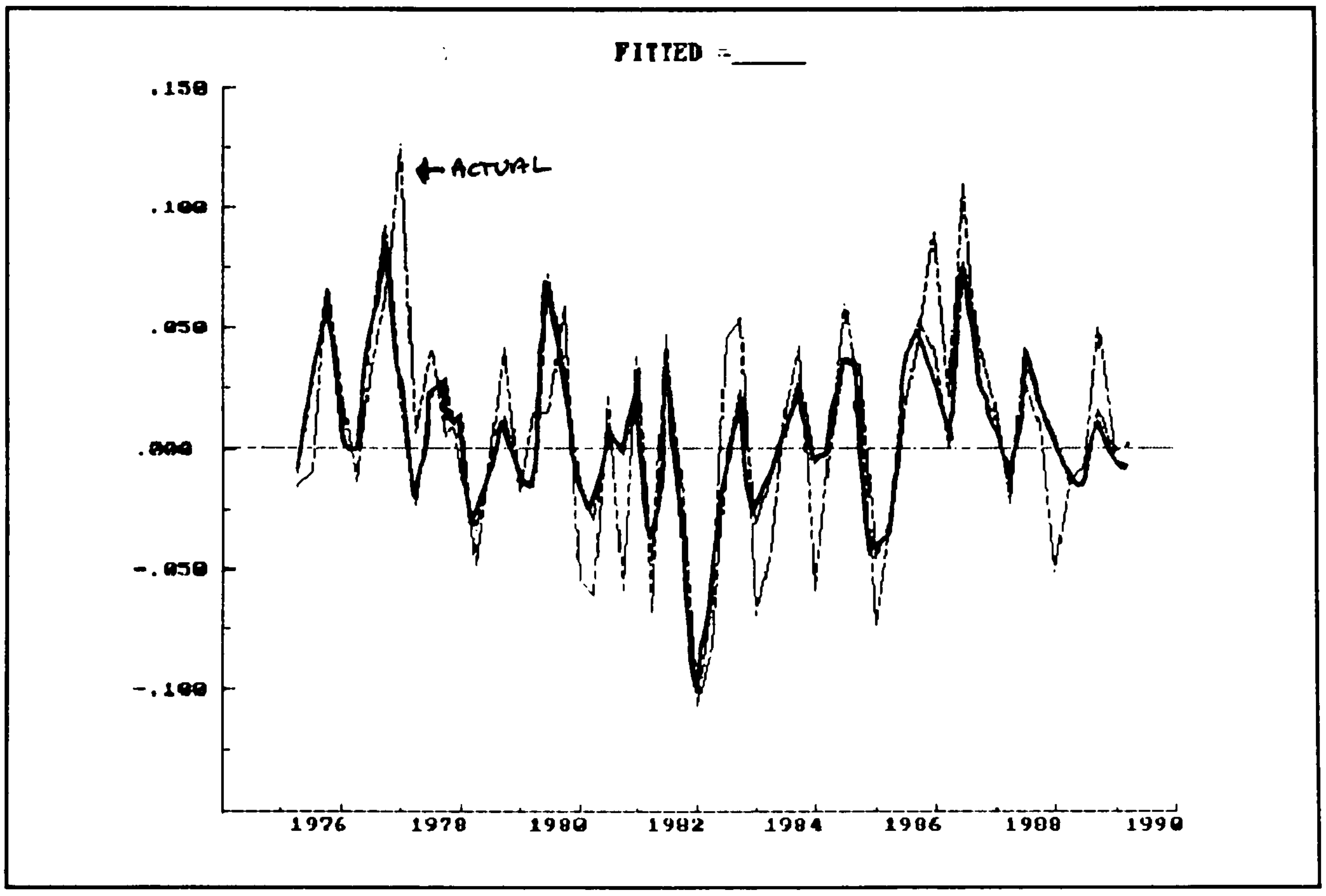


[44] Since the two models have a different number of parameters and the dependent variables have differing standard deviations, the σ and R^2 statistics are not strictly comparable. However it can be noted that while the M3 equation standard error is approximately 70% of the standard deviation of the dependent variable, that for the Divisia aggregate is less than 60% of the standard deviation, indicating a slightly greater degree of efficiency in the latter model.

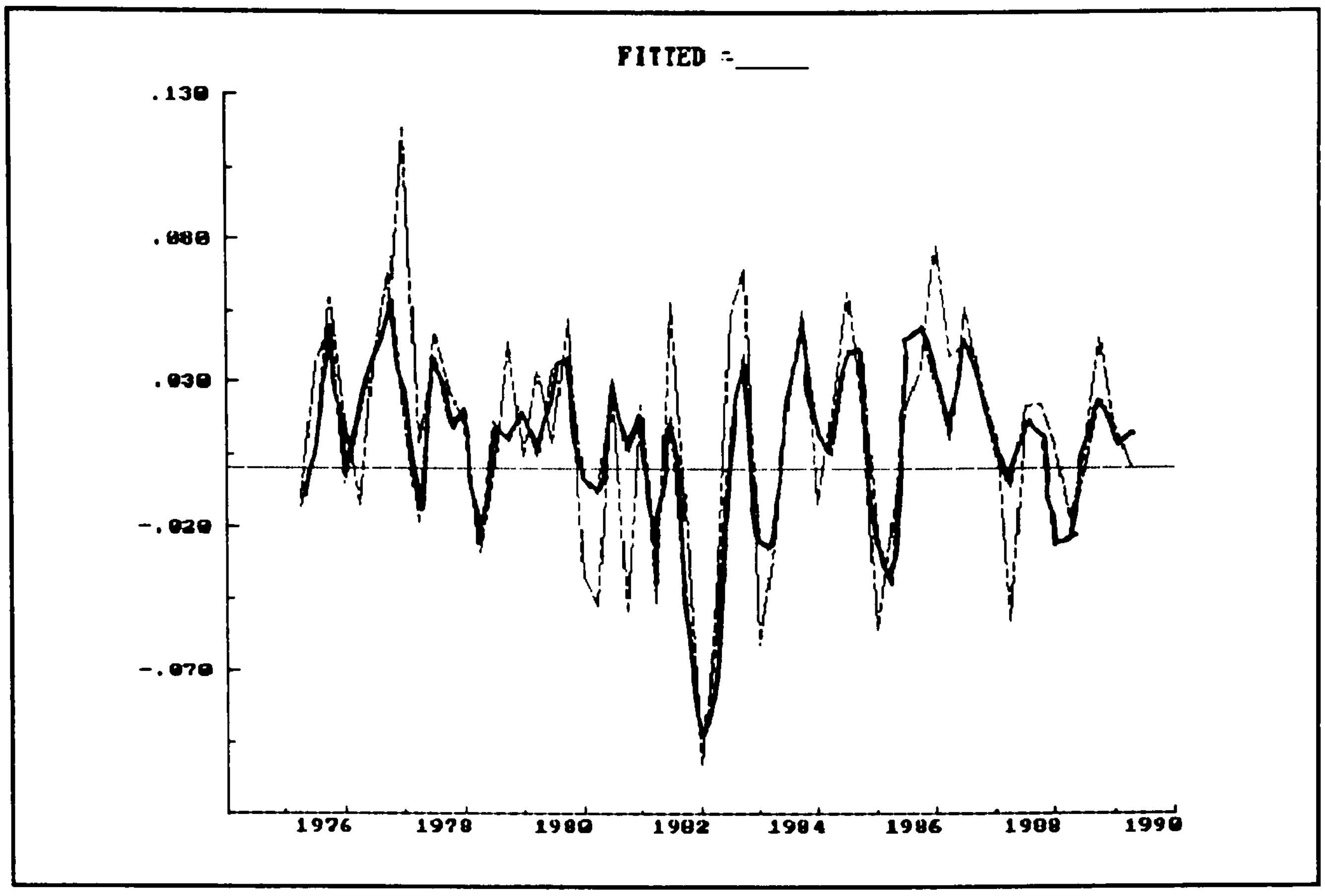
$\Delta(m1\text{-}p)$



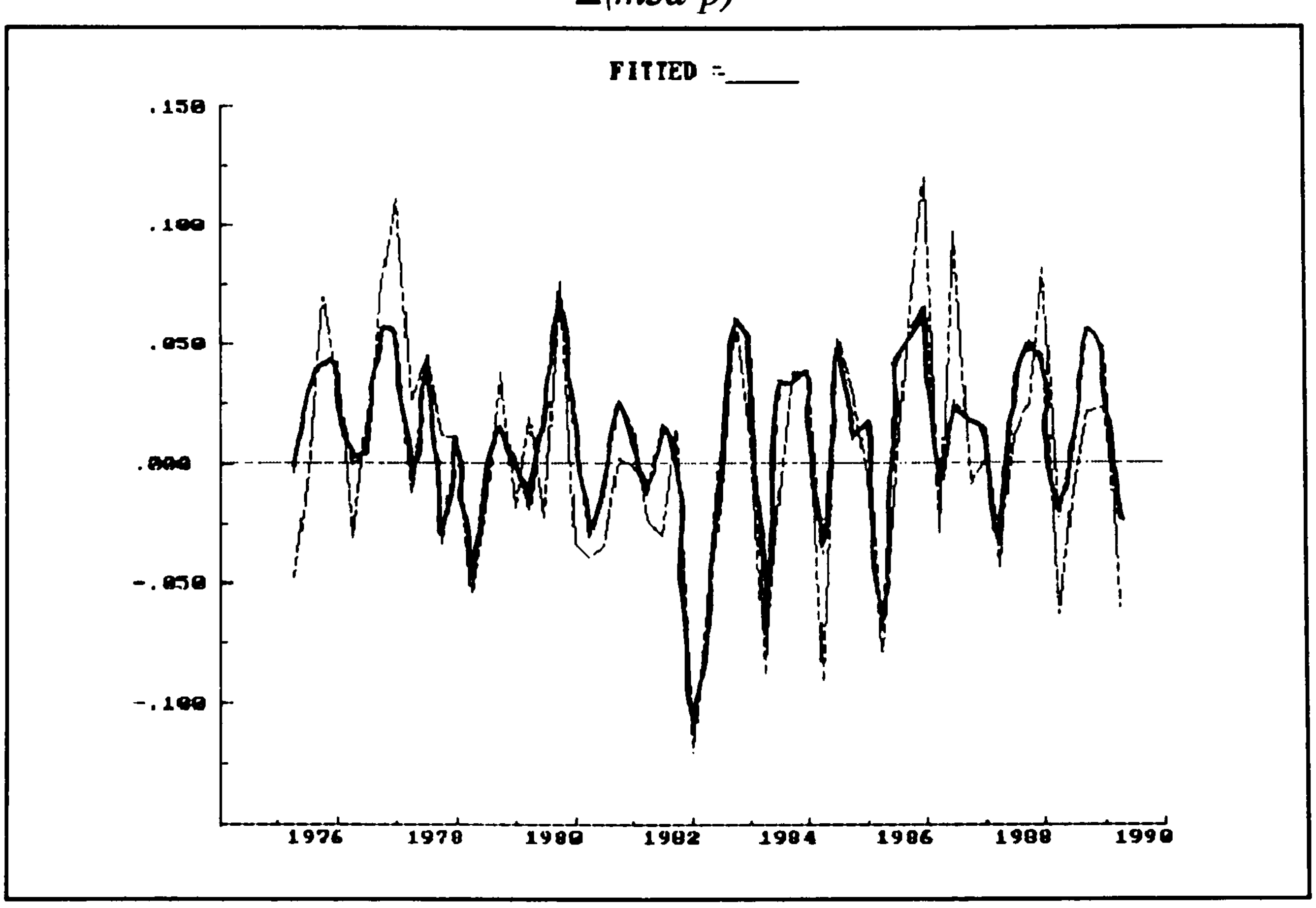
$\Delta(m2\text{-}p)$



$\Delta(m3\text{-}p)$



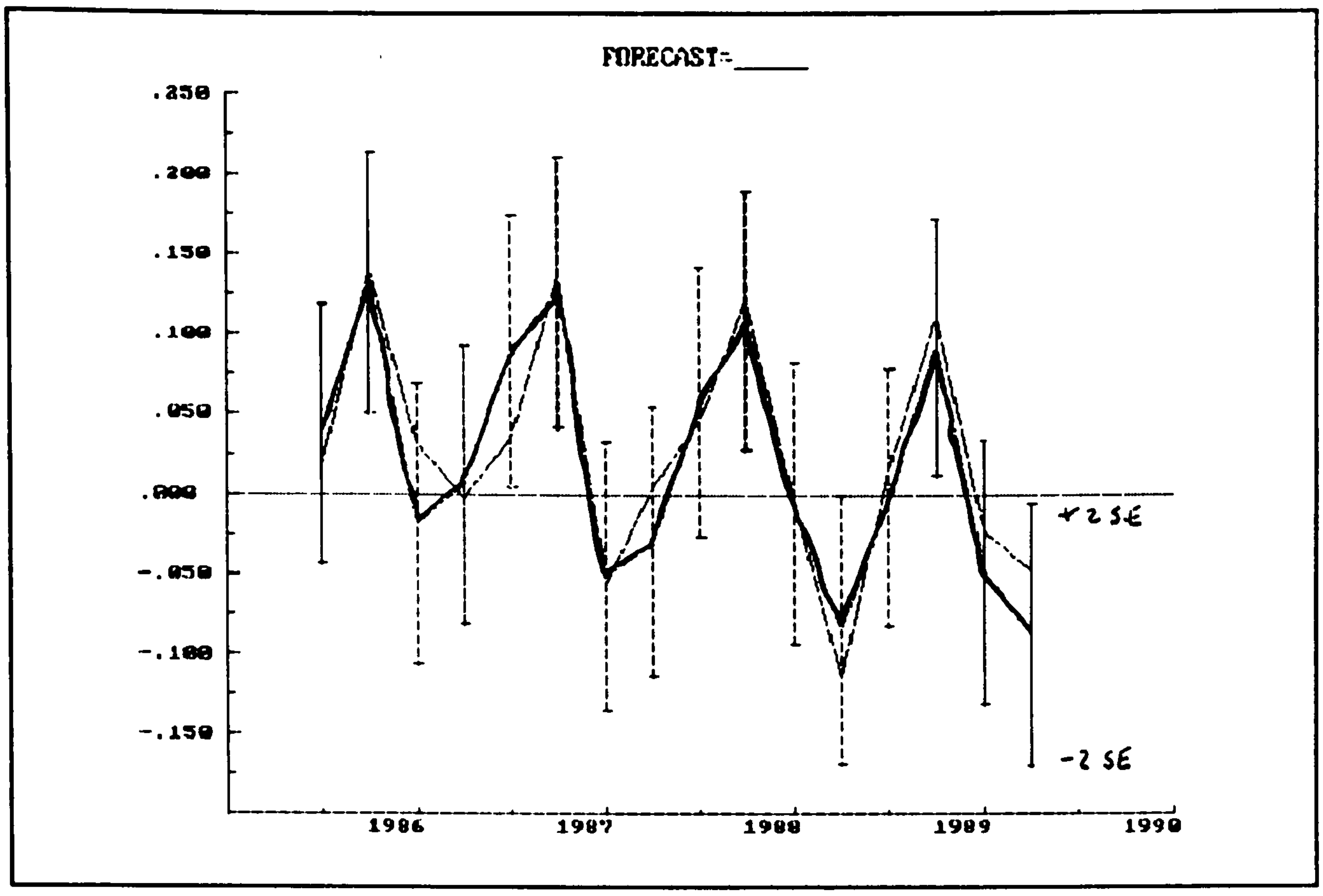
$\Delta(m3d\text{-}p)$



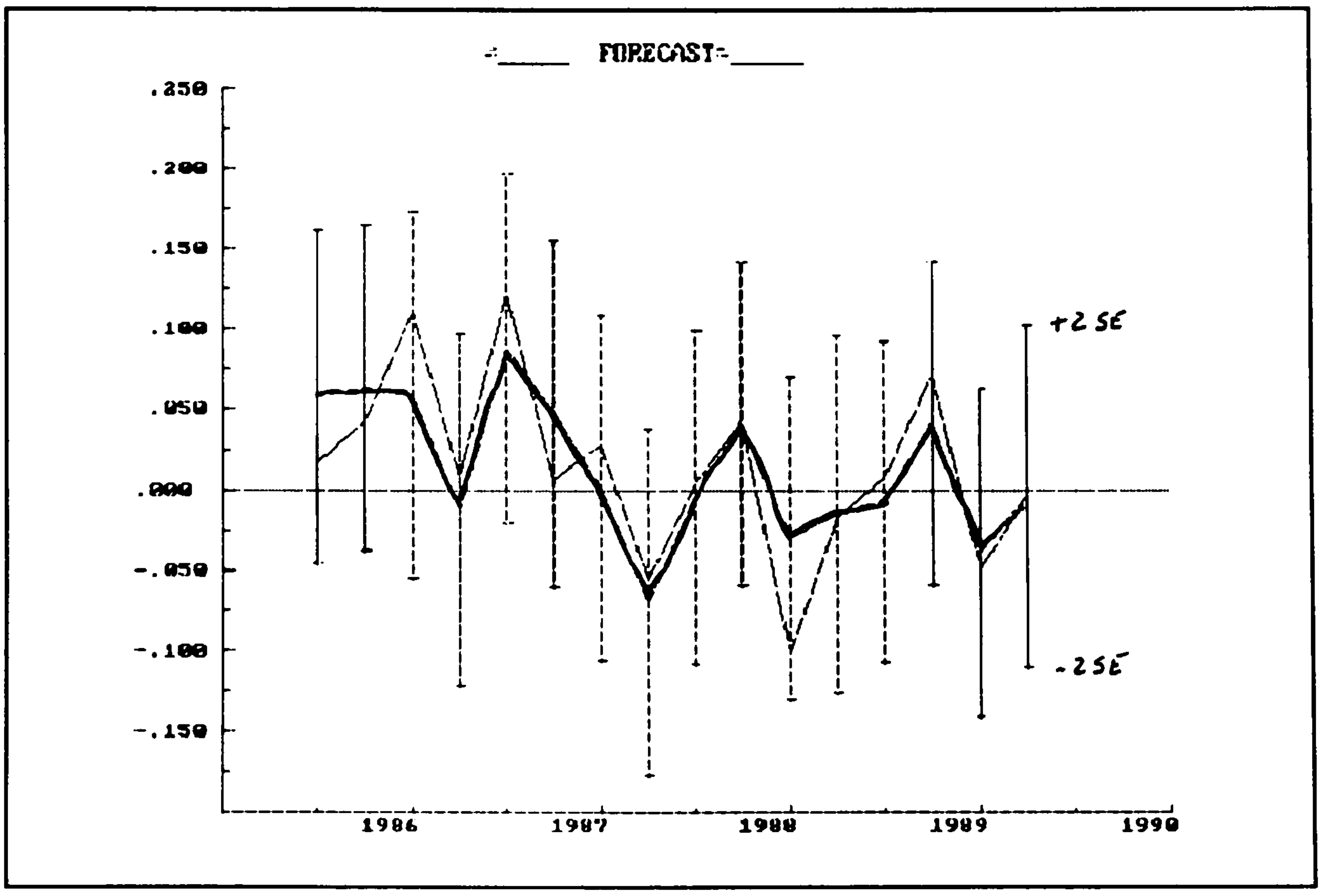
First we note the very strong seasonality in the quarter-to-quarter movements in holdings of narrow money balances (Fig 2.10a). More generally we can also see three distinct phases in the overall fit of the aggregates. The first is the period of the coffee boom in 1976 and 1977 where, because the boom was known to be transitory, movements in cash balances and in the corresponding aggregates were large and transitory, as money fulfilled a buffer stock function in the presence of lagged portfolio adjustment effects. However more interesting is the second phase from late 1979 to mid 1982, where the predictive power of the models seems to be at its weakest, and where it may be possible to argue that the stabilization and trade liberalization efforts during that period served to alter agents' short-term money demand function. The explanation for this has some interesting bearing on the inference on the implicit super-exogeneity conditions in the model (see Hendry and Engle (1986) and Hendry and Ericcson (1991)). In particular, as we discussed earlier this period was characterised by a level and volatility in domestic inflation which were much higher than previously experienced in Kenya, while the increased political uncertainty and loss of government credibility following the attempted *coup d'etat* in 1982 served to increase the parallel market premium. Thus while the deterioration in explanatory power of the models may indicate an omitted-variable bias (for example some measure of political credibility), it may also reflect a violation of super-exogeneity, or, in other words, the effect of the Lucas critique. This argument suggests that, in response to changes in the control regime (ie the introduction of stabilization and liberalization measures), the behaviour of agents will itself change. In terms of an econometric model this can be identified through recursive parameter instability, but, as we shall see shortly, though there is some evidence of such instability at this period, it was not sufficiently significant to reject the null of model and parameter constancy. Finally, in the third phase, as stabilization in Kenya was gradually re-established from mid-1983 onwards, the fit of the money demand functions can be seen to have improved, although (as occurred in 1977) a similar failure to capture the cash surge accompanying the 1986 coffee boom can again be noted.

Figure 2.11

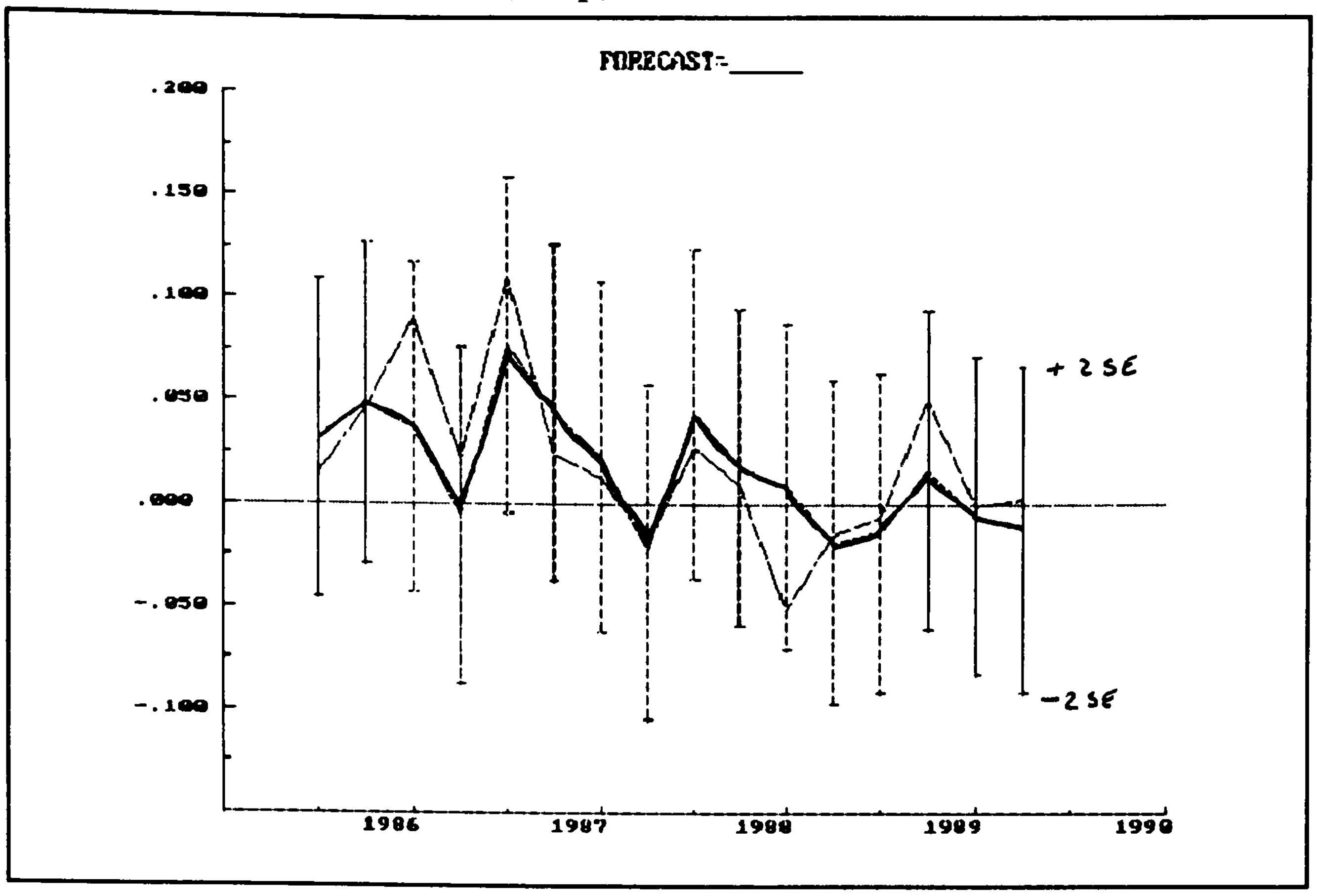
(a) Δ(m0-p) Actual vs Fitted



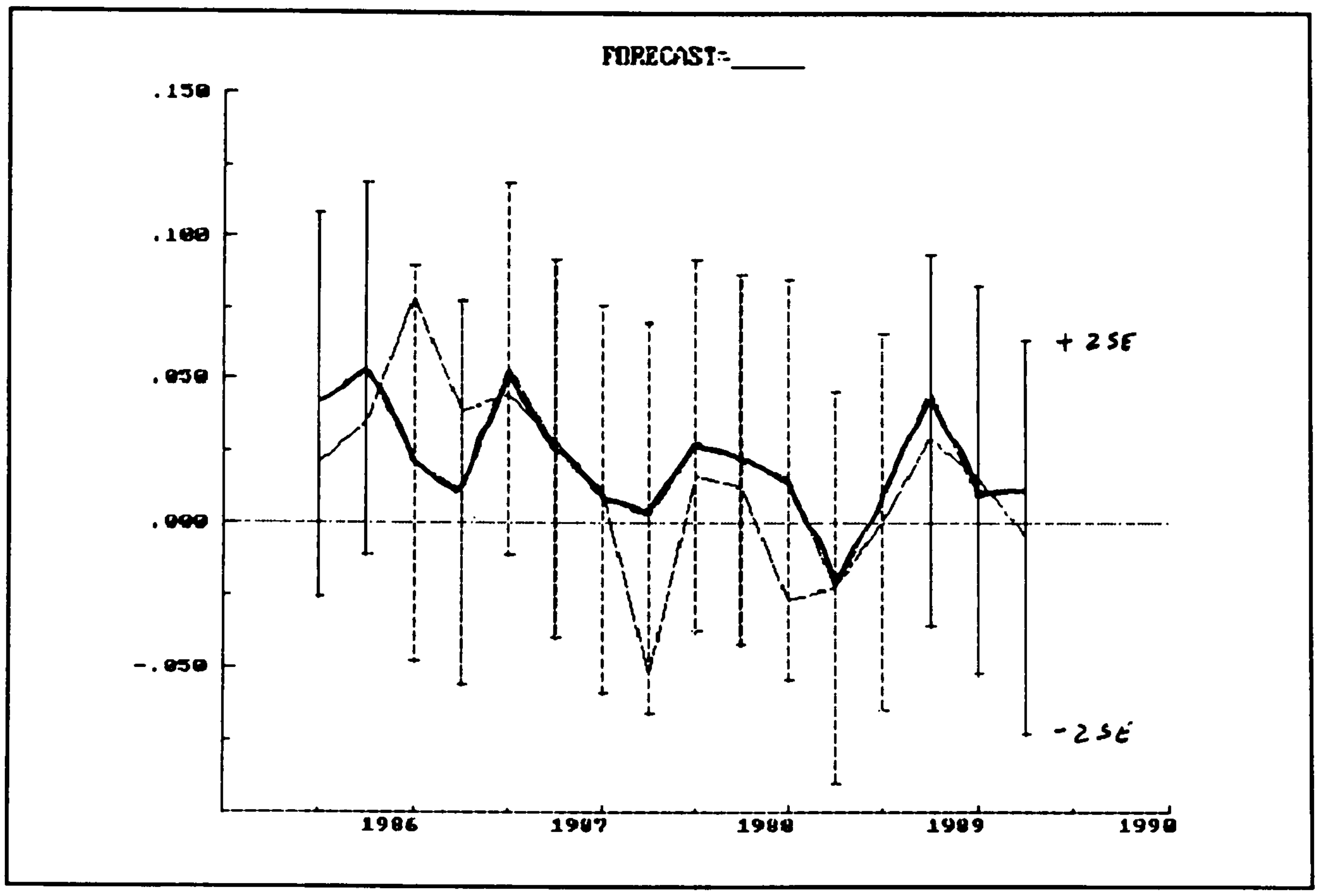
(b) Δ(m1-p) Actual vs Fitted



(c) Δ(m2-p) Actual vs Fitted



(d) Δ(m3-p) Actual vs Fitted



(e) Δ(m3d-p) Actual vs Fitted

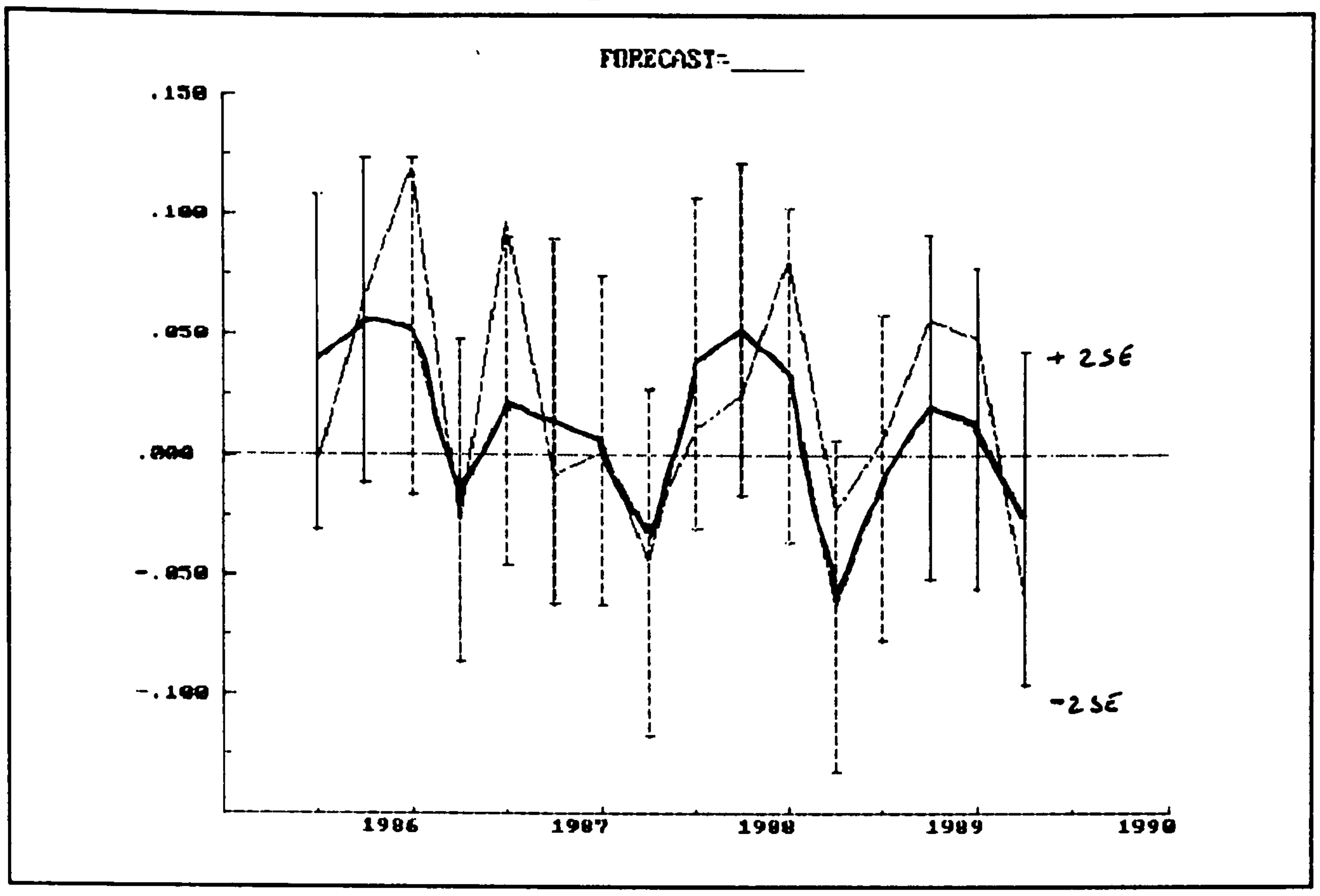
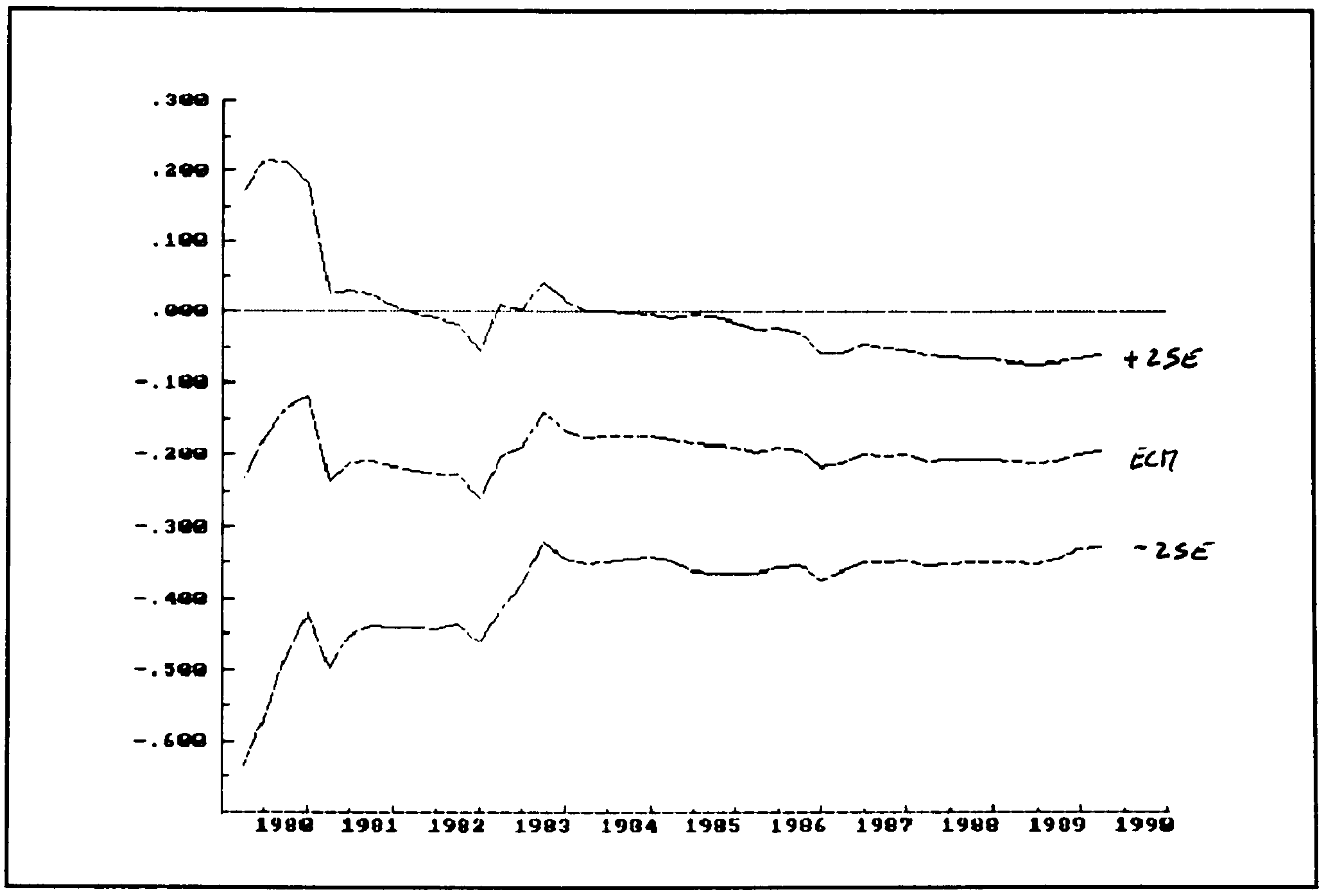
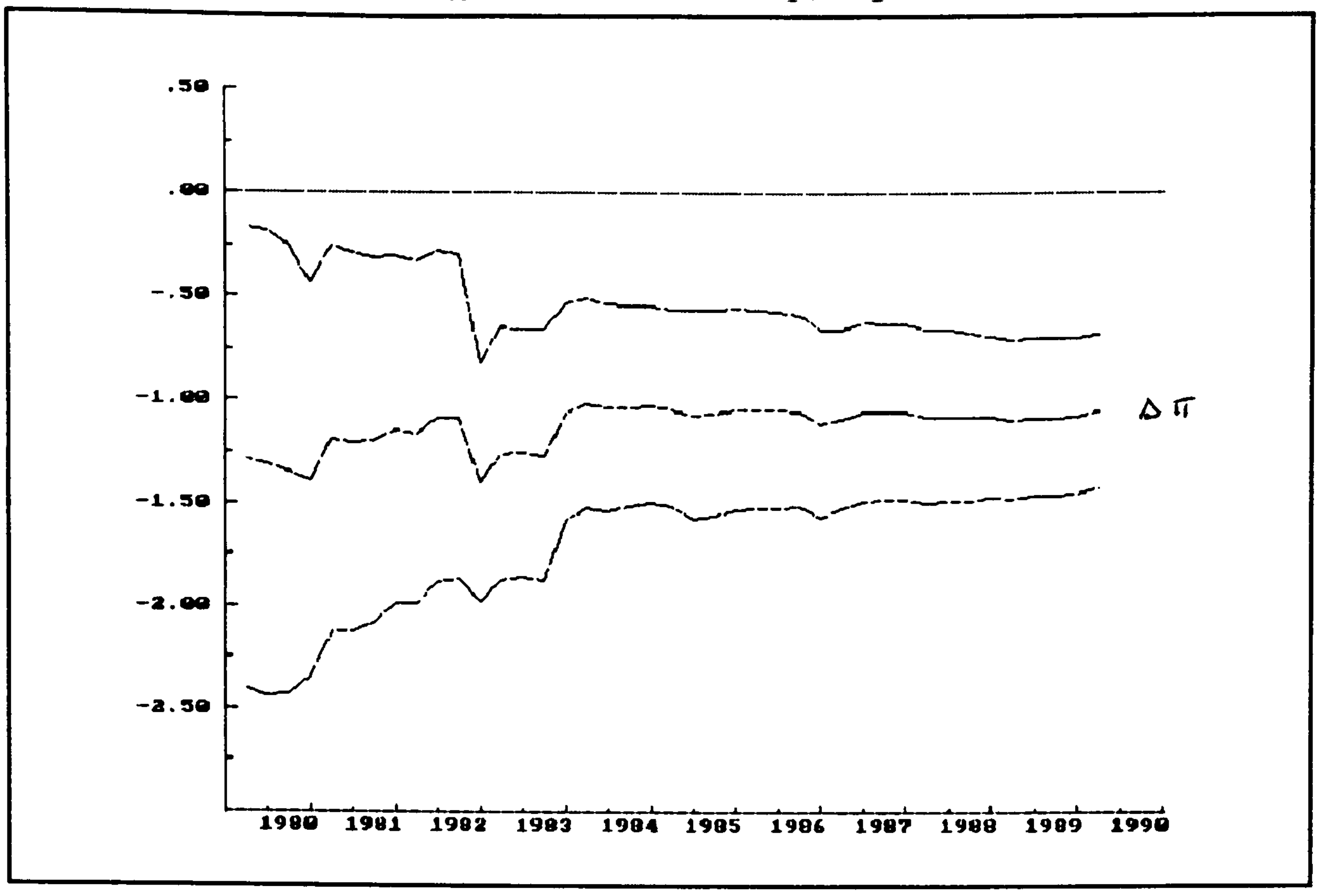


Figure 2.13

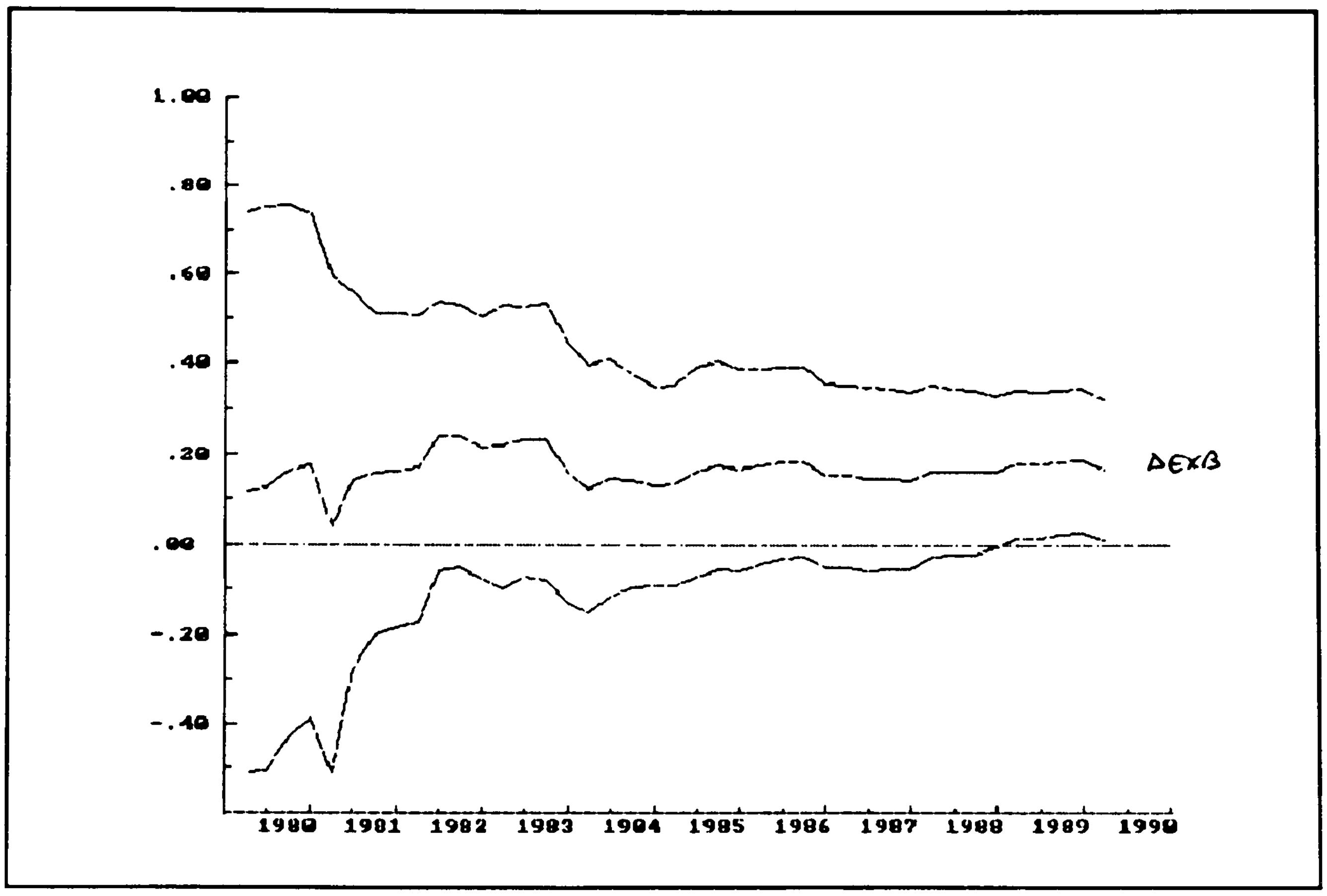
(a) RLS Coefficient Plot, Δ(m0-p) Equation: Ecm



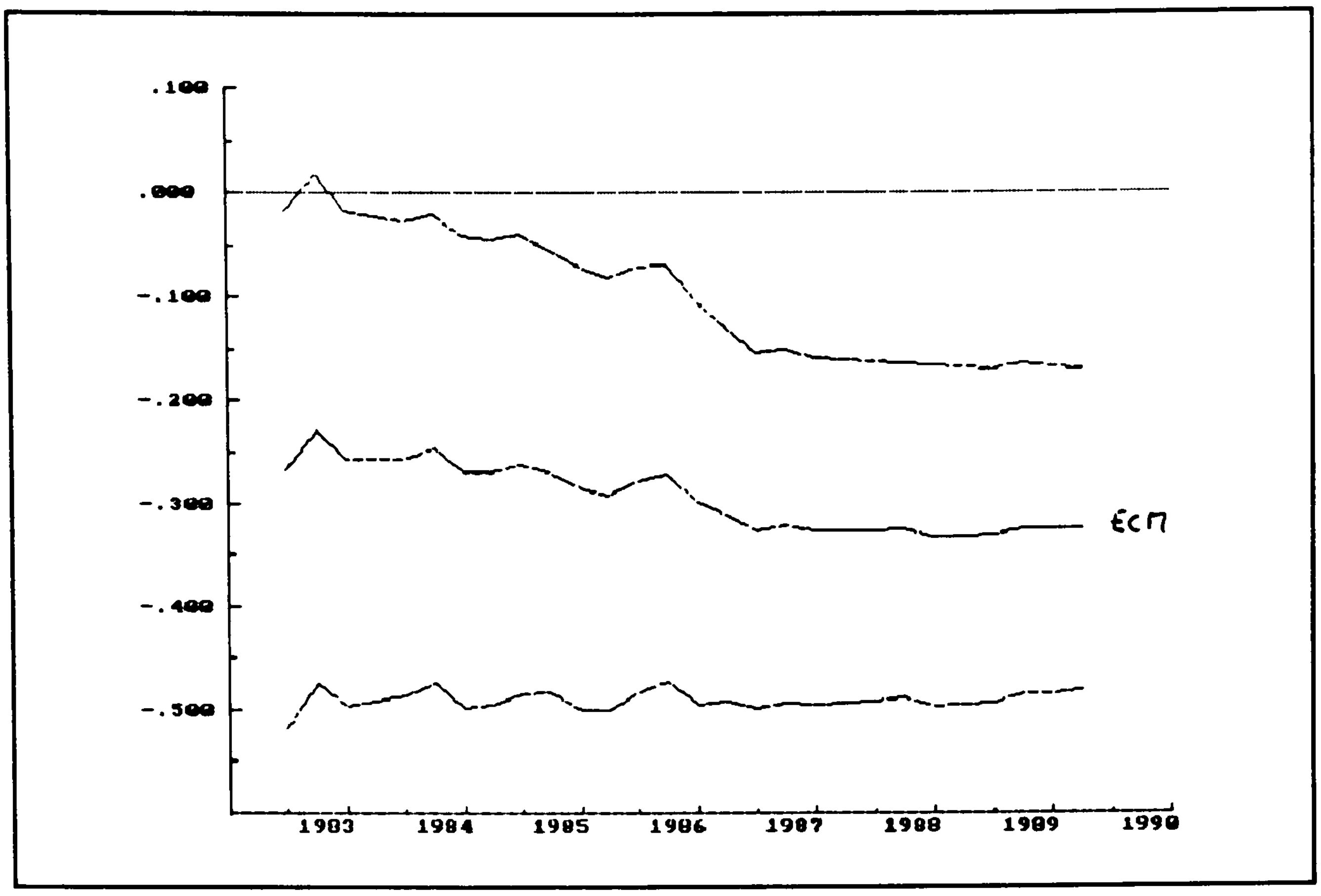
(b) RLS Coefficient Plot, Δ(m0-p) Equation: Δπ



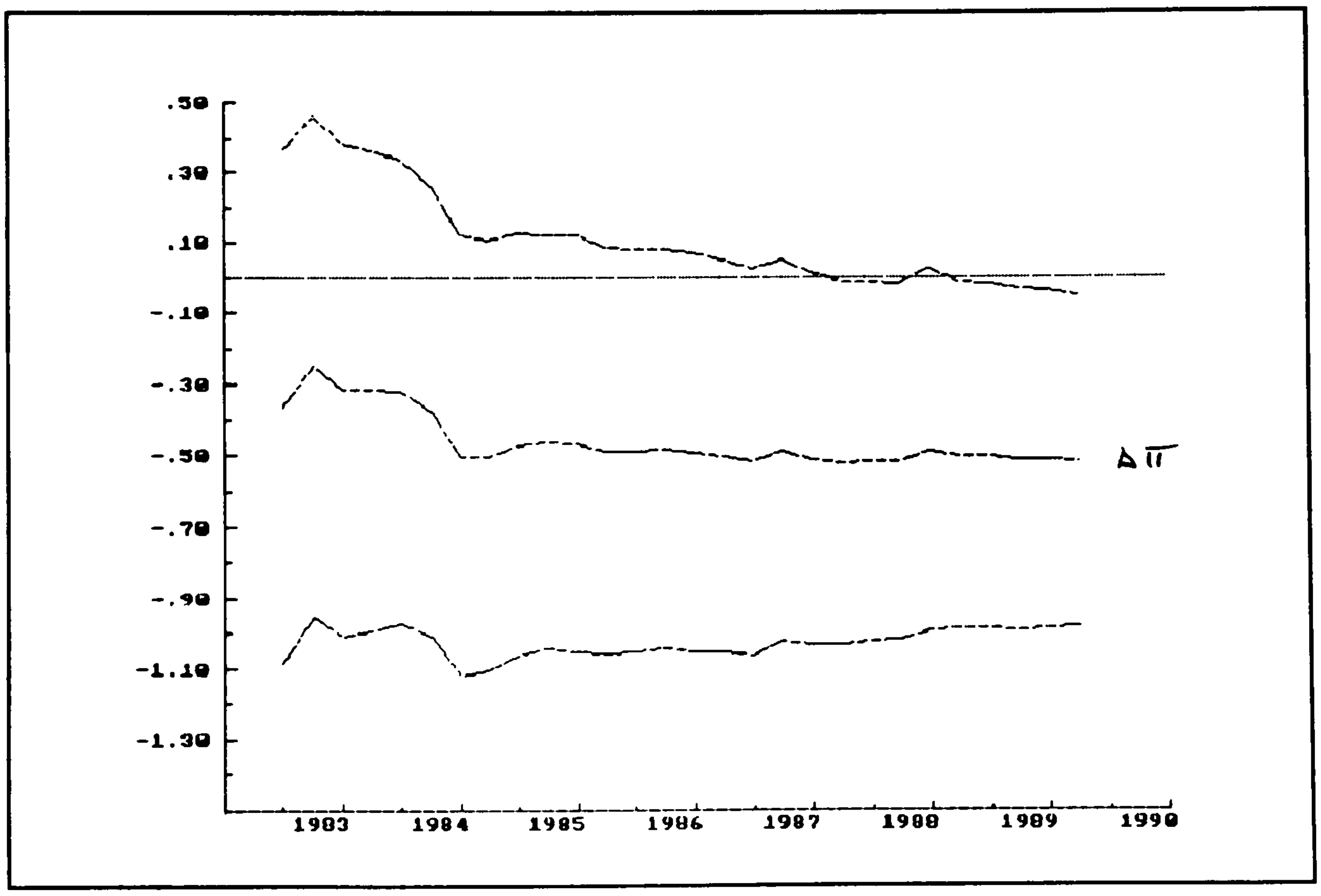
(c) RLS Coefficient Plot, Δ(m0-p) Equation: Δexb



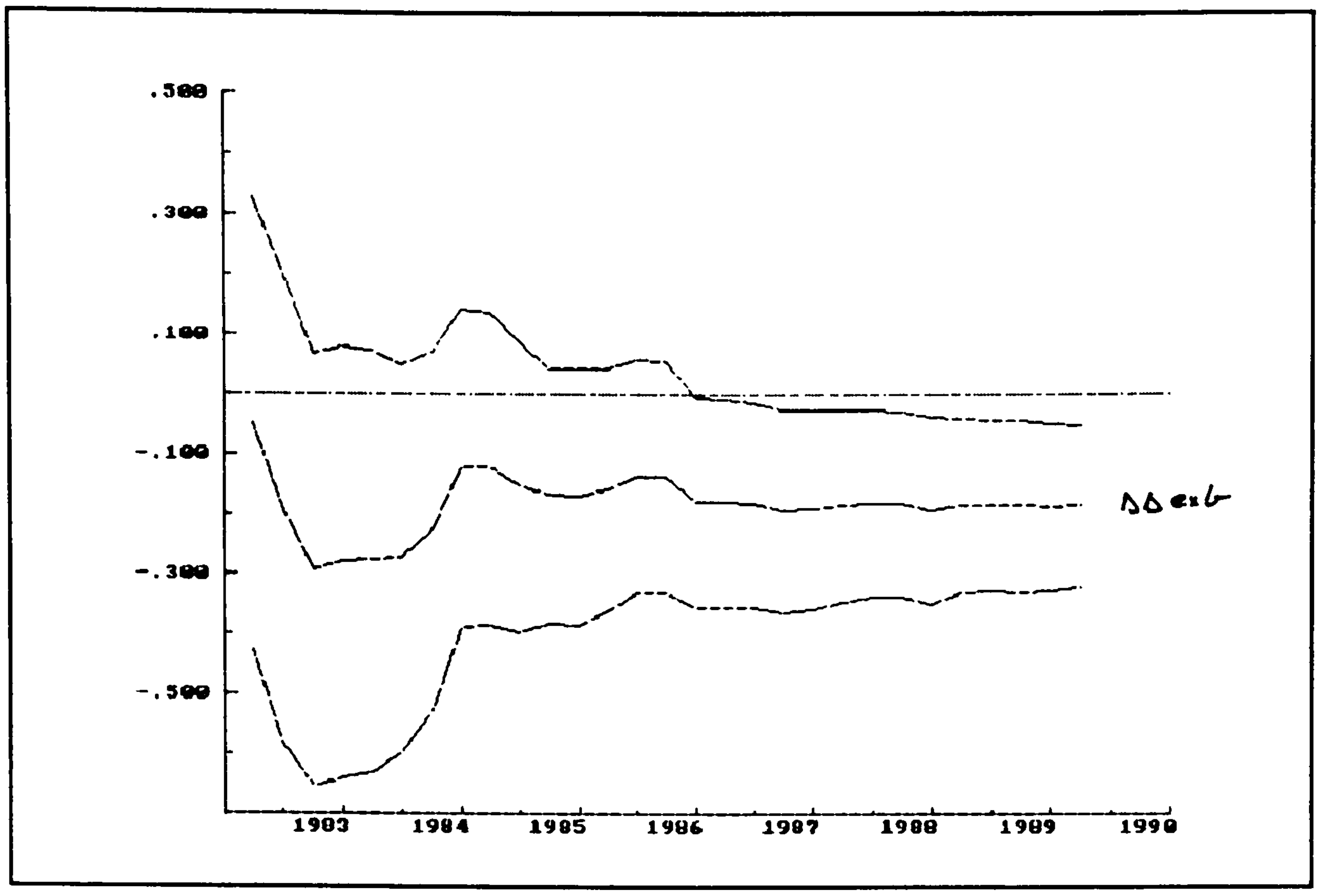
(d) RLS Coefficient Plot, Δ(m1-p) Equation: Ecm



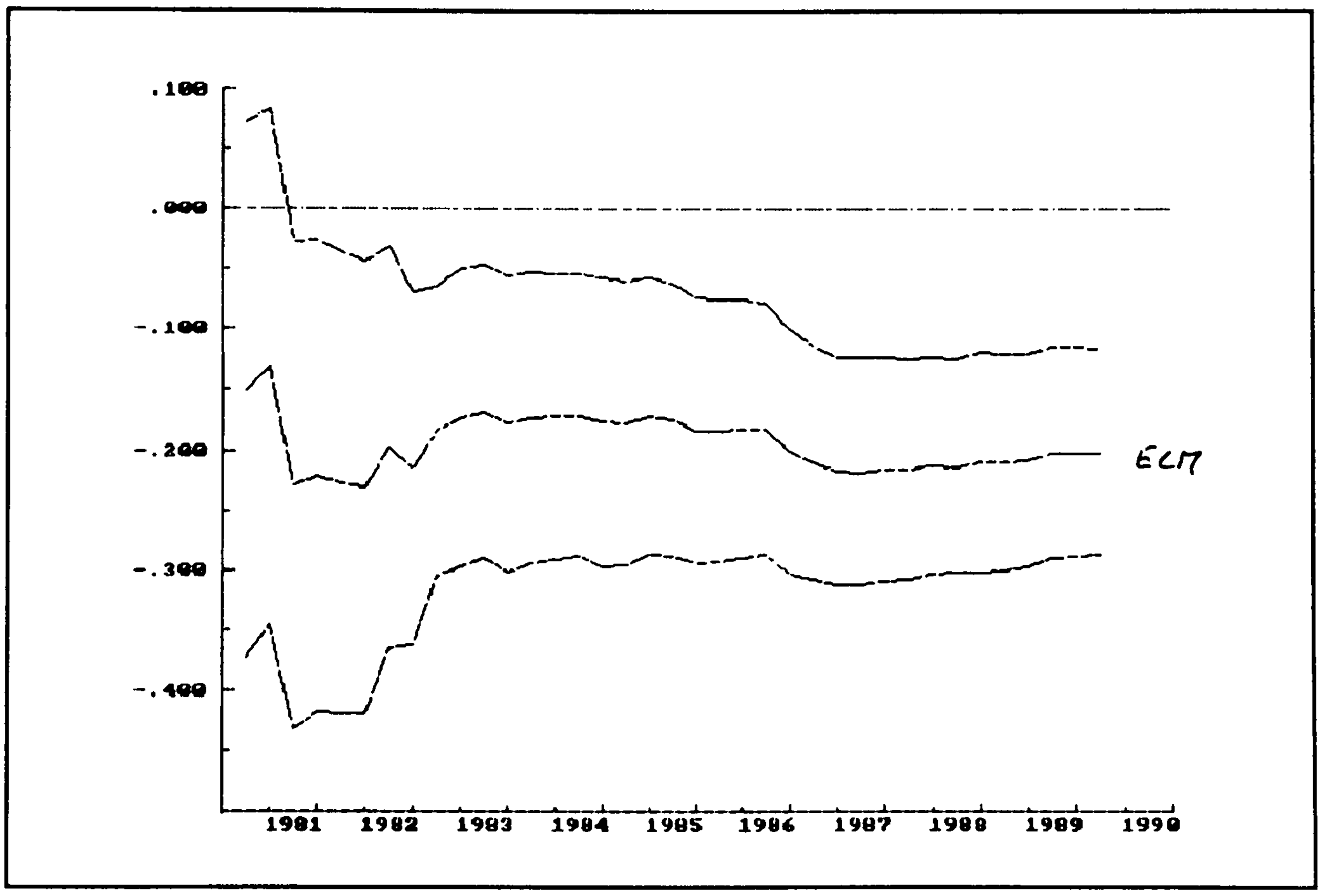
(e) RLS Coefficient Plot, Δ(m1-p) Equation: Δπ



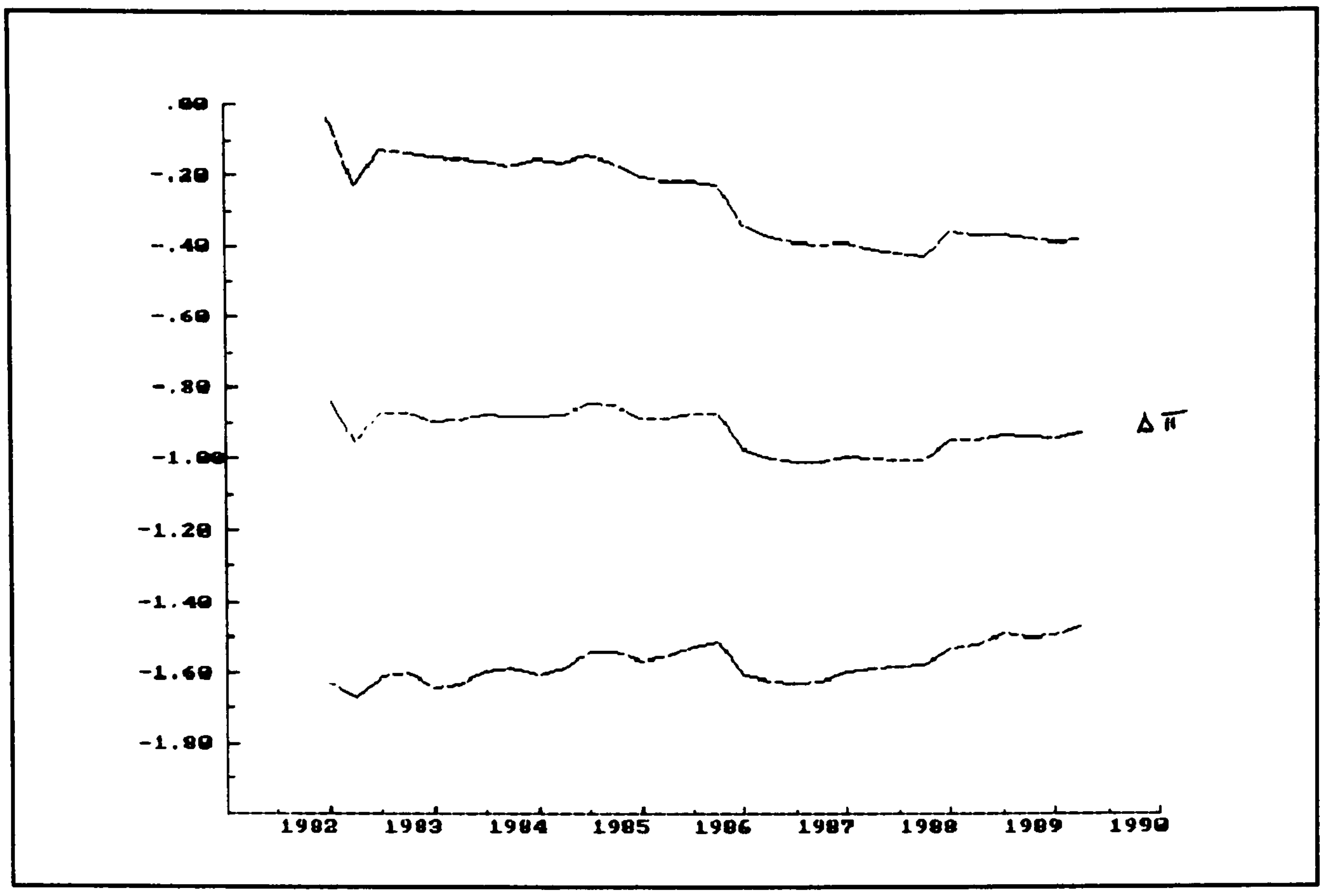
(f) RLS Coefficient Plot, Δ(m1-p) Equation: ΔΔexb



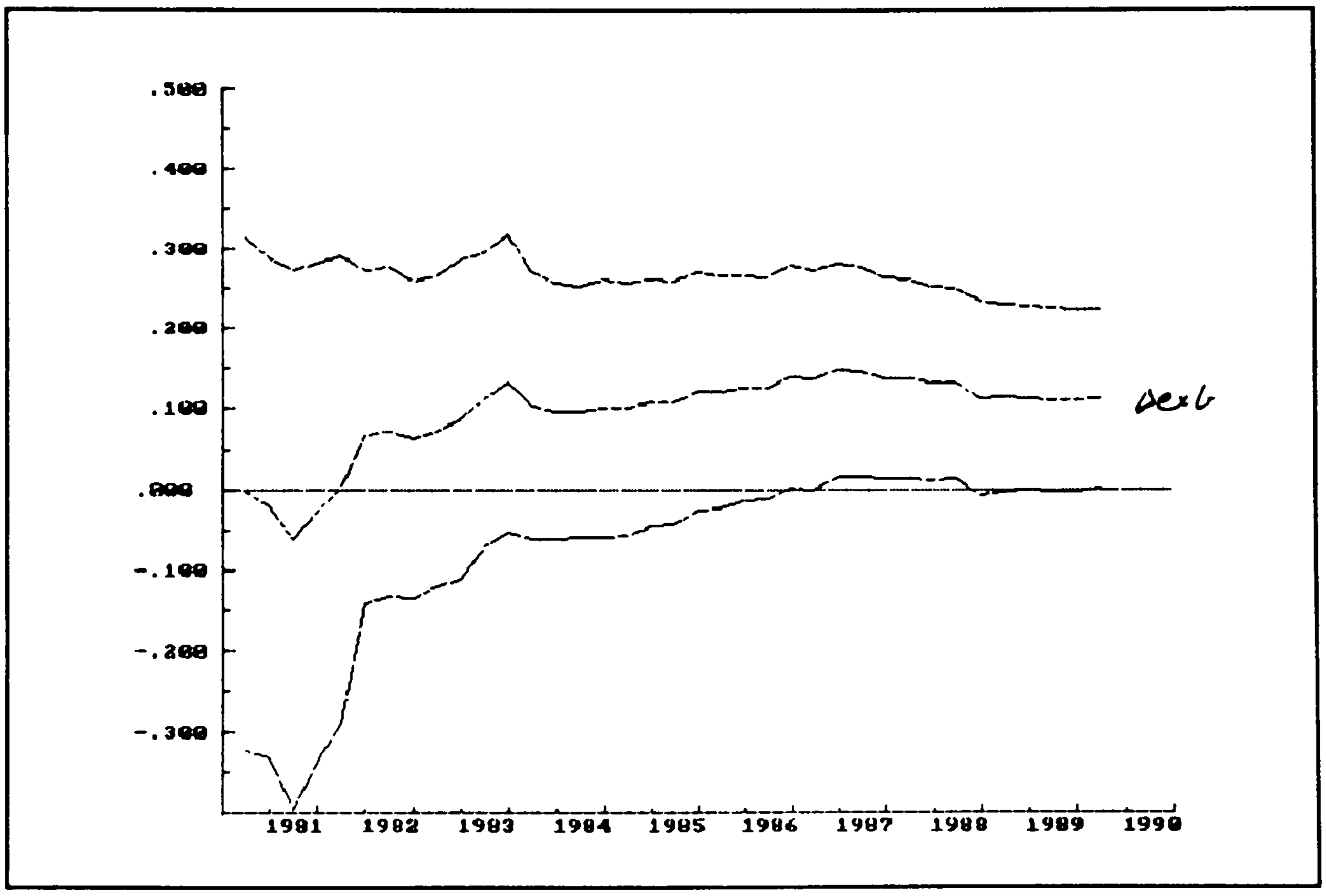
(g) RLS Coefficient Plot, Δ(m2-p) Equation: Ecm



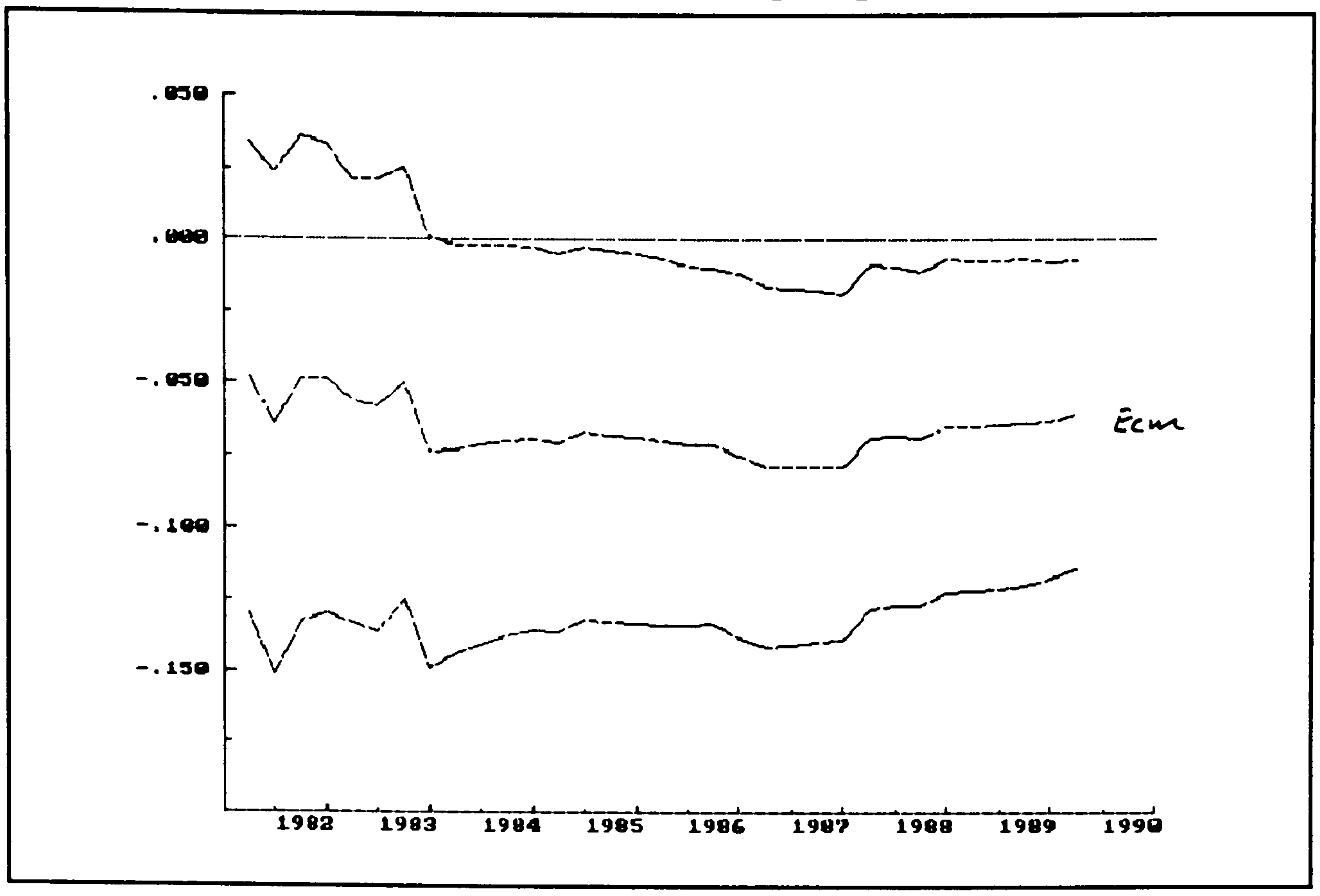
(h) RLS Coefficient Plot, Δ(m2-p) Equation: Δπ



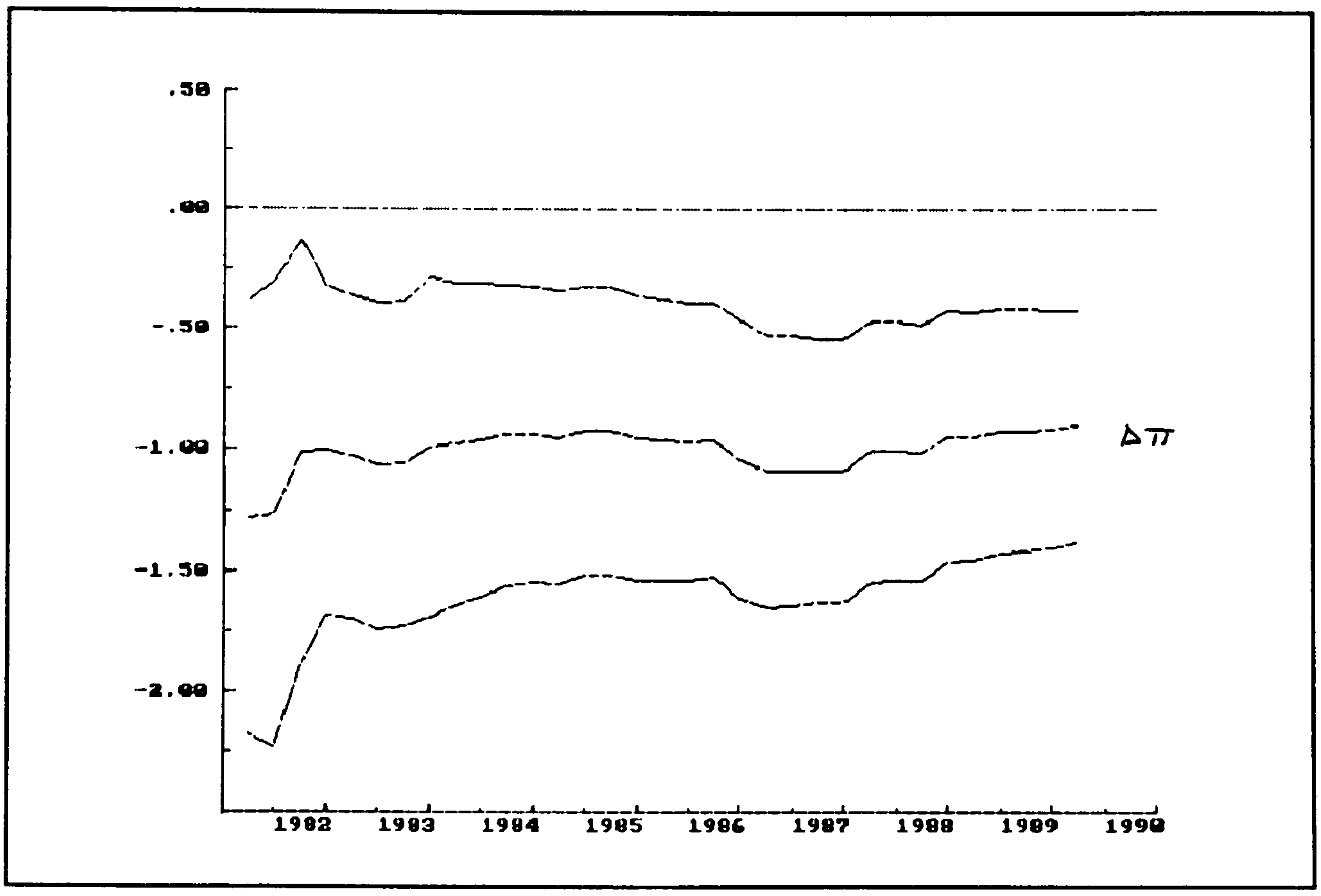
(i) RLS Coefficient Plot, Δ(m2-p) Equation: Δexb



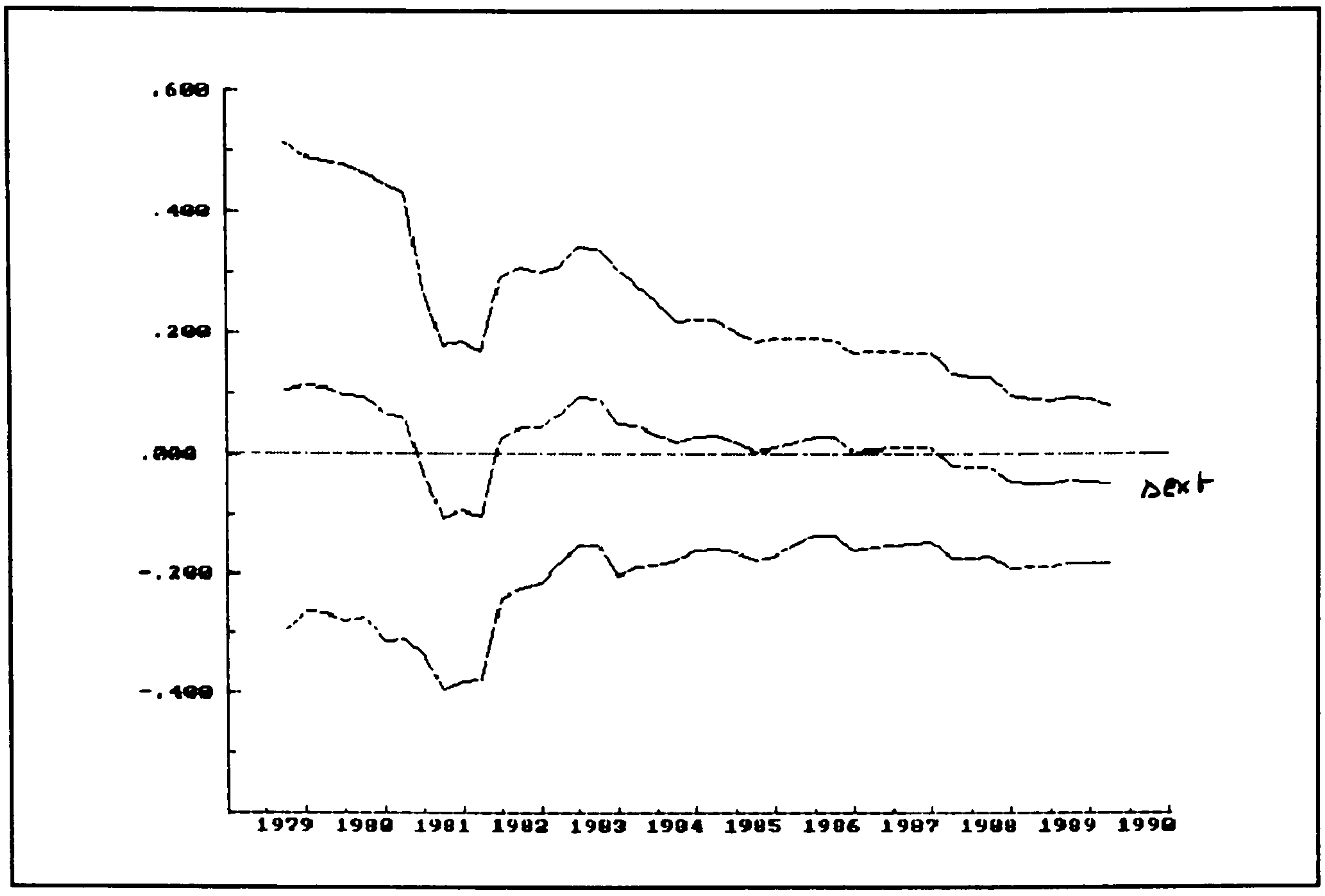
(j) RLS Coefficient Plot, Δ(m3-p) Equation: Ecm



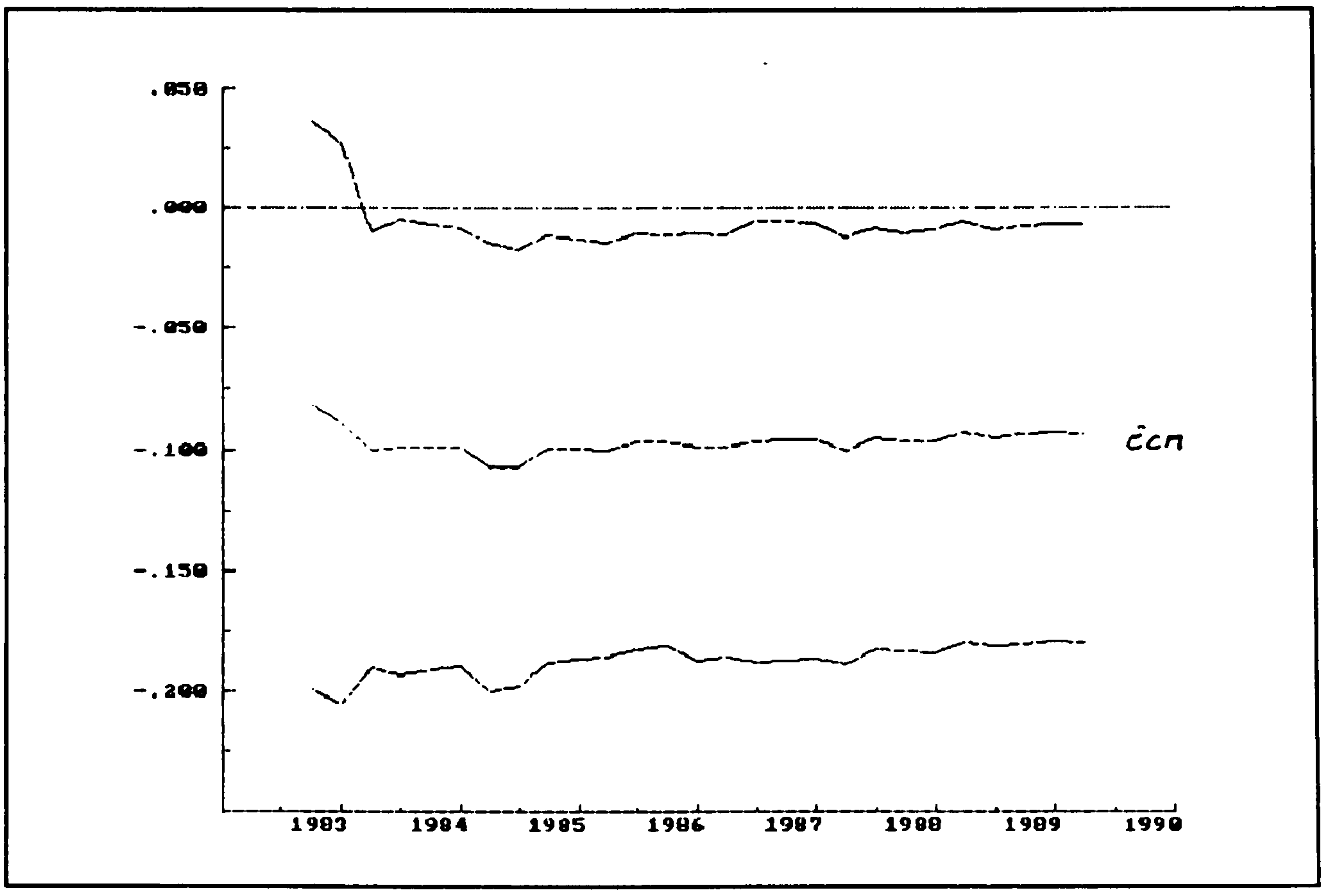
(k) RLS Coefficient Plot, Δ(m3-p) Equation: Δπ



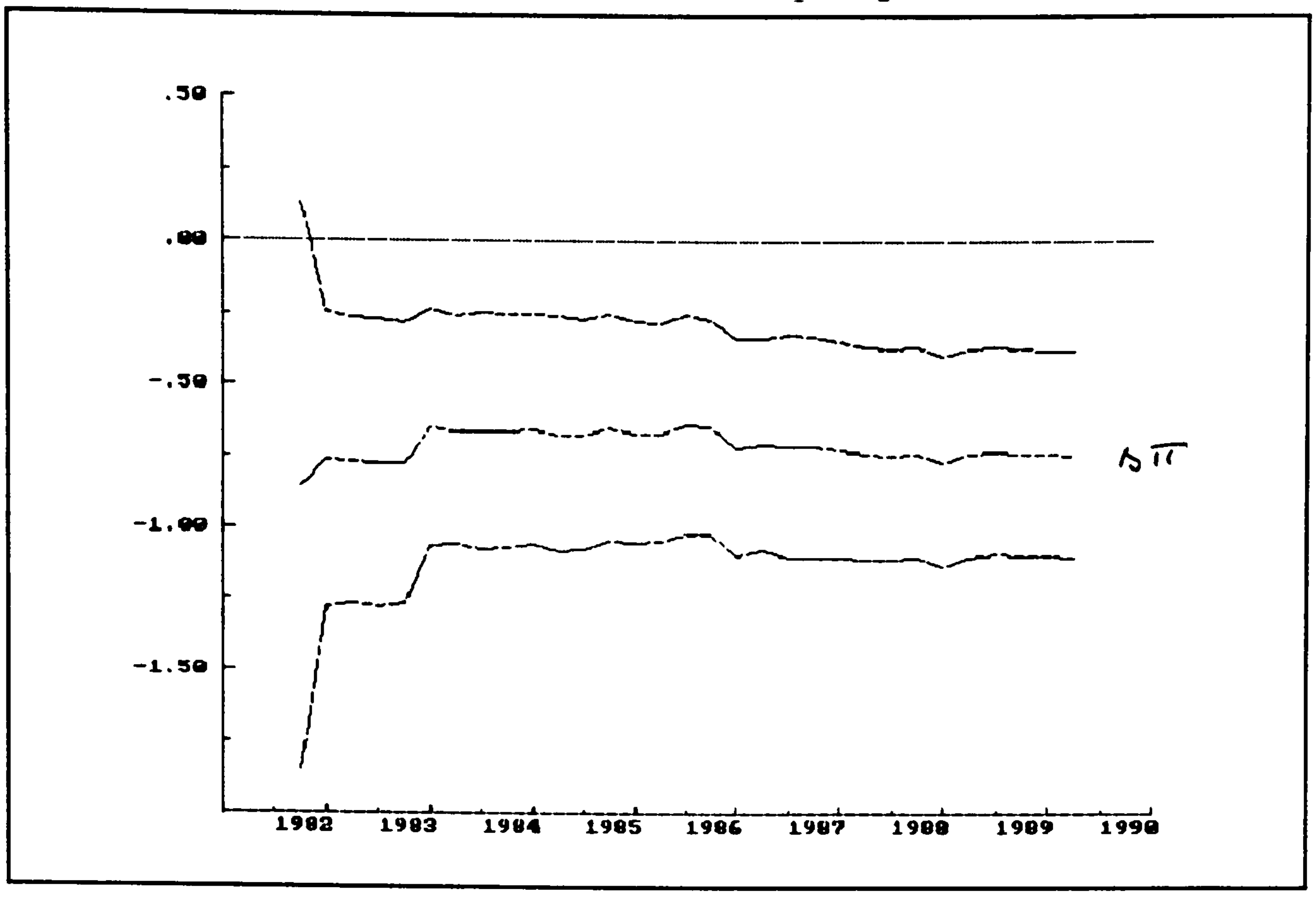
(l) RLS Coefficient Plot, Δ(m3-p) Equation: Δexb



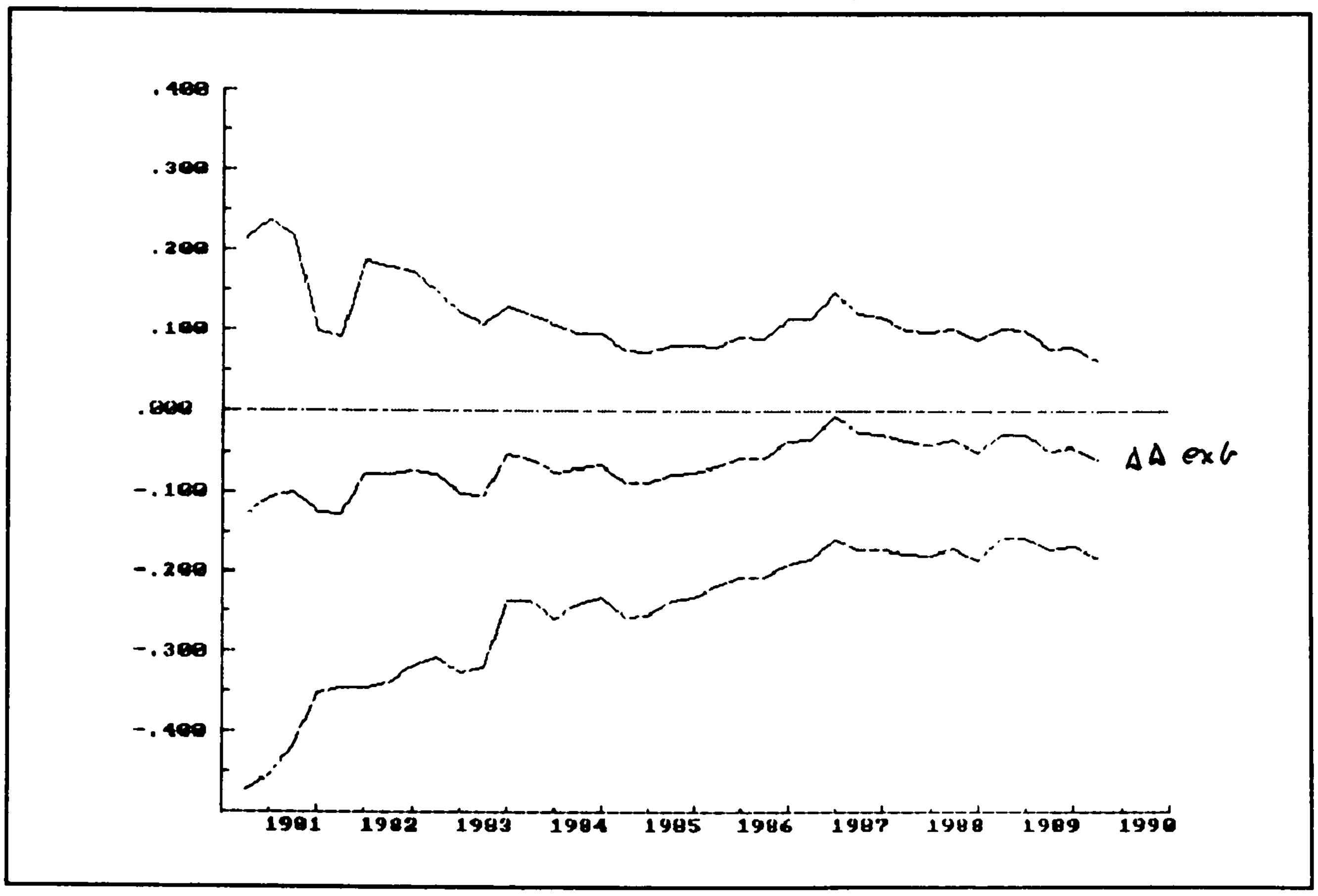
(m) RLS Coefficient Plot, Δ(m3d-p) Equation: Ecm



(n) RLS Coefficient Plot, Δ(m3d-p) Equation: Δπ



(o) RLS Coefficient Plot, Δ(m3d-p) Equation: ΔΔexb



The within-sample stability of the model and its coefficients can be gauged from Figures 2.11 and 2.12 which report the 16 quarter (1985(3) to 1989(2) forecast stability of the model (Fig 2.11), and a more comprehensive analysis of the parameter stability of the model achieved using a recursive least squares estimator (Fig 2.12). For each aggregate forecast stability cannot be rejected for the 16 quarter forecast (see also the ζ_5 statistics in Table 2.11), although as we have already noted, there is a systematic forecast error during the period of the 1986 coffee boom. Turning to the plots of the recursive estimators, a similar picture of parameter and model stability emerges. Because of the degrees-of-freedom limitation on the recursive estimator it is, unfortunately not possible to examine the recursive behaviour of the coefficients for the period before 1980 which is slightly frustrating given our prior expectations that it is likely to be over the periods of the first coffee boom and the 1979 to 1982 period of stabilization that any noticeable parameter instability (due *inter alia* to the absence of super exogeneity) may be expected to emerge.

This drawback notwithstanding, the recursive coefficient plots do suggest a number of strong features. First, the recursive equation residuals (not-reported) for all aggregates are relatively stationary, independent and homoscedastic over time: the equations in general do not grievously violate the classical regression assumptions. Second, for all aggregates the coefficients on the error correction terms and on the short-run inflation effects are well defined and stable. There is no significant deviation from the horizontal, and the standard error bounds are converging over time. Admittedly however, it is early in the sample (around the 1979-82 period) that any discernable parameter instability that does occur can be identified. Third, and finally, the RLS plots cast suggest that the short-run currency substitution effects (the Δexb term) is only reasonably well defined for the M0, M1 and,possibly, the M3d aggregates. The full-sample values for the M2 and M3 aggregates need therefore to be interpreted with extreme caution. Moreover the RLS plots for this term do quite clearly confirm the sign switch in this effect between the M0 and wider aggregates as was noted in Table 2.11. We discuss this effect in the next section.

Third, we note that for the full-sample model all five aggregates perform satisfactorily against the standard battery of diagnostic tests, and in no case can any violation of the conditions of error homoscedasticity, or zero autocorrelation be identified. Combined with the within-sample forecast stability and the evidence from the recursive analysis of the model coefficients we can therefore conclude that all the equations provide a tentatively adequate characterization of the data. On the basis of this we assess the encompassing implications of the models before considering the economics of the dynamic demand for money models.

Encompassing Implications

One of the minimum conditions for acceptance of new empirical work is that it encompasses existing studies in the field. Though the literature is not widespread it is possible to examine the encompassing issue with reference to Mwega (1990) which is the most comprehensive, the most recent, and the best of the existing studies of Kenyan demand for money.[45] Mwega estimated a partial adjustment specification where the dependent variable was the level of real money balances, as opposed to the first difference (as in the error-correction models estimated here). The results of his estimation, derived from the same data definitions (including, for consistency, the same income interpolation) are given in equations (2.30) and (2.31), where the same nomenclature as above is used, and where 't' statistics are reported in parentheses

$$(2.30)\quad (m1\text{-}p)_t = \underset{(1.5)}{0.94} + \underset{(0.7)}{0.04}(y\text{-}p)_t \underset{(3.0)}{-1.28}\,\pi_t \underset{(3.1)}{-0.04}\,rtb_t + \underset{(12.7)}{0.84}\,(m1\text{-}p)_{t-1}$$

$$R^2 = 0.82 \quad \sigma = 0.231 \quad DW = 2.03$$

$$(2.31)\quad (m2\text{-}p)_t = \underset{(0.5)}{0.20} + \underset{(1.7)}{0.07}(y\text{-}p)_t \underset{(5.1)}{-1.32}\,\pi_t \underset{(2.7)}{-0.02}\,rtb_t + \underset{(19.7)}{0.91}\,(m2\text{-}p)_{t-1}$$

$$R^2 = 0.92 \quad \sigma = 0.090 \quad DW = 2.00$$

[45] I am grateful to Francis Mwega for supplying data for his M1 and M2 demand equations which has allowed for the following encompassing exercise to be carried out.

In both equations, the current values for income, inflation and the interest rate are derived from Almon lag representations of the variables. We commence by assessing the competing models (estimated over the same data and sample period) relative to independent performance criteria, and then on the basis of a re-parameterization of the Mwega model into a first difference growth model we execute direct variance encompassing exercise. In both cases since only data for M1 and M2 were made available we restrict our encompassing exercise to these two aggregates. The relative performance of the models are compared in Tables 2.12 and 2.13. Table 2.12 indicates that in terms of general performance criteria the models estimated in this chapter generally out-perform those of Mwega, most notably with respect to forecast accuracy. This underlines the extent to which Mwega's model is dominated by the time series characteristics of the dependent variable itself.

Table 2.12
Competing Model Performance

		Equation Std Error	Schwarz Criterion	16 Forecast χ^2
M1	per Table 2.11	0.043	-5.81	0.43
	Mwega (2.30)	0.059	-5.15	2.83
M2	per Table 2.11	0.032	-6.32	0.53
	Mwega (2.31)	0.046	-6.05	1.43

Table 2.13 summarises the results of the nested-encompassing exercise in which the Mwega demand function is transformed into a first-difference model. The individual tests are explained in Hendry (1989), but in both cases model 1 (the

error correction dynamic model estimated in this chapter) significantly encompasses the Model 2 (ie the Mwega model), and, incidentally, easily encompasses the joint nesting model (the Joint Statistics).[46]

The ability of the error-correction models to encompass the form specified by Mwega is not surprising given the evidence on the long-run cointegration between the variables of the model, such that the addition of long-run information to the dynamic model will clearly improve the explanatory power of the model, but this exercise does serve to underline both the significance of the cointegrating relationships underlying the dynamic demand relationships, and, seemingly, the importance of currency substitution effects in portfolio aspects of the demand for money.

Table 2.13
Nested Variance Encompassing Tests

M1 Aggregate

Model 1 as per Appendix 2(B)

Model 2 is Mwega (1990) (2.30 above) in first differences.

$\sigma 1$ = .041732 $\sigma 2$ = .059459 σ[Joint] = .042776

Model 1 v Model 2	Form	Test	Form	Model 2 v Model 1
0.362	N(0,1)	Cox	N(0,1)	-28.369
0.373	F(4,48)	Joint	F(7,48)	8.324
[.8296]				[.0000]

[46] Under the null that M_1 encompasses M_2 the Cox test has a standard normal distribution. A significant value for the statistic indicates a failure to encompass. If both models fail to encompass each other, then the Cox statistic is significant for both M_1 vs M_2 and M_2 vs M_1 (note that for two models to fail to encompass each other is valid and is evidence of two weak models). The F test is a test of each model against the joint nesting model.

M2 Aggregate

Model 1 as per Appendix II(b)

Model 2 is Mwega (1990) (2.31 above) in first differences.

$\sigma 1$ = .032271 $\sigma 2$ = .046469 σ[Joint] = .033284

Model 1 v Model 2	Form	Test	Form	Model 2 v Model 1
0.477	N(0,1)	Cox	N(0,1)	-24.758
0.235	F(4,48)	Joint	F(7,48)	8.322
[.9170]				[.0000]

Economic Interpretation of the Models

In discussing the economic interpretation of these demand for money functions it needs to be borne in mind that in each case we are considering the dynamic behaviour of the equations around the long-run, or equilibrium, demand function characterised by the cointegrating vectors discussed in the previous section. In this respect the most important coefficient of the dynamic model is the feedback on the error correction term. Comparing tables 2.6 and 2.11 we note that the feedback reported in the dynamic single equation model (estimated unrestrictedly, and reported as Ecm) is virtually identical to the corresponding feedback reported in the α loadings matrix under the Johansen procedure and used in defining the cointegrating vectors. This closeness supports the validity of the structure of the cointegrating vectors used in the models.

These results suggest a relatively intuitive picture in which the narrow aggregates M0, M1 and M2 enjoy a much faster adjustment than broader aggregates where possibly higher transactions costs may preclude rapid adjustment. Thus in the case of the narrower money balances approximately 20 per cent of the previous disequilibrium from the long run solution is corrected per period, while for the broader M3 aggregates the figure is closer to 10 per cent per period. This speed of adjustment is again comparable to similar work for industrialised economies (for example Hendry and Mizon (1991) report a 10 per cent feedback effect for UK M1), but is almost twice as rapid as the adjustment speeds implied by Mwega's (1990) partial adjustment models which, in view of the autoregressive nature of the money aggregates, imply relatively slow adjustment to equilibrium.

In terms of the other short-run dynamic effects in the model a number of features warrant attention. The first is the relatively consistent short-run inflation effects for all aggregates. In each case the growth rate of inflation (ie the acceleration in the price level) has an immediate and significant effect on real money holdings (aside from other considerations of price homogeneity). In this economy then, while the price level may be neutral, its growth rate is not (as shown by the cointegrating vector), and its acceleration is similarly non-neutral in the short-run. This result is integral to the analysis of inflation tax pursued in Chapter 3, not least to the extent to which as a result of this relatively high, and rapid, substitutability between money and real assets and/or consumption, the scope for raising inflation tax from the private sector is likely to be limited. This is consistent with the fact that the short-run price acceleration effect is highest in the case of the M0 equation: whereas all the effect of inflation on narrow money balances represents a transfer to government, with broader aggregates the inflation effect consists of a "tax" component arising from wealth transfer on government liabilities (ie M0) plus an inside-money wealth transfer from creditors to debtors through the banking sector. In aggregate we would therefore expect a slightly lower inflation elasticity the broader the aggregate (as is borne out between the M0 and M3d cointegrating vectors and dynamic models).

A second feature of note concerns the short-run interest elasticity in the model. We noted during the analysis of the long-run cointegration relationships between the variables of the model that there existed a strong and stable stationary relationship between the rate of inflation and the market interest rate as proxied by the Treasury Bill discount rate. Table 2.11 indicates that in contrast to the positive long-run own interest rate elasticity, the short-run elasticity is negative. This is a relatively standard result reflecting the fact that the interest rate elasticity in this form of single-equation model is necessarily an amalgum of the positive own-rate effect and the negative effect of the rate on non-monetary financial assets (such as bonds). In this case as the money aggregate widens the short-run elasticity of demand with respect to the growth of the interest rate increases, indicating broader portfolio considerations in determining money holdings. While this result is standard, one result that may require some interpretation is the difference in the interest elasticity between the two M3 aggregates. This can be explained as follows: changes in the interest rate will induce two sets of effects, the first being out of money into other financial assets, but the second is the switch between non-interest bearing and interest bearing components of money. As we have discussed above, the principle behind the Divisia index is that the simple-sum aggregate overstates the substitutability between components of money, and consequently for any given rise in the interest rate the apparent elasticity of the simple-sum aggregate to *external* substitution effects will be dissipated by the *internal* substitution effects brought about by switches from non-interest bearing to interest bearing components of money. In contrast, however, the Divisia index by definition is neutral to changes in the composition of the money aggregate (in other words it has already captured the internal substitution effects) and as a result the interest elasticity represents only the external interest elasticity of demand (see also Barnett (1980) p 41).

Finally we consider the interpretation of the currency substitution effects. In the cointegrating vectors for the M1, M2 and M3 aggregates we identified a significant, but small, negative elasticity with respect to non-interest bearing (and illegal) foreign currency holdings as proxied by the parallel market exchange rate. There was however no identifiable long-run levels relationship between narrow money holdings and the parallel foreign exchange rate. This could be rationalised quite simply in terms of a economy where narrow money balances are held in the long run exclusively for domestic currency denominated transactions purchases while currency substitution entered as a portfolio/precautionary considerations in the determination of the level of broader money holdings. In the short-run however the picture is altered as we observe an economy in which there remains a currency substitution motive but which in which the narrow money holdings act as a buffer stock through which foreign currency transactions are effected. Thus, while (with the exception of the M2 aggregate) depreciation of the parallel market exchange rate reduces short run holdings of broader aggregates, it in fact *increases* holdings of cash in the short run. Since currency substitution is illegal in Kenya, transactions are of necessity conducted in cash and thus agents switch from deposits into cash in anticipation of currency substitution opportunities. Having said this, however, it may be noted that the currency substitution effects in the demand for money seems to be only weakly identified in these models and is relatively slight, and the dynamics not particularly well understood (see our discussion of the recursive stability of the models above). In part this reflects the known fact that in Kenya not only is the parallel market illegal, but, because the government has avoided the overvaluation of the official exchange rate, it is also a relatively small and specialised market, certainly in comparison to economies such as the Sudan, Uganda and Tanzania.

One criticism of this reduced form specification of the currency substitution effect has implications more broadly with the validity for the aggregate feedback models, such as those reported in this chapter, in accurately capturing the true forward-looking expectations of agents, since we note that in all cases the currency substitution effect occurs with a lag. Hendry (1988) discusses this issue in the context of forward-looking models of the demand for money in the UK and argues that, in aggregate, feedback models may provide a dynamic characterization to the true forward-looking (but unobservable) decision rules of agents in terms of the autoregressive processes in the model. He provides a set of encompassing implications which test for the discrimination between feedback and "true" rational expectations models (ie *a priori* forward-looking models in which unobservable expectations are proxied with a backward looking VAR process). The principal encompassing implication of this form of discrimination concerns the constancy of the model parameters in response to changes in the marginal processes determining the "forward looking" variables. In particular, in a forward-looking rational expectations world the conditional model (ie the demand for money equation) cannot be constant in the presence of variability in the structure of the model determining expectations (ie the Lucas critique). The discovery of parameter constancy in the conditional model in the presence of variation in the marginal model for the (possibly) forward-looking variables will serve to identify the model as a genuine and theoretically valid feedback model. We do not test this formally, but rather appeal to the evidence from the recursive estimations which indicate that though there is some parameter non-constancy in the explanatory variables (income, inflation interest rates and parallel market rates) over the 1982-4 period when the marginal processes are most likely to have been unstable it was not possible to conclusively reject the null of parameter constancy. If the forward-looking model was in fact correct the null would have to have been rejected more conclusively. We therefore tentatively accept that the feedback model does provide an adequate characterization of the decision rule employed by private sector agents in determining their demand for money in respect of expected black-market exchange rate depreciation.

2.8 The Weak Exogeneity of Inflation in the Demand for Money

A final issue which remains to be addressed in this chapter concerns the issue of the weak exogeneity of the current dated regressors, $\Delta\pi$, Δrtb in the dynamic models of money demand. If these regressors are, in fact, simultaneously determined with Δ(m-p), this necessarily violates the implicit weak exogeneity conditions of the model, and consequently invalidates inference drawn from the models presented so far. Traditionally this issue can be examined in two ways. First violations of weak exogeneity may be indicated by parameter non-constancy and therefore a recursive estimation method can be employed to examine model and parameter stability. As we have seen, the data do not seem to reject parameter constancy. A second approach to modelling the possible endogeneity of these variables is to re-estimate the demand equations using an instrumental variable estimator.

However a problematic issue arises with this approach in that single-equation Instrumental Variable estimates may not be valid either. This flows from the implicit assumptions of the vector cointegration analysis carried out above. An important implication of identifying multiple cointegration relationships across a vector of variables is that simultaneity will be present if the same cointegrating relationship is present in several equations in the system. In particular if the money demand cointegrating vector (Ecm) is significant for the models determining $\Delta\pi$ and Δrtb then the latter variables cannot be weakly exogenous with respect to the demand for money equation.

In the case of the demand for money in Kenya we shall examine the implications flowing from the identification of two cointegrating vectors across the variables as follows. We commence by investigating whether the cointegrating vector civ1, which we define empirically as

(2.32) $0.4\pi + \text{rtb} = c$

where c is a constant, is a significant determinant in the equations for Δ(m-p). In other words we test for possible biases which arise through the omission of the second cointegrating vector from the dynamic demand for money functions. We use a simple omitted variable test to examine this hypothesis.[47] The results, which are in the form of an F Test are presented in Table 2.14.

Table 2.14

F Test of significance of cointegrating vector (2.32) in money demand

Equation	F test	Probability
M0	0.264	[.6065]
M1	0.553	[.7387]
M2	0.518	[.7686]
M3	0.563	[.7283]
M3d	0.352	[.8814]

[47] This hypothesis was also tested by including the civ cointegrating vector in the FIML money demand equations reported below, and in all cases the variable was insignificant.

While these results clearly indicate that we cannot reject the null that civ1 is not significant for the demand for money function, they are necessary rather than sufficient to accept the weak exogeneity conditions in the demand for money functions. We therefore conclude this examination by considering the joint significance of the two error correction relationships in the determination of the dynamic equations for money, inflation and interest rates within a small simultaneous equation system, using a non-linear Full Information Maximum Likelihood (FIML) estimator. We maintain our preferred demand for money functional forms as reported in Appendix 2(C), but for the inflation and interest equations we specify standard autoregressive processes augmented by the two error correction terms. Since the purpose of this estimation is principally to test the nature of the cross equation restrictions we need not attempt to fully specify the processes determining these latter series, although it may be noted that for each model the Likelihood Ratio test for over-identification of the structural model relative to its nesting unrestricted reduced form system could not be rejected.[48] We therefore accept these marginal models as adequate first approximations to the true processes generating $\Delta\pi$ and Δrtb.

The results of this estimation, which are presented in Appendix 2(D), are somewhat challenging to our foregoing analysis. Most striking is that for M1, M2, and M3 the money demand cointegrating vector is a significant variable in determining the contemporaneous value of $\Delta\pi$, while for M0 it is a significant variable in determining the contemporaneous value of Δrtb. Consequently these two variables cannot be truly weakly exogenous in the demand for money equations for any of the simple-sum aggregates. Only in the case of the Divisia-based M3 aggregate can we accept that the cointegrating vectors impose no cross-equation restrictions in the model.

Examination of the FIML estimates bear out the implications of this violation of weak exogeneity in the demand for money. Only in the case of the

[48] The LR test computes the fall in the likelihood of the parameter vector which occurs as the result of imposing identification restrictions.

M3d aggregate do we find that the FIML estimate in Appendix 2(D) is not significantly different from the OLS estimate in Appendix 2(C). For all the other aggregates, by allowing for the cross-equation effects through the cointegrating vectors, and by letting $\Delta\pi$ and Δrtb be endogenous to the system along with Δ(m-p) we note some significant changes in the structure of the dynamic models of money demand. For M0 the FIML feedback on the cointegrating vector has fallen from 0.19 to 0.14, while the short run inflation acceleration terms has fallen from 1.20 to 0.57. The M1 FIML aggregate is generally very similar to the OLS estimate except for a slightly higher interest elasticity. The M2 aggregate seems to exhibit the largest deviations between the FIML and OLS estimates, especially in terms of the impact inflation elasticity, which more than doubles in the FIML estimate while the interest elasticity falls concomitantly. Finally the M3 aggregate reveals a fall in the inflation elasticity under a FIML estimates.

The results of these FIML estimates, with the exception perhaps of the M2 aggregate do not however radically alter our inference and conclusions concerning the nature of the demand for money in Kenya. Rather we conclude that in the main, there is a slightly lower instantaneous adjustment of narrow money holdings to inflation, a slightly higher interest elasticity in terms of M1 holdings, and a slightly lower interest elasticity in terms of M3. However we can maintain our conclusion about the validity of the Divisia adjustment in modelling broad money aggregates.

2.9 Conclusions

In this chapter we have successfully established a series of single-equation demand for money functions for the Kenyan economy from 1973 to 1989. In general, though estimated using an interpolated series for income, the equations embody long-run solution which are fully consistent with theoretical priors from the literature on the demand for money, while the dynamic specifications successfully track actual movements in holding of real money balances. More specifically we have successfully encompassed existing studies of Kenyan demand for money, while for each model the implicit assumption of parameter and model constancy across the entire sample could not be rejected. An important aspect of this chapter however concerned the effects of acknowledging the possible effects of the simultaneous determination of inflation and interest rates with the real money stock. We found that though the assumption of weak exogeneity of the growth of inflation and interest rates in the demand for money is not valid, although estimation of the models within a simultaneous system did not radically alter the economic inferences drawn from the OLS models.

In addition however the chapter has managed to establish a number of important results. The first concerns the appropriate definition of the money stock and suggests that, while not dramatic, the use of a Divisia-based aggregation for money stock aggregates which include the deposit liabilities of the NBFIs results in a more data coherent specification of broad money demand. Second, the identification of a stable and well defined demand function for narrow money balances, M0, has important implications for the analysis of the fiscal implications of inflation, by identifying both the steady-state inflation tax capacity of the private sector, and also the short-run dynamics of money holdings in response to changes in the rate of inflation. This will be central to our analysis undertaken in Chapter 3 of the thesis. Third, we have identified a limited currency-substitution effect which operates through a well-defined cash-based buffer-stock model. Finally, however there remains some important weaknesses with these result to the extent to which they provide only limited insight into the detailed processes of asset substitution, both within financial assets, and between financial assets and real assets. We deal with this issue in Chapter 4.

APPENDIX 2(A)
ANNUAL REGRESSION MODELS FOR INCOME INTERPOLATION

A series of models were estimated for the annual regression models of Gross National Income and Total Final Income. In both cases the selection procedure was concerned with the estimation of best-fitting (but non-spurious) static linear regressions which were able to capture any turning points in the annual series, especially during the period of the coffee boom. Initially models were based on trade and fiscal data, but these models did not fit the data well without recourse to the use of dummy variables, and it was found that data on total sales reported to the Business Expectations Enquiry[49] (Lsales), augmented by a terms-of-trade measure in which the barter terms of trade are weighted by the relative share of exports and imports in gross domestic product (Lgdptot), provided more coherent models.

Table A2.1 describes the data, which are all in log nominal terms, and the final models are reported in Equations A2.1 and A2.2. From Table A2.1 we note that, on the basis of the Durbin-Watson statistics the data are all highly non-stationary. In the estimation therefore, although these models do not purport to be structural model of the process generating income, it will be necessary to ensure that the regressions are non-spurious.

Table A2.1
Descriptive statistics

	Lgny	Ltfe	Lsales	Lgdptot
Mean	10.858	11.174	10.864	2.993
Standard Deviation	0.619	0.606	0.707	0.342
Durbin Watson test	0.059	0.051	0.053	0.272

[49] The Business Expectations Enquiry (BEE) has been maintained by the CBS since 1973 and is based on a regular survey of 1400 firms in Kenya, which represents all firms employing more than 50 persons and a 25% systematic sample of firms employing 20-49 persons. Firms employing less than 20 persons are excluded from the coverage. Data are collected quarterly at enterprise level and though some activity level data are available, the bulk of the data is at ISIC division level.

Equation (A2.1)
Modelling Lgny by OLS (Sample: 1973 to 1988)

Variable	Coefficient	Std.Error	t-value	Partial R^2
Constant	0.62854	0.40914	1.53626	0.16442
Lsales	0.91360	0.02685	34.02949	0.98971
Lgdptot	0.10079	0.04631	2.17648	0.28301

$R^2 = 0.99563$ $F(2, 13) = 1367.02$ $\sigma = 0.041968$ DW = 1.146

LM Autocorrelation Test: $F(2, 11) = 0.26$ [0.7791]
LM ARCH Test: $F(1, 11) = 0.02$ [0.8832]
Jarque Bera Normality $\chi^2(2) = 1.5119$

Equation (A2.2)
Modelling Ltfe by OLS (Sample: 1973 to 1988)

Variable	Coefficient	Std.Error	t-value	Partial R^2
Constant	0.67518	0.41938	1.60997	0.1662
LSales	0.93276	0.02530	36.87334	0.9905
Lgnpwtol	0.07442	0.04984	1.49349	0.1465

$R^2 = 0.9982$ $F(2, 13) = 3778.97$ $\sigma = 0.0269964$ DW = 1.93

LM Autocorrelation Test: $F(2, 11) = 0.592$ [0.5685]
LM ARCH Test: $F(1, 11) = 0.8546$ [0.3758]
Jarque Bera Normality $\chi^2(2) = 0.0691$

In both cases the regressions reveal a high degree of data coherence, and the equation standard error is significantly lower than the standard error of the dependent variable. Importantly also is the fact that though the model variables are all non-stationary, the DW statistic for the equation, interpreted as a cointegrating-regression Durbin Watson statistic indicates that the residuals are stationary, and thus neither model is a spurious regression. Similarly the limited diagnostic test possible over this small sample indicates that the equation residuals are homoscedastic independently normal. Further tests, not reported, indicate that the equations are recursively stable. Consequently the parameter values from these two models are used in the interpolation of quarterly series for gross national income and total final expenditure.

Appendix 2(b)
Full Vector Cointegration Vectors and Loadings

1973(1) to 1989(2)

(m0-p) Standardized ß' Eigenvectors

Variable	(m0-p)	(gny-p)	π	rtb
(1)	1.000	-1.305	-5.629	-5.765
(2)	-0.963	1.000	-4.612	0.639

(m0-p) Standardized α Coefficients

Variable	(1)	(2)
(m0-p)	-.4912	0.2281
(gny-p)	0.0717	-0.0335
π	-0.2162	-0.0234
rtb	-0.0092	-0.0120

Note: Equation 2.18 identified by vector (1) + vector (2) x 9.00

(m1-p) Standardized ß' Eigenvectors

Variable	(m1-p)	(gny-p)	π	rtb	exb
(1)	0.004	0.030	0.392	1.000	-0.024
(2)	1.000	-0.868	5.076	-1.518	0.208

Standardized α Coefficients

Variable	(1)	(2)
(m1-p)	-.8829	-.5946
(gny-p)	-6.9207	.1570
π	-3.3646	-.0079
rtb	.4939	.0114
exb	-4.2237	.0163

Note: Equation 2.19 identified by vector (1) + vector (2) (m2-p) Standardized ß' Eigenvectors

Variable	(m2-p)	(gny-p)	π	rtb	exb
(1)	-0.016	0.053	0.338	1.000	-0.025
(2)	1.000	-0.884	6.291	-3.510	0.215

Standardized α Coefficients

Variable	(1)	(2)
(m2-p)	1.9470	-.1620
(gny-p)	-9.3657	.1098
π	-2.8763	-.0548
rtb	.3263	.0109
exb	-5.5966	.0767

Note: Equation 2.20 identified by vector (1) + vector (2)

(m3-p) Standardized ß' Eigenvectors

Variable	(m3-p)	(gny-p)	π	rtb	exb
(1)	-0.011	0.044	0.277	1.000	-0.022
(2)	1.000	-1.138	5.854	-18.944	0.351

Standardized α Coefficients

Variable	(1)	(2)
(m3-p)	.1024	-.1094
(gny-p)	-13.5423	.1200
π	-3.9534	-.0516
rtb	.3330	.0139
exb	-9.3242	.1309

Note: Equation 2.21 identified by vector (1) + vector (2) (m3-pd) Standardized ß' Eigenvectors

Variable	(m3d-p)	(gny-p)	π	rtb	exb
(1)	-0.023	0.073	0.492	1.000	-0.204
(2)	1.000	-1.230	0.421	-4.277	0.106

Standardized α Coefficients

Variable	(1)	(2)
(m3d-p)	.8031	-.3840
(gny-p)	-4.0024	.4066
π	-3.1608	-.0822
rtb	.4203	.0152
exb	-1.4618	.1083

Note: Equation 2.21 identified by vector (1) + vector (2) x 4.30

APPENDIX 2(C)
FINAL OLS MONEY DEMAND EQUATION AND FORECAST ANALYSIS

Modelling $\Delta(m0-p)$ by OLS Sample is 1974(3) to 1989(2)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
Constant	.0818376	.00946	.01186	8.65368	.5949
Q 1	-.1309355	.01284	.01434	-10.19459	.6708
Q 2	-.1391293	.01296	.01421	-10.73314	.6931
Q 3	-.0619953	.01225	.01411	-5.05899	.3341
Δ2rtb	-3.0139988	1.17588	1.36665	-2.56319	.1141
Σ03Δ(m0-p)1	.5425604	.18183	.14587	2.98381	.1486
$\Delta\pi$	-1.2007735	.18152	.22492	-6.61498	.4618
Ecm0 1	-.1932344	.06017	.05954	-3.21123	.1682
Δexb 2	.1869660	.07240	.07145	2.58232	.1156

R^2 = .8531734 σ = .0320912 F(8, 51) = 37.04 [.0000] DW = 1.946

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(6, 45) = .68 [.6693]	F(6, 39) = .79 [.5813]
F(5, 46) = .64 [.6697]	F(5, 41) = .88 [.5058]
F(4, 47) = .68 [.6116]	F(4, 43) = .86 [.4932]
F(3, 48) = .69 [.5606]	F(3, 45) = .25 [.8598]
F(2, 49) = .25 [.7830]	F(2, 47) = .21 [.8113]
F(1, 50) = .01 [.9268]	F(1, 49) = .00 [.9980]

Jarque - Bera Test for Error Normality χ^2 (2) = 1.538
White's Heteroscedastic Error Test F(18, 28) = .7710 [.6838]

Δ(m0-p) One-Step Forecast Analysis 1985 Q3 to 1989 Q2

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-value
1985 3	.016356	.028455	-.012100	.037640	-.321460
1985 4	.138874	.134726	.004148	.037605	.110303
1986 1	.031514	-.011271	.042785	.040711	1.050953
1986 2	-.002672	.010813	-.013486	.039208	-.343950
1986 3	.034545	.102113	-.067568	.039438	-1.713252
1986 4	.135518	.142935	-.007417	.039538	-.187579
1987 1	-.056701	-.031055	-.025646	.039600	-.647638
1987 2	.003725	.002374	.001351	.041162	.032827
1987 3	.046521	.075153	-.028632	.039331	-.727972
1987 4	.120481	.121840	-.001359	.037789	-.035970
1988 1	-.003781	.022062	-.025844	.041945	-.616134
1988 2	-.115274	-.087375	-.027899	.038335	-.727778
1988 3	.015361	.020012	-.004652	.038449	-.120981
1988 4	.110321	.102154	.008167	.037291	.219003
1989 1	-.023273	-.044176	.020902	.038215	.546964
1989 2	-.048057	-.093829	.045773	.037962	1.205761

Tests of Parameter Constancy over: 1985(3) - 1989(2)

Forecast $\chi^2(16)/16$	=	.63
Chow Test F(16, 34)	=	.50
Zero Forecast Innovation t(15)	=	-.36

Modelling $\Delta(m1\text{-}p)$ by OLS Sample is 1974(3) to 1989(2)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
CONSTANT	.0608067	.01229	.01256	4.94741	.3287
Q 1	-.0740473	.01653	.01990	-4.48008	.2864
Q 2	-.1110592	.01847	.01625	-6.01436	.4198
Q 3	-.0494678	.01812	.01873	-2.73070	.1298
Ecm1 1	-.3252310	.07830	.08922	-4.15363	.2565
$\Sigma 02\Delta rtb$	-6.7767617	3.79990	3.46558	-1.78340	.0598
$\Delta\pi$	-.5190740	.23266	.27635	-2.23100	.0905
$\Delta 3\Delta exb$ 2	-.1869746	.06753	.06170	-2.76860	.1329
$\Sigma 03\Delta(m1\text{-}p)1$	.5757866	.27242	.25592	2.11361	.0820
$\Delta 3\Delta(y\text{-}p)1$	-.1736261	.07735	.06680	-2.24481	.0916

R^2 = .5938998 σ = .0425577 F(9, 50) = 8.12 [.0000] DW = 2.016

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(6, 44) = .86 [.5319]	F(6, 38) = .44 [.8450]
F(5, 45) = .31 [.9028]	F(5, 40) = .42 [.8339]
F(4, 46) = .33 [.8597]	F(4, 42) = .42 [.7960]
F(3, 47) = .29 [.8357]	F(3, 44) = .45 [.7208]
F(2, 48) = .30 [.7457]	F(2, 46) = .41 [.6671]
F(1, 49) = .02 [.9004]	F(1, 48) = .08 [.7727]

Jarque - Bera Test for Error Normality χ^2 (2) = 7.189
White's Heteroscedastic Error Test F(18, 28) = 1.1706 [.3388]

Δ(ml-p) One-Step Forecast Analysis 1985 Q3 to 1989 Q2

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-value
1985 3	.016960	.058157	-.041197	.051820	-.795007
1985 4	.042971	.063260	-.020289	.050703	-.400155
1986 1	.110978	.058833	.052145	.056959	.915476
1986 2	.007421	-.012557	.019978	.054688	.365302
1986 3	.121655	.088094	.033560	.054296	.618089
1986 4	.006101	.047794	-.041693	.054076	-.771015
1987 1	.028105	.001019	.027086	.053726	.504147
1987 2	-.055768	-.069239	.013471	.053825	.250271
1987 3	.004086	-.004151	.008237	.051815	.158962
1987 4	.042046	.041481	.000564	.050185	.011241
1988 1	-.101726	-.029838	-.071887	.049854	-1.441954
1988 2	-.017900	-.015301	-.002599	.055562	-.046774
1988 3	.007122	-.007224	.014346	.049646	.288967
1988 4	.071376	.041071	.030305	.050531	.599735
1989 1	-.048803	-.038769	-.010034	.050940	-.196979
1989 2	-.004479	-.003799	-.000680	.053322	-.012756

Tests of Parameter Constancy over: 1985(3) - 1989(2)

Forecast $\chi^2(16)/16$ = .43

Chow Test F(16, 34) = .41

Zero Forecast Innovation t(15) = .05

Modelling $\Delta(m2\text{-}p)$ by OLS Sample is 1975(2) to 1989(2)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
$\Delta\pi$	-.9253064	.27015	.22358	-3.42513	.1997
Σ02Δrtb	-7.8143049	2.91120	2.68445	-2.68422	.1329
Ecm2 1	-.2015763	.04281	0.03849	-4.70899	.3206
Δ3Δ(y-p)1	-.1157329	.05916	.05248	-1.95615	.0753
CONSTANT	.0364967	.00937	.00744	3.89478	.2440
Q 1	-.0324361	.01305	.01589	-2.48510	.1161
Q 2	-.0721695	.01471	.01234	-4.90619	.3387
Q 3	-.0237910	.01448	.01249	-1.64314	.0543
Σ03Δ(m-p)1	.4002921	.22272	.18555	1.79732	.0643
Δexb05	.1123071	.05537	.05177	2.02831	.0805

R^2 = .5998514 σ = .0326962 F (9, 47) = 7.83 [.0000] DW = 2.083

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(6, 41) = 1.07 [.3976]	F(6, 35) = .25 [.9551]
F(5, 42) = .09 [.9926]	F(5, 37) = .30 [.9122]
F(4, 43) = .12 [.9759]	F(4, 39) = .18 [.9481]
F(3, 44) = .16 [.9232]	F(3, 41) = .13 [.9413]
F(2, 45) = .05 [.9523]	F(2, 43) = .13 [.8803]
F(1, 46) = .10 [.7551]	F(1, 45) = .05 [.8198]

Jarque - Bera Test for Error Normality χ^2 (2) = 4.845
White's Heteroscedastic Error Test F(12, 36) = 1.2452 [.2928]

Δ(m2-p) One-Step Forecast Analysis 1985 Q3 to 1989 Q2

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-value
1985 3	.014580	.032038	-.017458	.038364	-.455052
1985 4	.047034	.048521	-.001486	.039038	-.038077
1986 1	.089849	.036710	.053139	.039946	1.330262
1986 2	.021680	-.005828	.027508	.040723	.675481
1986 3	.110044	.076522	.033522	.040816	.821280
1986 4	.024022	.044125	-.020103	.040839	-.492252
1987 1	.012972	.022347	-.009376	.042259	-.221858
1987 2	-.017576	-.023350	.005774	.040371	.143013
1987 3	.027418	.043854	-.016436	.040128	-.409576
1987 4	.009134	.018165	-.009030	.038477	-.234694
1988 1	-.050939	.008411	-.059350	.039179	-1.514842
1988 2	-.014915	-.018702	.003786	.039169	.096668
1988 3	-.006167	-.013796	.007628	.038790	.196660
1988 4	.050384	.016499	.033885	.038801	.873299
1989 1	-.000841	-.005664	.004823	.038668	.124718
1989 2	.002309	-.012605	.014913	.039238	.380080

Tests of Parameter Constancy over: 1985(3) - 1989(2)

Forecast $\chi^2(16)/16$	=	.53
Chow Test F(16, 34)	=	.49
Zero Forecast Innovation t(15)	=	.23

Modelling Δ(m3-p) by OLS Sample is 1975(2) to 1989(2)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
$\Delta\pi$	-.9331610	.24081	.22912	-3.87516	.2346
Ecm3 3	-.0726517	.02761	.04075	-2.63125	.1238
CONSTANT	.0289555	.00609	.00503	4.75577	.3158
Q 1	-.0321299	.00998	.01299	-3.22009	.1747
Q 2	-.0304054	.01053	.01059	-2.88746	.1454
Δexb 2	-.0892926	.07040	.07420	-1.26834	.0318
ΔΔ(m3-p)3	-.2354050	.09002	.10731	-2.61497	.1225
Σ02Δrtb	-5.4656929	2.51074	3.34212	-2.17692	.0882

R^2 = .5621595 σ = .0289741 F(7, 49) = 8.99 [.0000] DW = 2.024

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(6, 43) = 1.16 [.3448]	F(6, 37) = .27 [.9457]
F(5, 44) = .40 [.8458]	F(5, 39) = .32 [.8971]
F(4, 45) = .15 [.9610]	F(4, 41) = .31 [.8690]
F(3, 46) = .03 [.9932]	F(3, 43) = .32 [.8127]
F(2, 47) = .03 [.9668]	F(2, 45) = .47 [.6270]
F(1, 48) = .01 [.9203]	F(1, 47) = .20 [.6597]

Jarque - Bera Test for Error Normality χ^2 (2) = 10.085
White's Heteroscedastic Error Test F(12, 36) = .9368 [.5228]

Δ(m3-p) One-Step Forecast Analysis 1985 Q3 to 1989 Q2

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-Value
1985 3	.020615	.041337	-.020722	.033502	-.618538
1985 4	.035132	.053880	-.018748	.032584	-.575356
1986 1	.078380	.021126	.057254	.034376	1.665494
1986 2	.038882	.010701	.028181	.033247	.847632
1986 3	.044818	.054054	-.009236	.032627	-.283075
1986 4	.028065	.026338	.001727	.032781	.052668
1987 1	.011288	.008494	.002793	.033785	.082679
1987 2	-.052591	.002200	-.054791	.033927	-1.614952
1987 3	.016300	.027209	-.010909	.032340	-.337327
1987 4	.012532	.022390	-.009857	.032114	-.306950
1988 1	-.026831	.015374	-.042205	.034733	-1.215130
1988 2	-.022497	-.022331	-.000166	.033938	-.004890
1988 3	.008791	.000426	.008365	.032670	.256058
1988 4	.045657	.029179	.016478	.032298	.510174
1989 1	.009092	.015521	-.006429	.033861	-.189862
1989 2	.012015	-.004501	.016517	.034159	.483528

Tests of Parameter Constancy over: 1985(3) - 1989(2)

Forecast $\chi^2(16)/16$	=	.69
Chow Test F(16, 34)	=	.60
Zero Forecast Innovation t(15)	=	-.36

Modelling Δ(m3d-p) by OLS Sample is 1975(2) to 1989(2)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
Δ(m3d-p)3	-.3013017	.10621	.09989	-2.83683	.1462
Σ02Δ(y-p)3	.4231503	.18445	.17907	2.29406	.1007
Δπ	-.7432367	.18129	.16539	-4.09981	.2634
Σ02Δrtb	-11.0640513	2.67007	2.53958	-4.14373	.2676
CONSTANT	.0322678	.00997	.00798	3.23810	.1824
Q 1	-.0188569	.01435	.01374	-1.31431	.0355
Q 2	-.0616722	.01547	.01450	-3.98665	.2527
Q 3	-.0115919	.01348	.01382	-.85988	.0155
Ecm3d 4	-.0933928	.04323	.02551	-2.16053	.0903
Δ2Δexb	-.0609182	.06139	.06516	-.99237	.0205

R^2 = .6430255 σ = .0329316 F(9, 47) = 9.41 [.0000] DW = 1.981

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(6, 41) = .83 [.5556]	F(6, 35) = 1.08 [.2470]
F(5, 42) = .38 [.8604]	F(5, 37) = 1.40 [.3257]
F(4, 43) = .43 [.7877]	F(4, 39) = 1.20 [.3257]
F(3, 44) = .42 [.7381]	F(3, 41) = 1.14 [.3548]
F(2, 45) = .01 [.9879]	F(2, 43) = 1.79 [.1794]
F(1, 46) = .02 [.8816]	F(1, 45) = 3.15 [.0827]

Jarque - Bera Test for Error Normality χ^2 (2) = 1.544
White's Heteroscedastic Error Test F(12, 36) = .9620 [.5135]

Δ(m3d-p) One-Step Forecast Analysis 1985 Q3 to 1989 Q2

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-Value
1985 3	-.004532	.038717	-.043249	.035036	-1.234414
1985 4	.065151	.056148	.009004	.033774	.266587
1986 1	.120409	.053629	.066780	.034991	1.908498
1986 2	-.029373	-.018835	-.010538	.033582	-.313798
1986 3	.096964	.022196	.074768	.034128	2.190828
1986 4	-.008945	.014022	-.022967	.037662	-.609836
1987 1	.001425	.005977	-.004552	.034209	-.133077
1987 2	-.032359	-.044990	.012631	.036300	.347965
1987 3	.010714	.038064	-.027350	.034482	-.793174
1987 4	.025016	.053192	-.028176	.034559	-.815312
1988 1	.081900	.033705	.048194	.034847	1.383010
1988 2	-.023070	-.063227	.040157	.034864	1.151803
1988 3	.006142	-.009126	.015268	.033874	.450730
1988 4	.056554	.020678	.035875	.035714	1.004521
1989 1	.048882	.011469	.037414	.033440	1.118853
1989 2	-.059923	-.026325	-.033598	.034787	-.965828

Tests of Parameter Constancy over: 1985(3) - 1989(2)

Forecast $\chi^2(16)/16$	=	1.41
Chow Test F(16, 34)	=	1.28
Zero Forecast Innovation t(15)	=	1.07

APPENDIX 2(D)
FIML ESTIMATES WITH Δ(M-P), ΔΠ, AND ΔRTB ENDOGENOUS

Model 1 for Δ(m0-p), Δπ and Δrtb: Sample is 1974(3) to 1989(2)

Equation 1 for Δ(m0-p)

Variable	Coefficient	t-Value
CONSTANT	.0878	9.234
Q 1	-.1375	10.658
Q 2	-.1422	11.023
Q 3	-.0586	4.578
Δ2rtb	-3.6412	3.641
Σ03Δ(m-p)1	.3870	2.832
Δπ	-.5897	2.137
Ecm0 1	-.1400	2.399
Δexb 2	.2136	3.897

$\sigma =$ .03223

Equation 2 for Δπ

Variable	Coefficient	t-Value
Constant	.0005	0.096
Q 1	-.0040	0.519
Q 2	.0000	0.000
Q 3	-.0028	0.346
civ 1	.1419	0.717
Ecm0 1	-.0289	0.714
Δπ 1	.2863	3.071
Δπ 2	.0247	0.258
Δπ 3	.1097	1.179
Δπ 4	-.4973	4.565

$\sigma =$ .02057

Equation 3 for Δrtb		
Variable	Coefficient	t-Value
CONSTANT	.0003	0.454
Q 1	.0011	1.183
Q 2	.0003	0.333
Q 3	-.0009	1.033
civ 1	.0408	1.294
Ecm0 1	.0098	2.250
Δrtb 1	.0597	0.468
Δrtb 2	.0369	0.294
Δrtb 3	.0214	0.162
Δrtb 4	-.1908	1.545
σ = .00238		

Model 2 for Δ(ml-p), $\Delta\pi$ and Δrtb: Sample is 1974(3) to 1989(2)

Equation 1 for Δ(m1-p)		
Variable	Coefficient	t-Value
CONSTANT	.0592	5.239
Q 1	-.0834	5.562
Q 2	-.1071	6.155
Q 3	-.0367	2.184
Σ02Δ2rtb	-5.7899	1.492
Σ03Δ(m-p)1	.6058	2.724
Δ3Δ(y-p) 1	-.1641	2.263
$\Delta\pi$	-.5069	1.752
Ecm1 1	-.3230	4.507
Δ3Δexb 2	-.1767	2.991
σ = .03883		

Equation 2 for $\Delta\pi$		
Variable	Coefficient	t-Value
CONSTANT	.0032	0.592
Q 1	.0111	1.403
Q 2	-.0129	1.498
Q 3	-.0148	1.866
civ 1	.2997	1.256
Ecm1 1	-.1033	3.790
$\Delta\pi$ 1	-.8234	6.759
$\Delta\pi$ 2	-.5023	3.052
$\Delta\pi$ 3	-.2970	1.909
$\Delta\pi$ 4	-.1261	1.216
$\sigma =$ .01924		

Equation 3 for Δrtb		
Variable	Coefficient	t-Value
CONSTANT	.0002	1.066
Q 1	.0008	2.369
Q 2	.0007	2.029
Q 3	-.0001	0.399
civ 1	.0127	1.087
Ecm1 1	.0004	0.341
Δrtb 1	1.0089	8.061
Δrtb 2	-.0113	0.069
Δrtb 3	-.6272	3.785
Δrtb 4	.2953	2.472
$\sigma =$ .00089		

Model 3 for Δ(m2-p), Δπ and Δrtb: Sample is 1974(3) to 1989(2)

Equation 1 for Δ(m2-p)

Variable	Coefficient	t-Value
CONSTANT	.0268	1.388
Q 1	-.0423	1.212
Q 2	-.0485	1.412
Q 3	-.0021	0.060
Σ02Δrtb	-3.1410	-3.867
Σ03Δ(m-p)1	.3512	1.863
Δπ	-2.1468	1.724
Ecm2 1	-.2804	2.979
Δexb05	.1048	2.117
Δ3Δ(y-p)1	-.1074	2.015

$\sigma =$ .03741

Equation 2 for Δπ

Variable	Coefficient	t-Value
CONSTANT	.0024	0.549
Q 1	.0115	1.835
Q 2	-.0107	1.594
Q 3	-.0132	2.038
civ 1	.2597	1.350
Ecm2 1	-.0673	2.743
Δπ 1	-.0311	0.206
Δπ 2	.0218	0.154
Δπ 3	-.1095	0.908
Δπ 4	-.1084	1.065

$\sigma =$ .01665

Equation 3 for Δrtb		
Variable	Coefficient	t-Value
CONSTANT	.0000	0.121
Q 1	.0010	1.177
Q 2	.0003	0.328
Q 3	-.0009	1.048
civ 1	.0457	1.481
Ecm2 1	.0024	0.932
Δrtb 1	.1414	1.181
Δrtb 2	.0673	0.567
Δrtb 3	.1173	0.984
Δrtb 4	-.2269	1.939

$\sigma =$ .00242

Model 4 for Δ(m3-p), $\Delta\pi$ and Δrtb: Sample is 1974(3) to 1989(2)

Equation 1 for Δ(m3-p)		
Variable	Coefficient	t-Value
CONSTANT	.0318	3.875
Q 1	-.0375	3.049
Q 2	-.0348	2.900
Q 3	.0008	0.224
Σ02Δ2rtb	-3.6785	1.273
$\Delta\Delta$(m-p)3	-.2295	2.755
$\Delta\pi$	-1.0602	2.104
Ecm3 3	-.0887	1.884
Δexb 2	-.0935	1.454

$\sigma =$ .02699

Equation 2 for $\Delta\pi$		
Variable	Coefficient	t-Value
CONSTANT	.0001	0.028
Q 1	-.0014	0.242
Q 2	-.0014	0.249
Q 3	-.0054	0.900
civ 1	.4983	2.545
Ecm3 3	-.0772	5.884
$\Delta\pi$ 1	.1705	1.952
$\Delta\pi$ 2	.0727	0.803
$\Delta\pi$ 3	-.0339	0.387
$\Delta\pi$ 4	-.0160	0.141
$\sigma =$ .01561		

Equation 3 for Δrtb		
Variable	Coefficient	t-Value
CONSTANT	-.0002	0.959
Q 1	.0007	2.183
Q 2	.0006	1.936
Q 3	-.0001	0.224
civ 1	.0123	1.051
Ecm3 3	.0008	1.477
Δrtb 1	.9878	8.001
Δrtb 2	-.0613	0.381
Δrtb 3	-.5325	3.342
Δrtb 4	.2544	2.169
$\sigma =$ .00088		

Model 5 for Δ(m3d-p), Δπ and Δrtb: Sample is 1974(3) to 1989(2)

Equation 1 for Δ(m3d-p)

Variable	Coefficient	t-Value
CONSTANT	.0345	3.791
Q 1	-.0237	2.100
Q 2	-.0681	4.795
Q 3	-.0080	0.650
Σ02Δ2rtb	-9.2451	3.274
Δ(m3d-p)3	-.3174	3.413
Δπ	-.8895	3.293
Ecm3d 4	-.1137	2.587
Δ2Δexb2	-.0528	0.944
Σ02Δ(y-p)3	.4666	2.825

$\sigma =$ .03032

Equation 2 for Δπ

Variable	Coefficient	t-Value
CONSTANT	-.0001	0.025
Q 1	-.0046	0.611
Q 2	.0012	0.168
Q 3	-.0026	0.348
civ 1	.3344	1.339
Ecm3d 4	.0198	0.578
Δπ 1	.3207	2.247
Δπ 2	.0594	0.514
Δπ 3	-.0993	0.872
Δπ 4	-.4891	4.443

$\sigma =$ .01987

Equation 3 for Δrtb		
Variable	Coefficient	t-Value
CONSTANT	-.0002	0.908
Q 1	.0008	2.364
Q 2	.0006	1.943
Q 3	-.0001	0.419
civ 1	.0112	0.945
Ecm3d 4	.0008	0.735
Δrtb 1	1.0135	8.006
Δrtb 2	-.0134	0.008
Δrtb 3	-.6112	3.712
Δrtb 4	.2871	2.349
$\sigma =$ .00089		

3

THE FISCAL IMPLICATIONS OF FINANCIAL AND MONETARY CONDITIONS IN KENYA
HISTORICAL IMPACT AND COUNTERFACTUAL ANALYSIS

Introduction

The previous chapter estimated the aggregate private sector demand for money in the Kenyan economy. In this Chapter we use these estimates to analyze the historical importance of implicit taxation of private agents' holdings of the financial liabilities of the government. The chapter draws together two principal strands: the first is the analysis of seigniorage and inflation tax revenue, while the second focuses on the implicit fiscal revenue effects of financial repression.

The analysis of inflation tax has typically been the domain of researchers on hyper-inflation economies, especially in Latin America (for example, Dornbusch (1992)), and the examination of these issues in the Kenyan context, where inflation has averaged between 10 per cent and 15 per cent per annum since independence and has only twice exceeded 20 per cent, thus requires some justification. Three reasons can advanced. First, whereas much of the literature on hyper-inflation examines the short-run role of inflationary finance in the context of the loss of monetary control, it is also important to quantify the magnitude of the *sustainable* revenue raising capacity of financial and monetary taxation instruments relative to other tax instruments in an economy where a stable private sector demand for money has been identified. Second, much of the literature on seigniorage and inflation tax, especially in Latin America, has concerned economies where financial assets have often been index-linked and legal currency substitution (or dollarization) is widespread. In Kenya the range of financial assets is limited, and they are not indexed. Moreover, although there is a small parallel foreign exchange market, legal currency substitution is not permitted. Liquidity is thus only provided by Shilling-denominated cash, and non-indexed financial assets. *A priori* the potential for sustainable deficit finance through seigniorage and inflation deficit will be higher in such an economy. Finally, the dynamic analysis of the demand for financial assets, and the implications for short-run inflation tax collection in Kenya, may provide an archetypical illustration of the policy implications for other sub-Saharan African economies undergoing programmes of financial liberalization.

The exposition of this chapter is restricted to a simple partial equilibrium framework in which we examine only the direct transmission from changes in monetary and financial conditions to changes in the overall government budget position. The chapter thus abstracts from two important considerations. The first is the set of general equilibrium effects of changes in domestic monetary conditions on the relative prices of tradable and non-tradable goods: we assume throughout that the composition of the primary government budget, and private sector expenditure and output decisions are inflation-neutral. In Chapter 5 we relax this assumption when we look at the change in the private sector demand for financial and real assets in response to policy changes. Second we also abstract from feedback effects from monetary conditions to the policy reaction of government.

The Chapter is structured as follows. Section 3.1 defines the seigniorage and inflation tax measures to be used later in the chapter. In addition in this section we discuss the measurement of the implicit tax earned by governments as the result of maintaining domestic interest rates on domestic sovereign debt at below market-determined rates. Section 3.2 then outlines the methods used for calculating the extent of both inflation- and financial repression- taxes for Kenya, and presents an *ex post* quantification of the average implicit revenue earned by the government over the period since 1972, from both the bank- and non-bank private sector as a proportion of GDP and total cash revenue earned by government.

In section 3.3 we seek to link the *ex post* actual values for these taxes with evidence from the demand side of the economy. We start by estimating the revenue-maximizing rate of inflation given the structure of the demand for money using the evidence from our analysis in Chapter 2. This approach also allows us to examine the short-run dynamics of the inflation tax, and to consider the implication for the inflation tax in the presence of opportunities for currency substitution. We then examine the non-bank private sector demand for government debt to estimate the revenue-maximizing implicit taxation rate through financial repression. The analysis in this section concerns the behaviour of the non-bank sector only, since the modelling of the loan portfolio and credit allocation decisions of the banking sector is beyond the scope of this thesis. The final section (Section 3.4) draws together these results to offer an illustrative counterfactual analysis of the implication of alternative scenarios concerning the introduction of policies of financial liberalization and inflation reduction. In this section we consider the implications of these policy changes solely from the perspective of their static government budget implications. Later, in the final Chapter of the thesis we use the demand share model from Chapter 4 to consider the demand-side implications of the financial sector proposals envisaged in the wake of the Government of Kenya Sessional Paper No.1 of 1986 on *Economic Management for Renewed Growth.*

3.1 Revenue from the Taxation of Financial Assets

In a monetary economy the issue of base money at virtually zero cost yields revenue to the issuer of that money.[50] Usually it is the central bank which issues notes and coins, but since the financial surplus or deficit of the central bank can be consolidated with that of the government this revenue, referred to as seigniorage, can be treated as accruing directly to the government. The rate of

[50] The importance of this form of revenue has long been acknowledged. Keynes for example remarked: "A government can live for a long time...by printing paper money. That is to say, it can by this means secure the command over real resources, resources just as real as those obtained by taxation. The method is condemned, but its efficacy, up to a point, must be admired....So long as the public use money at all, the government can get resources by a continuous practice of inflation...unless the sums they seek to raise in this way are grossly excessive....What is raised by printing notes is just as much taken from the public as is a beer duty or an income tax". (Tract on Monetary Reform, 1923)

seigniorage revenue can be defined as the real value of the growth of the money supply[51]

$$(3.1) \quad S = (dM/dt)/P$$

which can be re-expressed in terms of the percentage rate of growth of the money supply as

$$(3.2) \quad S = ((dM/dt)/M)\,(M/P) = \gamma m.$$

where m is the stock of real money, and γ the proportional rate of growth of the money stock. Inflation tax is defined as the transfer of wealth from the holders of high powered money to its issuer as a result of the reduction in the value of the debt due to inflation. This transfer, represents a source of revenue to the issuer of the debt, and is generally defined as

$$(3.3) \qquad (dP/dt)(M/P) = \pi m$$

where $(dP/dt) = \pi$ is the rate of inflation (taken here to be the change in the CPI)[52] and m the real money stock. Under these definitions, the inflation tax is equal to seigniorage revenue when $\gamma = \pi$, ie the rate of growth of the monetary base is equal to the rate of inflation, for any given level of real income growth. In equilibrium seigniorage revenue will be identical to inflation tax revenue. Out of equilibrium, obviously, the two will deviate.[53] Since we do not explicitly model the dynamics of the money supply process in Kenya, our analysis is concerned principally with the inflation tax. The discussion in this chapter concerning the setting of revenue maximizing inflation rates therefore abstracts

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[51] See for example Blanchard and Fisher (1989) Chapter 4.

[52] See Chapter 2, section 2.3 for a discussion of the validity of the CPI as a measure of prices.

[53] See for example Bolnick (1978) for a discussion of movements in the determinants of the money supply and their relation to the rate of inflation in Kenya.

from the extent to which domestic inflation is controlled in the short run through government monetary and or fiscal policy.[54]

Seigniorage and/or inflation tax revenue will be generated in any monetary economy experiencing a growth in the demand for high powered money and/or inflation. However in regimes where there are controls on the capital account, and where there are reserve requirements imposed on financial sector institutions, there is also scope for the government to earn revenue from the maintenance of a regime of financial repression. We shall discuss the nature of the tax-base for financial repression in the next section, but can note here that this form of tax can be thought of as consisting of two components. First is the direct implicit tax on compulsory holdings of government debt by the banking system in accordance with reserve requirements (see *inter alia* Romer (1985), Brock (1989), and Siegel (1981)). In addition, when foreign asset accumulation is prohibited, the revenue from financial repression may be thought of as the equivalent of a tariff imposed on foreign financial asset accumulation by the domestic private sector.

We can define the per unit annual implicit taxation arising from financial repression as the value t_f which equalizes the domestic and foreign real rate of interest such that

$$(3.4) \qquad \left.\begin{array}{l} r_f = (1-t_f)r_k' \\ r_f = (1-t_f)r_d \end{array}\right\} \begin{array}{l} \text{if } r_k' > r_d \\ \text{if } r_k' < r_d \end{array}$$

where r_f is the actual rate of interest on financial assets (assuming that there is no expected capital gain), r_k' is the notional world interest rate and r_d the domestic notional market-clearing real interest rate. Diaz (1987), studying Mexico, implicitly assumes that $r_k' < r_d$ and proposes that with efficient bond markets, the return on risk-free long-dated government debt will be approximately equivalent to the real rate of growth of the economy, which is then taken as r_d. More

[54] This statement however is somewhat disingenuous since although we only examine the demand side explicitly, the implicit model used in this thesis is characteristically monetarist: real output is determined by a vertical aggregate supply function, and prices are determined through the interaction of the real demand for money and the domestic money supply, which, in the absence of open-market activities by the central bank, is determined, and therefore controlled through the domestic financing of the government deficit.

recently Giovannini and de Melo (1990) assume that $r_k' > r_d$ and uses the average cost of government borrowing as the measure of r_k'.

The measure used here combines the two approaches although we define r_k' as the uncovered interest rate parity measure against the SDR deposit interest rate. For simplicity we assume as a counterfactual that Kenya is a price taker in the international capital market where the uncovered interest parity condition holds, and where the nominal exchange rate is set independently of the capital account. Under these conditions, the counterfactual domestic interest rates is that rate which satisfied the UIP condition

$$(3.5) \quad E_t(s_{t+1}) - s_t = r_k{}'_t - r^*_t + \epsilon_t$$

where s is the spot exchange rate, E the expectations operator, r^* is the foreign (SDR) deposit rate, and ϵ_t a random error term, which equals zero in the mean. Rearranging (3.5), assuming perfect foresight such that $E_t(s_{t+1}) = s_{t+1}$ gives

$$(3.6) \quad r_k{}'_t = r^*_t + \Delta s_{t+1} - \epsilon_t$$

which defines $r_k{}'_t$ as the domestic rate of interest at which the expected returns from holding domestic and foreign assets are equalized.

The Tax Base

The aggregate revenue implications of both the inflation and financial repression taxes depend also on how the tax base is defined. The distinction between inside and outside money liabilities, and thus the net tax base depends on the ownership structures within the financial sector. Theoretical models of seigniorage and the inflation tax tend to make a variety of assumptions: Calvo (1978) and Calvo and Fernandez (1983) assume that the banking sector is the only holder of high-powered money and that the non-bank sector operates through checking or deposit accounts only. The non-bank private sector thus holds no primary liabilities of the government, and the inflation tax incidence can be analyzed simply in terms of the profit maximizing behaviour of the banking system, under alternative assumptions about competitive structures. Further, they assume that banks always lend to the limit of their reserve requirements. Fry (1981), on the other hand, examines a situation where the private sector makes portfolio choices over cash, deposits, and real assets. However Fry's model considers a fully nationalised, monopoly banking sector, and his analysis proceeds to examine the interaction between the optimal (ie revenue maximizing) rate of inflation and the monopolists choice of deposit rate. Seigel (1981), and Brock (1989) generalize these results and provide a synthesis of the relationship between seigniorage, regulation and the competitive structure of the banking system. These analytical simplifications are, however, not wholly tenable in the case of Kenya. First, both the banking and non-banking sector hold notes and coin issued by government. Second one of the persistent features of the commercial banking sector is the extent to which they hold liquid assets (ie non-interest bearing cash balances and treasury bills) in excess of the minimum statutory cash and liquid asset requirements. Finally, the banking system, despite being a price-taker in the loan and deposit markets is almost totally private (the principal exception being the 60 per cent of Kenya Commercial Bank still owned by government) and, as a result, transfers between the banks and non-banks in response to the inflation tax and financial repression taxes falling on deposits (ie inside money) represent intra-private sector transfers rather than tax revenue transfers from the private to the public sector. In our analysis we can therefore treat the banking system as being wholly private so that the base for the inflation tax consists solely of the non-interest bearing deposits of the liabilities issued by the Government of Kenya through the central bank. The inflation-tax base therefore consist of two elements. The first element is the holdings of notes and coin by the non-bank private sector, and the second is the holdings of till-cash and non-interest bearing reserves at the central bank by the commercial banking sector in terms of the 1968 Banking Act.

Figure 3.1
Distribution of Government Stock

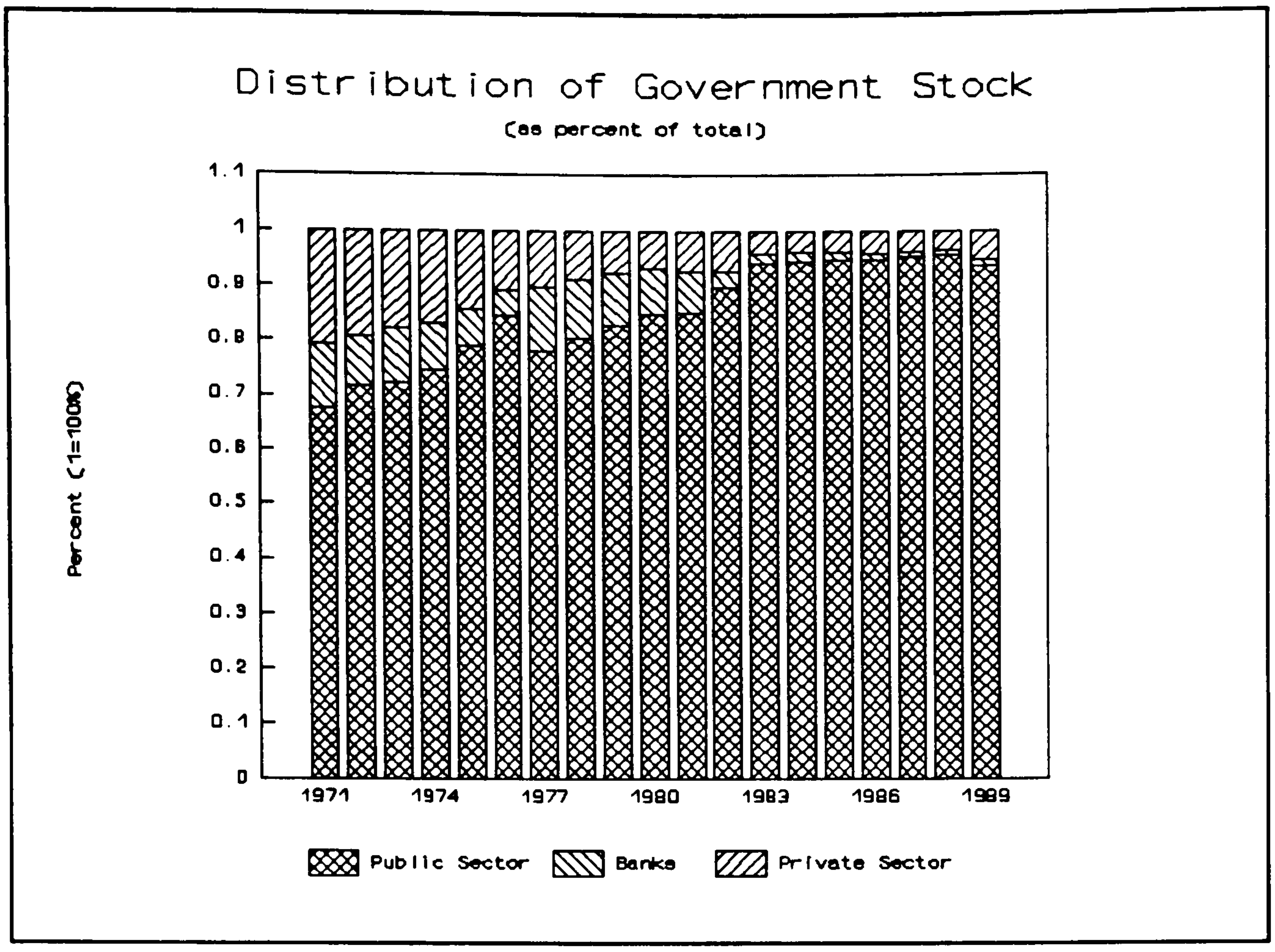
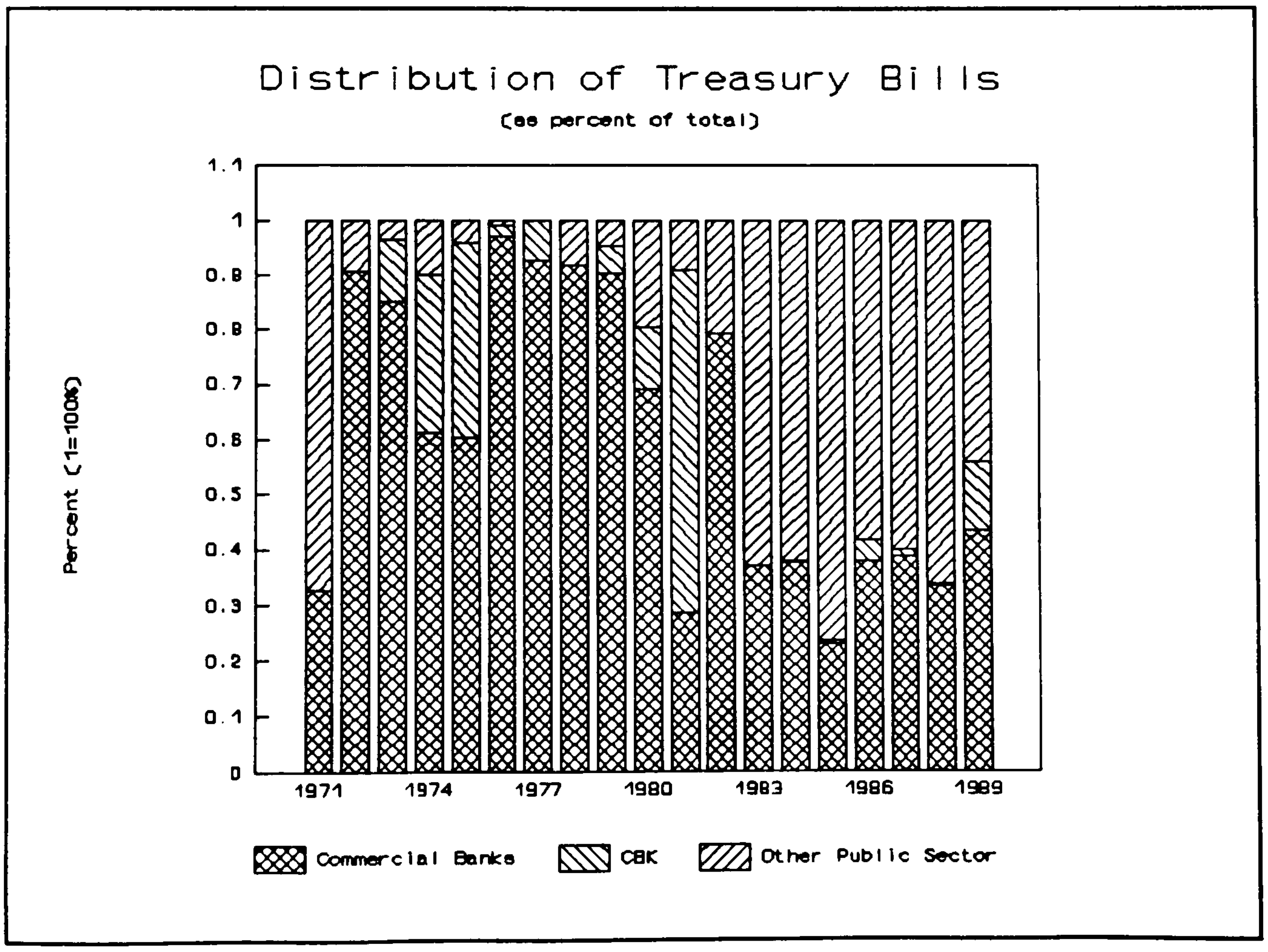


Figure 3.2
Distribution of Treasury Bills



As Figures 3.1 and 3.2 indicate, the bulk of central government interest bearing debt liabilities are held either by the Central Bank or other public sector institutions. Consequently, the effect of the financial repression tax is internalised within the public sector, since any implicit tax or subsidy imposed through the pricing of debt is offset by an equivalent decrease or increase in profits remitted by public sector institutions to their shareholder, the government. The relevant base for the calculation of the tax revenue from financial repression tax is debt held by the private sector only.[55] Over the period, the private sector share of total outstanding domestic government debt has averaged 21 per cent of the total, equivalent to 6.2 per cent of GDP. The debt is held both as long-dated government loan stock and short-dated Treasury Bills. The latter are held almost exclusively by the commercial banks, while the former are held only by the non-bank private sector.

Thus the tax base consists of four separate elements, namely: notes and coin held by the non-bank private sector; till-cash and non-interest bearing reserves at the central bank by the commercial banking sector; the stock of government debt held by the non-bank private sector; and other liquid assets held by the commercial banks, principally Treasury Bills.[56]

Given the absence of any direct regulation on the non-bank private sector, their holdings of high-powered money and government interest bearing debt can be determined in relation to the standard demand for money theory applied elsewhere in the thesis. For the commercial banking sector however the analysis would need to proceed differently to account for the presence of cash reserve and liquid asset requirements. Required cash and liquid assets are set by the Central Bank and are expressed as a minimum proportion of the level of eligible deposits of the banking system. As noted in the introduction, the cash ratio has however been operational only periodically and, in general, actual cash holdings by the

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[55] Collier and Gunning (1991) discuss the implications of this form of composition of debt holdings on the interpretation of the high-powered money multiplier.

[56] Liquid assets are defined in terms of the 1968 Banking Act and consist of: (i) till cash (defined as total notes and coin issued by the central bank less that held outside the banking sector); (ii) non-interest bearing balances held with the Central Bank of Kenya; (iii) Treasury Bills; and (iv) net inter-bank balances. Obviously the final element will net out to zero for the banking system as a whole.

banks have been well in excess of the statutory minimum. A similar picture emerges with the liquid asset ratio (which has been used more actively during the period), although persistent excess liquidity has been a feature of commercial bank behaviour over the period. The presence of aggregate excess liquidity principally reflects the effect of voluntary or involuntary credit rationing. Arguments for voluntary credit rationing arise from incomplete markets in information and are well known (Stiglitz and Weiss (1982)). Involuntary credit rationing may emerge as a result of the existence of quantitative controls on domestic credit expansion, as have occurred throughout much of the 1980s (Killick and Mwega (1990), and Mosely *et al.* (1991)). If lending is constrained in the short-run in this way, then one-off and unexpected, increases in deposits (for example during the coffee booms of 1976 and 1986) will be reflected in high levels of excess liquidity. Similarly, when the commercial banks face costs of adjustment in their asset portfolio, growing deposit liabilities will also be matched by the short-run accumulation of liquid assets prior to increasing lending. The banking sector in this case increases its claims of the government sector through holdings of cash, increasing its deposits with the central bank, or accumulating government bills and bonds. Involuntary credit rationing also arises from the banks' position as price-takers in the deposit and loan markets. Given administered rates, the predominance of liquid assets in the total asset portfolio reflects their high risk-adjusted rate of return relative to lending, even though the unadjusted real rate of return to liquid assets is negative. In the next section, although we do not attempt to formally model the portfolio choice of the banking sector, we do offer a decomposition of the total tax borne by the commercial banking sector into its statutory and excess components.

3.2 Measurement of Revenue from Inflation and Financial Repression

In this section we calculate the *ex post* incidence of the inflation and financial repression taxes for Kenya over the period since 1972. It is important to state that the results in this section do not consist of a counterfactual analysis, but rather a measure of how important a source of revenue implicit taxation of the financial liabilities of the government have been.

The Inflation Tax

Table 3.1
Direct Seigniorage Revenue

Year	Money Base	Growth of Base	CPI (85=100)	Infl.	Real Money	Real Seigniorage
1971	1127.60	10.00%	16.49	7.40%	6839.62	683.96
1972	1235.20	9.54%	17.04	3.35%	7249.51	691.78
1973	1340.56	8.53%	19.63	15.21%	6829.07	582.51
1974	1719.53	28.27%	22.76	15.94%	7555.47	2135.90
1975	1539.72	-10.46%	27.10	19.07%	5681.86	-594.15
1976	1963.13	27.50%	30.19	11.40%	6502.99	1788.27
1977	3153.40	60.63%	37.07	22.80%	8506.32	5157.49
1978	3177.24	0.76%	41.98	13.23%	7569.16	57.22
1979	3855.05	21.33%	45.44	8.26%	8482.93	1809.69
1980	4244.49	10.10%	52.25	14.97%	8123.95	820.69
1981	4550.97	7.22%	59.10	13.12%	7700.12	556.00
1982	5528.82	21.49%	73.30	24.02%	7542.52	1620.63
1983	5437.24	-1.66%	81.09	10.62%	6705.46	-111.07
1984	5945.86	9.35%	89.76	10.70%	6624.20	619.65
1985	7114.44	19.65%	100.00	11.41%	7114.44	1398.25
1986	9750.36	37.05%	103.66	3.66%	9406.35	3485.08
1987	11076.94	13.61%	111.60	7.66%	9925.57	1350.42
1988	11991.23	8.25%	123.10	10.30%	9741.05	804.03
1989	13794.41	15.04%	135.15	9.79%	10206.74	1534.84
Average		15.90%		12.53%	7859.32	1317.07
Max		60.63%		24.02%	10206.74	5157.49
Min		-10.46%		3.35%	5681.86	-594.15
Std Dev		15.55%		5.44%	1254.32	1302.07

Note: Base consists of notes and coin in circulation plus Commercial Bank Reserves.

Table 3.1 calculates the real seigniorage revenue earned over the period, which averaged approximately Ksh 1.3 billion per annum in constant 1985 prices, equivalent to approximately 1.27 per cent of GDP per annum. These calculations are based on year-end stock data, and year-on-year inflation figures.

In theory the true calculation of the cash flow from seigniorage and the inflation tax is in continuous time. A discrete-time approximation such as this is exact only when inflation is constant throughout the period. Chamley (1991) computes the biases for situations where inflation is non-constant within years, and find that for high inflation economies (for example with average annual inflation rates in excess of 60 per cent), the percentage error in computation can in excess of 20 per cent. Although from Chapter 2 we know that the quarterly inflation rate is not constant, the variation in the inflation ranges prevalent in Kenya are not large enough to produce a significant bias in the calculations based on year-on-year figures.

Notwithstanding this measurement error, the nominal growth of the money stock (ie the total nominal seigniorage) can be decomposed into its principal components, namely the revenue earned from the inflation tax, that accruing to the autonomous growth in the real money base (as a result of the growth in the real demand for money), and the interaction of the two. This decomposition is defined as:

$$(3.7)\ dM = dm|_{P0} + dP|_{m0} + dP.dm$$

The first term on the right hand-side represents the real (non-inflationary) growth in the monetary base; the second represents the "pure" inflation tax component; and the third term is the interaction between the two effects. This decomposition is reported in Table 3.2.

This decomposition illustrates the potentially counteracting effects of monetary base growth and inflation in the economy. In general, revenue accrues to the government through both the growth-induced increase in the real value of the money stock, and through the inflation tax; however in the presence of high levels of inflation, agents seek to reduce their exposure to the tax and economize on their holdings of high-powered money. This effect is evident in a number of years where the real value of money balances declined, while in 1975 and 1983 the inflation tax effect so outweighed the real balance effect, that there was a reduction in the *nominal* money base as well. It is the persistence of this inflation effect which leads, eventually, to the switch out of money, and which underlies the existence of a revenue-maximizing rate of inflation (sometimes referred to as an "optimal" rate of inflation), to which we return in the next section. It is relevant to note that in the case of the Kenyan economy, although there has been some variation, the size of the monetary base in relation to income has remained relatively constant at approximately 7.75 per cent of GDP which, given the unitary income elasticity of demand for money identified in Chapter 2, suggests that the economy has not been operating at above its "optimal" inflation rate.

Table 3.3 reports the pure inflation tax revenue in Kenya which, as can be confirmed from Table 3.2, is lower than the total seigniorage revenue by the extent of the real balance effect. Total inflation tax, in 1985 Shillings, amounted on average to Ksh 830 million per annum throughout the 1972-1989 period, equivalent to approximately 0.8 per cent of GDP, or 3.7 per cent of total government tax revenue. At its maximum, in 1978 and 1983, it accounted for over 7 per cent of total revenue and 1.75 per cent of GDP. Approximately 70 per cent of the inflation tax has been borne by the non-bank private sector in terms of individuals' transactions cash balances, with the remaining 30 per cent accruing from taxation of the cash balances of the banking system (Tables 3.3.a. and 3.3.b.).

Comparisons with estimates from other countries are slightly problematic since though the inflation tax has frequently been considered to represent a significant source of revenue, there have been relatively few attempts to quantify it. Estimates for industrialised economies (for example Fischer (1982) suggest that the inflation tax may account for approximately 0.5 per cent of GDP per annum). For developing countries estimates vary quite widely, not least because they include estimates of short-run inflation tax revenues which, in the light of our earlier comments on the offsetting effects of inflation tax and real balance effects, are not sustainable. Reported tax yields can be biased upwards by the presence of such non-sustainable levels of the inflation tax amongst high-inflationary economies. Thus Chamley's (1991) estimates for four Sub-Saharan African economies (Ghana, Somalia, Zaire and Zambia), which indicate that inflation tax revenue over the period from 1971-1986 averaged 4.8 per cent of GDP for Somalia and Zambia, 6.8 per cent for Ghana and 7.8 per cent for Zaire, are likely to overstate the sustainable level of tax revenue.[57] Diaz's (1987) study of inflation tax in Mexico is much closer to the methodology used here and suggests a comparable level of inflation tax of 0.76 per cent of GDP in 1977 and 1.13 per cent in 1980.

Table 3.2

Decomposition of Nominal Base Money

	Decomposition of Nominal Increase in Base				Proportional Decomposition			
Year	Nominal Base Increase	Inflation Tax	Real Balances	Joint Effect	Nominal Base Increase	Inflation Tax	Real Balances	Joint Effect
1971								
1972	107.6	83.47	22.47	1.66	100.0%	77.6%	20.9%	1.5%
1973	105.3	41.36	61.92	2.07	100.0%	39.3%	58.8%	2.0%
1974	378.9	203.92	151.94	23.11	100.0%	53.8%	40.1%	6.1%
1975	-179.8	274.05	-391.47	-62.39	100.0%	-152.4%	217.7%	34.7%
1976	423.4	293.63	109.00	20.79	100.0%	69.3%	25.7%	4.9%
1977	1190.2	223.80	867.57	98.90	100.0%	18.8%	72.9%	8.3%
1978	23.8	719.00	-566.09	-129.07	100.0%	3015.9%	-2374.5%	-541.4%
1979	677.8	420.38	227.35	30.08	100.0%	62.0%	33.5%	4.4%
1980	389.4	318.56	65.47	5.41	100.0%	81.8%	16.8%	1.4%
1981	306.4	635.28	-286.00	-42.81	100.0%	207.3%	-93.3%	-14.0%
1982	977.8	597.20	336.50	44.16	100.0%	61.1%	34.4%	4.5%
1983	-91.5	1328.30	-1144.83	-275.04	100.0%	-1450.4%	1250.1%	300.3%
1984	508.6	577.44	-62.21	-6.61	100.0%	113.5%	-12.2%	-1.3%
1985	1168.5	635.96	481.15	51.46	100.0%	54.4%	41.2%	4.4%
1986	2635.9	811.66	1637.45	186.81	100.0%	30.8%	62.1%	7.1%
1987	1326.5	356.60	935.76	34.22	100.0%	26.9%	70.5%	2.6%
1988	914.2	848.77	60.86	4.66	100.0%	92.8%	6.7%	0.5%
1989	1803.1	1235.66	514.51	53.02	100.0%	68.5%	28.5%	2.9%
Average	703.71	533.61	167.85	2.25	100.00%	137.28%	-27.78%	-9.50%
Max	2635.92	1328.30	1637.45	186.81	100.00%	3015.93%	1250.09%	300.33%
Min	-179.81	41.36	-1144.83	-275.04	100.00%	-1450.42%	-2374.52%	-541.41%
Std Dev	705.95	351.75	595.39	92.25	0.00%	781.28	635.47%	145.94%

Notes: See text for description of decomposition

[57] A further complication in using Chamley's results is that he uses M2 as the tax base in order to also capture the tax receipts from the use of reserve requirements and from other forms of financial repression.

Table 3.3
Inflation Tax Revenue by Source

	Total Direct Inflation Tax					Direct Inflation Tax on NBPS					Direct Inflation Tax on Banks				
Year	Inf Tax per period	Real Inf Tax (85 Kshm)	Inf Tax as % Rev	Inf Tax as % GDP	Inf Tax as % Deficit	Inf Tax per period	Real Inf Tax (85 Kshm)	Inf Tax as % Rev	Inf Tax as % GDP	Inf Tax as % Deficit	Inf Tax per period	Real Inf Tax (85 Kshm)	Inf Tax as % Rev	Inf Tax as % GDP	Inf Tax as % Deficit
1972	83.47	489.90	3.33%	0.55%	11.33%	60.97	357.8	3.43%	0.41%	8.27%	22.50	132.07	0.90%	0.15%	3.05%
1973	41.36	210.72	1.49%	0.24%	7.06%	30.55	155.63	1.10%	0.17%	5.21%	10.81	55.09	0.39%	0.06%	1.85%
1974	203.92	896.01	4.79%	0.96%	28.48%	128.76	565.75	3.02%	0.61%	17.98%	75.16	330.26	1.76%	0.35%	10.50%
1975	274.05	1011.30	6.09%	1.15%	13.90%	219.72	810.83	4.88%	0.92%	11.14%	54.33	200.47	1.21%	0.23%	2.75%
1976	293.63	972.65	5.76%	1.01%	20.81%	243.07	805.17	4.77%	0.84%	17.23%	50.56	167.48	0.99%	0.17%	3.58%
1977	223.80	603.69	3.18%	0.60%	16.14%	154.88	417.80	2.20%	0.42%	11.17%	68.91	185.89	0.98%	0.19%	4.97%
1978	719.00	1712.87	7.16%	1.75%	48.58%	521.62	1242.65	5.20%	1.27%	35.24%	197.38	470.23	1.97%	0.48%	13.34%
1979	420.38	925.04	3.56%	0.90%	24.45%	291.52	641.48	2.47%	0.63%	16.96%	128.86	283.55	1.09%	0.28%	7.50%
1980	318.56	609.72	2.53%	0.59%	13.00%	227.52	435.47	1.81%	0.42%	9.28%	91.04	174.25	0.72%	0.17%	3.71%
1981	635.28	1074.88	4.43%	1.02%	13.62%	498.17	842.88	3.48%	0.80%	10.68%	137.12	232.0	0.96%	0.22%	2.94%
1982	597.20	814.71	4.06%	0.85%	13.11%	402.26	548.77	2.73%	0.57%	8.83%	194.94	265.94	1.33%	0.28%	4.28%
1983	1328.30	1638.12	7.47%	1.73%	193.63%	997.47	1230.13	5.61%	1.30%	145.40%	330.83	407.99	1.86%	0.43%	48.23%
1984	577.44	643.32	3.05%	0.65%	24.72%	424.42	472.84	2.24%	0.48%	18.17%	153.02	170.47	0.81%	0.17%	6.55%
1985	635.96	635.96	3.08%	0.63%	7.28%	450.31	450.31	2.18%	0.45%	5.16%	185.65	185.65	0.90%	0.18%	2.13%
1986	811.66	783.02	3.25%	0.69%	12.21%	530.36	511.65	2.12%	0.45%	7.98%	281.30	271.37	1.13%	0.24%	4.23%
1987	356.60	319.53	1.26%	0.27%	6.21%	247.48	221.76	0.88%	0.19%	4.31%	109.11	97.77	0.39%	0.08%	1.90%
1988	848.77	689.50	2.52%	0.57%	53.28%	604.21	490.83	1.80%	0.40%	37.93%	244.56	198.67	0.73%	0.16%	15.35%
1989	1235.66	914.28	3.20%	0.73%	14.58%	864.83	639.90	2.24%	0.51%	10.20%	370.83	274.38	0.96%	0.22%	4.37%
Average	533.61	830.29	3.90%	0.83%	29.02%	383.23	602.32	2.84%	0.60%	21.17%	150.38	227.97	1.06%	0.23%	7.85%
Max	1328.30	1712.87	7.47%	1.75%	193.63%	997.47	1242.65	5.61%	1.30%	145.40%	370.83	470.23	1.97%	0.48%	48.23%
Min	41.36	210.72	1.26%	0.24%	6.21%	30.55	155.63	0.88%	0.17%	4.31%	10.81	55.09	0.39%	0.06%	1.85%
Std. Dev	351.75	374.19	1.71%	0.40%	41.90%	253.99	286.78	1.35%	0.31%	31.47%	101.60	100.33	0.43%	0.10%	10.50%

The variance around the mean value of the inflation tax in Kenya has, however, been quite substantial due both to the rate of tax (ie the inflation rate), and also to the volatility in the nominal monetary base. Domestic inflation has varied from approximately 20 per cent in 1977 and again in 1982 to less than 3 per cent in 1986, and although there is not a direct, stable short-run relationship between inflation and movements in the monetary base,[58] the latter does seem to explain, in part, the volatility in inflation. In the absence of an effective short-term money market, the Kenyan monetary authorities have only very limited control over the growth of reserves in the presence of weak fiscal control, which, for much of the period was exacerbated by the persistence of acyclical sterilization of the monetary implications of changes in net foreign assets.[59] On the demand side, faced with limited scope for asset substitution between outside and inside domestic financial assets, and, more importantly, between domestic and foreign assets in the short run leads to the persistence of disequilibrium levels of cash holdings by the bank and non-bank financial sector. We return to this in Section 3.3.

Financial Repression Tax

An analogous set of results is presented in Tables 3.4 to 3.6 for the calculation of the financial repression tax borne by the bank and non-bank private sector, based on the methodology outlined above. Though both the banking and non-banking private sectors hold both Treasury Bills and Bonds, the former are held almost exclusively by the banking system, and the latter by the non-bank private sector. For simplicity we assume that the non-bank private sector only holds bonds, and the commercial banks only Treasury Bills.

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[58] See for example Killick and Mwega (1990) and Bolnick (1978).

[59] Increases in net foreign assets (particularly during the coffee boom) typically have been monetized through the expansion in the monetary base, while falls in reserves have been offset by expansions in the base.

The evidence suggests that the average implicit tariff on government debt, as defined in (3.4) above, held by the non-bank private sector was equivalent to approximately 9 percentage points. For Treasury Bills the value was 8.3 percentage points. In other words, the period average rate of return on Bills was 8.75 per cent per annum and that for bonds 8.14 per cent compared to a domestic-equivalent world deposit rate (given perfect foresight exchange rate expectations) of 16.65 per cent. The method of calculation of the UIP equivalent world interest rate, which implicitly assumes that agents correctly forecast movements in the Kenyan Shilling / SDR exchange rate, means that the calculated implicit tariff, t_f, varies considerably from year-to-year. The variation in the equivalent rate is however is consistent with developments in the world economy which are *ex post* interpretable, and which may have been forecasted *ex ante*. Thus the tariff varies from zero in at the time of the coffee boom when world interest rates were low and the Shilling relatively strong, to a peak level of almost 31 per cent in 1980 when world (SDR) interest rates were very high (10 per cent to 11 per cent) following the tight monetary stance adopted in response to the second oil shock.

Total implicit revenue from repression of the rate on government debt, by this measure, represented on average 6.7 per cent of total government revenue, or 1.4 per cent of GDP, slightly more than twice the yield from the inflation tax. Again we can compare this with results reported by Giovannini and de Melo (1990) which, though employing a slightly different method for calculating the notional yield on world capital markets, reports an average repression tax revenue over the period from 1972 to 1987 for a sample of 24 developing countries of 1.8 per cent of GDP, and an implicit tariff, t_f, of 18 per cent. Within this sample, the only comparable economy is Zimbabwe, where the implicit tariff is estimated (from 1980-86) to be 19.5 per cent, yielding revenue equivalent to 5.5 per cent of GDP. Our results are thus broadly consistent with those of Giovannini and de Melo (1990), and we believe that the higher contribution of financial repression revenue accruing to the government of Zimbabwe reflects the fact that a larger proportion of domestic debt is held by the non-bank private sector.

In contrast to the inflation tax, the *average* share of the financial repression tax borne by the commercial banks and the non-bank private sectors has been approximately equal over the period as a whole. However the stock of debt held by the non-bank private sector has dropped sharply over the period, both in

Table 3.4
Calculation of Financial Repression

Financial Repression Revenue

Year	Bills with Banks	Stock with Pri Sector	T.Bill Rate	Stock Rate	Outside Debt/GDP Rate	SDR Deposit	UIP Ksh SDR Dep Rate [1]	Real Income Growth	Max Rd,Rk' [1]
	65.26	866.32	4.00%	3.00%	7.34%	4.97%	4.97%	5.00%	5.00%
1972	290.14	891.54	3.69%	3.00%	7.85%	4.68%	12.35%	14.66%	14.66%
1973	442.07	1089.50	1.60%	3.00%	8.72%	8.02%	13.49%	1.33%	13.49%
1974	313.79	965.75	6.00%	5.00%	6.03%	8.22%	19.51%	4.12%	19.51%
1975	482.56	1025.58	6.00%	5.00%	6.30%	5.57%	5.54%	-5.25%	5.54%
1976	1019.54	881.09	4.37%	5.00%	6.54%	4.88%	4.86%	9.05%	9.05%
1977	391.10	1498.14	1.41%	5.00%	7.77%	5.01%	4.93%	4.21%	4.93%
1978	1193.04	1599.78	6.67%	5.00%	6.81%	6.01%	6.09%	-2.69%	6.09%
1979	1609.43	1615.70	4.45%	5.00%	6.92%	8.36%	8.35%	5.01%	8.35%
1980	903.02	1793.44	5.77%	6.00%	5.00%	10.39%	36.93%	0.63%	36.93%
1981	1515.49	1948.71	9.99%	10.00%	5.59%	11.83%	31.11%	1.70%	31.11%
1982	2309.00	1612.18	13.35%	12.50%	5.58%	9.74%	12.92%	-8.59%	12.92%
1983	1858.85	1705.07	15.00%	12.50%	4.63%	7.29%	12.81%	-1.01%	12.81%
1984	2875.50	1639.80	12.43%	11.00%	5.06%	8.47%	26.69%	4.72%	26.69%
1985	2225.86	1966.18	14.14%	11.00%	4.16%	6.87%	15.29%	1.33%	15.29%
1986	5070.59	2221.81	12.15%	11.00%	6.21%	5.33%	28.97%	12.49%	28.97%
1987	6936.84	2174.57	13.00%	11.50%	6.98%	5.03%	12.20%	3.15%	12.20%
1988	5274.04	2077.17	13.52%	11.50%	4.92%	5.54%	19.70%	3.81%	19.70%
1989	7628.24	2218.45	14.00%	13.50%	5.78%	6.04%	27.99%	3.90%	27.99%
Average	2407.73	1606.91	8.75%	8.14%	6.16%		16.65%		
Max	7628.24	2221.81	15.00%	13.50%	8.72%		36.93%		
Min	290.14	881.09	1.41%	3.00%	4.16%		4.86%		
Std. Dev	2213.70	450.57	4.60%	3.60%	1.18%		9.65%		

Notes: [1] See text for description of counterfactual interest rates

Table 3.5

Decomposition of Financial Repression Revenue

Year	Non-Bank Private Sector					Commercial Banking Sector					Total Financial Repression			
	(1-tr) Stock 1	Real Fin Repr (85 Kshm)	Fin Repr as % Rev	Fin Repr as % GDP	Fin Repr as % Deficit	(1-tr) Bills 1	Real Fin Repr (85 Kshm)	nf Tax as % Rev	Inf Tax as % GDP	Inf Tax as % Deficit	Real Fin Repr (85 Kshm)	Inf Tax as % Rev	Inf Tax as % GDP	Inf Tax as % Deficit
1971	2.00%	105.10	0.73%	0.14%	2.36%	1.00%	3.95	0.03%	0.01%	0.09%	109.0	50.76%	0.14%	2.45%
1972	11.66%	610.32	4.15%	0.69%	14.11%	10.97%	186.82	1.27%	0.21%	4.32%	797.15	5.42%	0.90%	18.43%
1973	10.49%	582.36	4.12%	0.65%	19.51%	11.90%	267.92	1.90%	0.30%	8.97%	850.27	6.01%	0.95%	28.48%
1974	14.51%	615.74	3.29%	0.66%	19.57%	13.51%	186.28	0.99%	0.20%	5.92%	802.02	4.28%	0.86%	25.49%
1975	0.54%	20.27	0.12%	0.02%	0.28%	-0.46%	-8.27	-0.05%	-0.01%	-0.11%	12.01	0.07%	0.01%	0.16%
1976	4.05%	118.14	0.70%	0.12%	2.53%	4.68%	157.91	0.94%	0.16%	3.38%	276.05	1.64%	0.29%	5.91%
1977	-0.07%	-2.87	-0.02%	0.00%	-0.08%	3.52%	132.18	0.70%	0.13%	3.53%	129.32	0.68%	0.13%	3.46%
1978	1.09%	41.65	0.17%	0.04%	1.18%	-0.58%	-16.48	-0.07%	-0.02%	-0.47%	25.17	0.11%	0.03%	0.71%
1979	3.35%	119.02	0.46%	0.12%	3.15%	3.90%	138.00	0.53%	0.13%	3.65%	257.03	0.99%	0.25%	6.79%
1980	30.93%	1061.55	4.40%	1.03%	22.63%	31.16%	538.55	2.23%	0.52%	11.48%	1600.11	6.63%	1.55%	34.11%
1981	21.11%	696.18	2.87%	0.66%	8.82%	21.12%	541.55	2.23%	0.52%	6.86%	1237.73	5.11%	1.18%	15.68%
1982	0.42%	9.22	0.05%	0.01%	0.15%	-0.43%	-13.66	-0.07%	-0.01%	-0.22%	-4.45	-0.02%	0.00%	-0.07%
1983	0.31%	6.54	0.03%	0.01%	0.77%	-2.19%	-50.16	-0.23%	-0.05%	-5.93%	-43.62	-0.20%	-0.05%	-5.16%
1984	15.69%	286.64	1.36%	0.29%	11.01%	14.26%	456.90	2.17%	0.46%	17.56%	743.54	3.53%	0.75%	28.57%
1985	4.29%	84.29	0.41%	0.08%	0.97%	1.14%	25.42	0.12%	0.03%	0.29%	109.71	0.53%	0.11%	1.26%
1986	17.97%	385.10	1.60%	0.34%	6.00%	16.81%	822.43	3.42%	0.73%	12.82%	1207.53	5.01%	1.07%	18.83%
1987	0.70%	13.69	0.05%	0.01%	0.27%	-0.80%	-49.53	-0.20%	-0.04%	-0.96%	-35.84	-0.14%	-0.03%	-0.70%
1988	8.20%	138.36	0.51%	0.11%	10.69%	6.18%	264.76	0.97%	0.22%	20.46%	403.12	1.47%	0.33%	31.15%
1989	14.49%	237.85	0.83%	0.19%	3.79%	13.99%	789.63	2.76%	0.63%	12.59%	1027.47	3.59%	0.81%	16.38%
Average	8.87%	279.11	1.39%	0.28%	6.96%	8.26%	242.79	1.09%	0.23%	5.79%	521.91	2.48%	0.51%	12.75%
Max	30.93%	1061.55	4.40%	1.03%	22.63%	31.16%	822.43	3.42%	0.73%	20.46%	1600.11	6.63%	1.55%	34.11%
Min	-0.07%	-2.87	-0.02%	0.00%	-0.08%	-2.19%	-50.16	-0.23%	-0.05%	-5.93%	-43.62	-0.20%	-0.05%	-5.16%
Std. Dev	8.61%	302.21	1.56%	0.31%	7.40%	8.85%	269.77	1.09%	0.24%	6.81%	505.26	2.36%	0.49%	12.51%

Notes: [1] See text for description of counterfactual interest rates absolute terms and relative to commercial bank holdings of Treasury Bills. Whereas from 1971 to 1980 the non-bank private sector bore 63 per cent of the total tax on government debt, this share fell to less than 40 per cent in the second half of the decade.

As with total seigniorage, we can decompose the change in total revenue from financial repression into that part explicable in terms of changes in the real volume of government stock for a given rate of taxation, and that accounted for by the increase in the rate of taxation on a given volume of stock as follows:

$$(3.8) \quad dR = dg|_t + dt|_g + dg.dt$$

where R is total financial repression revenue, g is the real stock of debt, and t the implicit tax rate. This decomposition is presented in Table 3.6.

Real revenue from financial repression on all government liabilities increased by an average of Ksh 51 million per annum in 1985 prices, but this consisted of an annual increase in the tax on Treasury Bills of Ksh 44 million and only Ksh 7 million in the tax on private sector holdings of stock. Although the rate of taxation on bills and bonds is virtually identical, the reduction in the tax on private sector debt results solely from the offsetting effect of the rapid decline in the real tax base. We return to this in more detail in Section 4.3 where we attempt to estimate the private sector demand for government debt.

Finally in this section, we decompose the total tax (from inflation and financial repression) borne by the commercial banking sector into its "compulsory" and "excess" components. This is presented in Table 3.7.

This decomposition is somewhat arbitrary in that it assumes that in determining the composition of their liquid assets, the sector first meets its cash requirements (if in place), then its compulsory non-interest bearing deposits with the central bank, and then chooses its holdings of Treasury Bills. The tax on excess liquidity is thus the sum of that on cash and non-interest bearing deposits held in excess of the statutory cash ratio and Treasury Bills held in excess of the liquid asset requirement, and accounts for approximately 1 per cent of the total

Table 3.6

Decomposition of Financial Repression Tax

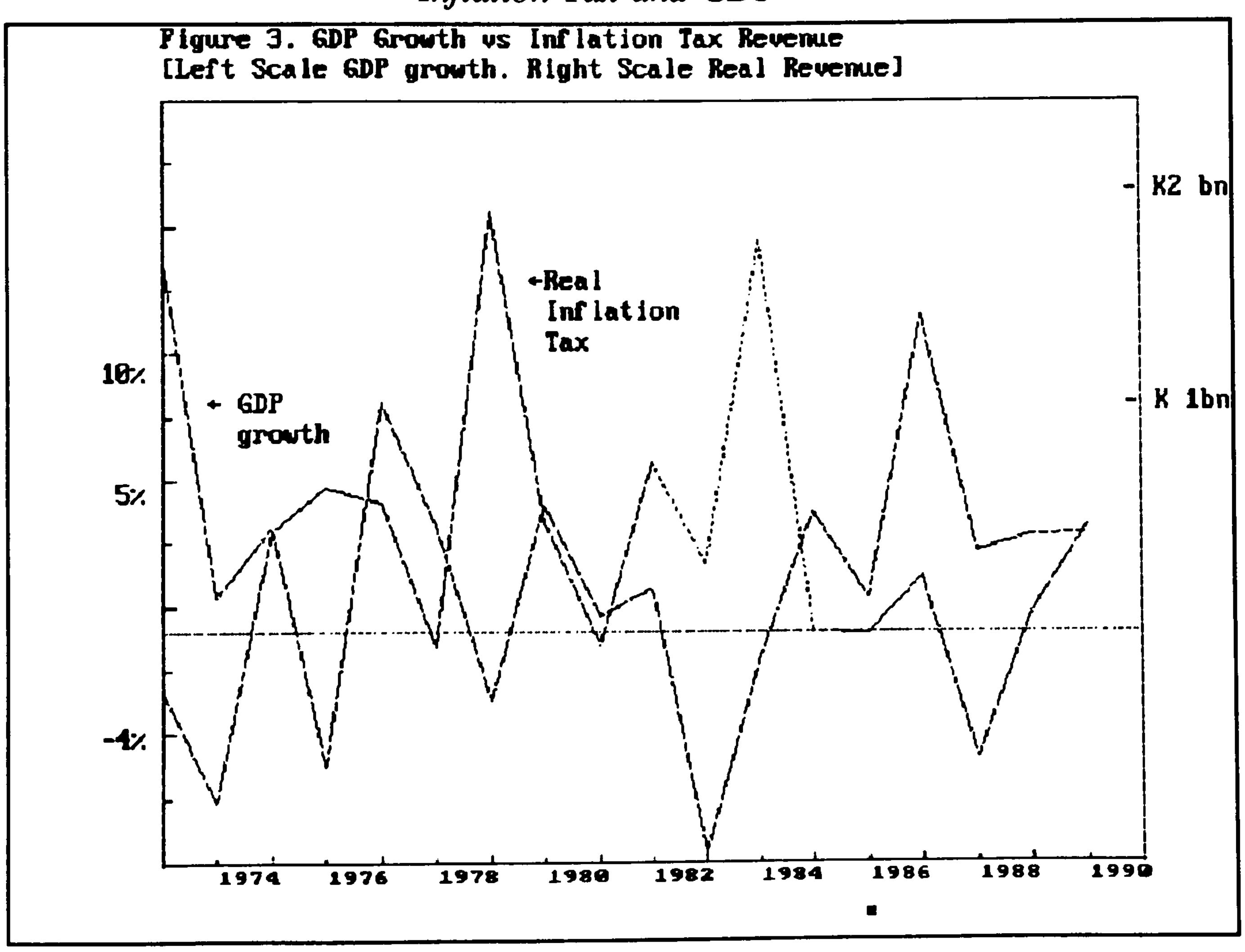
Year	Non-Bank Private Sector				Commercial Banks				Total			
	Change in Real Revenue	Real Balance Increase	Tax Rate Increase	Joint Effect	Change in Real Revenue	Real Balance Increase	Tax Rate Increase	Joint Effect	Change in Real Revenue	Real Balance Increase	Tax Rate Increase	Joint Effect
1972	505.23	-0.45	507.82	-2.15	182.87	13.05	39.48	130.34	688.10	12.61	466.68	208.81
1973	-27.97	37.04	-61.29	-3.72	81.09	60.25	15.76	5.08	53.12	97.29	-207.69	163.53
1974	33.38	-137.11	222.99	-52.50	-81.64	-103.89	36.34	-14.09	-48.25	-240.9	-81.38	274.12
1975	-595.47	-66.58	-593.01	64.12	-194.55	54.31	-192.68	-56.17	-790.01	-12.27	-601.08	-176.66
1976	97.87	-4.64	132.92	-30.41	166.18	-7.41	91.53	82.06	264.05	-12.05	77.50	198.60
1977	-121.01	45.44	-120.21	-46.24	-25.73	17.54	-38.94	-4.33	-146.74	62.98	-94.32	-115.40
1978	44.52	0.16	47.03	-2.68	-148.66	-32.07	-153.94	37.34	-104.14	-31.90	3.44	-75.68
1979	77.37	-2.80	85.94	-5.77	154.48	-4.05	127.23	31.31	231.85	-6.85	5.87	232.83
1980	942.53	-4.11	980.46	-33.83	400.55	-70.65	965.51	-494.31	1343.08	-74.76	-35.67	1453.51
1981	-365.38	-41.90	-336.77	13.29	2.99	260.43	-173.52	-83.91	-362.38	218.53	-663.09	82.18
1982	-686.96	-231.79	-682.36	227.19	-555.21	123.72	-552.67	-126.26	-1242.17	-108.07	-694.85	-439.25
1983	-2.67	-0.40	-2.37	0.10	-36.50	3.72	-55.26	15.05	-39.17	3.32	-19.38	-23.11
1984	280.09	-0.86	323.38	-42.43	507.06	-19.94	377.12	149.89	787.16	-20.80	13.42	794.54
1985	-202.35	21.86	-208.32	-15.88	-431.48	-139.44	-420.31	128.27	-633.83	-117.59	-341.70	-174.54
1986	300.81	7.60	268.97	24.25	797.01	30.45	348.81	417.75	1097.82	38.05	-54.92	1114.70
1987	-371.41	-35.01	-370.04	33.64	-871.96	222.62	-861.41	-233.17	-1243.37	187.61	-413.99	-1016.99
1988	124.67	-1.84	146.08	-19.58	314.29	15.39	433.64	-134.75	438.96	13.56	-303.39	728.79
1989	99.49	-3.76	106.14	-2.89	524.87	84.04	334.62	106.21	624.36	80.27	-396.41	940.50
Average	7.38	-23.29	24.85	5.81	43.65	28.23	17.85	-2.43	51.02	4.94	-185.61	231.69
Max	942.53	45.44	980.46	227.19	797.01	260.43	965.51	417.75	1343.08	218.53	466.68	1453.51
Min	-686.96	-231.79	-682.36	-52.50	-871.96	-139.44	-861.41	-494.31	-1243.37	-240.99	-694.85	-1016.99
Std. Dev	373.42	64.21	381.80	60.77	394.94	97.29	397.05	181.69	708.93	104.12	287.55	576.88

inflation tax: approximately equal to that levied on compulsory holdings of cash and bills.

Conclusions

The foregoing summary analysis indicates that inflation taxation and financial repression have represented a relatively small but significant sources of revenue to the Kenyan economy over the past two decades, contributing together the equivalent of almost 6.4 per cent of total government revenue per annum, or 1.33 per cent of GDP (Table 3.8). Approximately 0.8 per cent of GDP per annum has been raised through the inflation tax, and 0.5 per cent from the maintenance of controls on the capital account and domestic financial repression. In total this revenue has been roughly equivalent to half the revenue raised through the levy of domestic sales taxes on imports.[60]

Figure 3.3
Inflation Tax and GDP



[60] Government of Kenya Economic Survey (1990)

Table 3.7

Compulsory and Excess Tax Yield from the Banking Sector

	Cash Ratio	Till Cash	Stat. Cash Ratio [2]	Stat. Cash	Excess Cash	Liquid Asset Ratio	[---- Liquid Assets ----] Bills	Cash	Nib Bals	Stat. LAR	Stat. Liquid Assets	Excess Liquid Assets	Compulsory Repression Tax: Real Inf Tax 85 Ksm	Inf Tax as % Rev	Inf Tax as % GDP	Inf Tax as % Deficit	Voluntary Repression Tax: Real Inf Tax 85 Ksm	Inf Tax as % Rev	Inf Tax as % GDP	Inf Tax as % Deficit
1971	12.3%	386.10		0.00	386.10	18%	65.26	386.10	111.64	12%	392.0	171.00	109.05	0.76%	0.14%	2.45%	0.00	0.00%	0.00%	0.00%
1972	9.7%	312.92	5.0%	161.30	151.62	22%	290.14	312.92	113.94	15%	484.0	233.00	573.57	3.90%	0.65%	13.26%	223.58	1.52%	0.25%	5.17%
1973	8.2%	337.35		0.00	337.35	25%	442.07	337.35	268.58	15%	627.0	421.00	689.38	4.88%	0.77%	23.09%	160.90	1.14%	0.18%	5.39%
1974	10.5%	438.90		0.00	438.90	21%	313.79	438.90	119.31	16%	671.0	201.00	802.02	4.28%	0.86%	25.49%	0.00	0.00%	0.00%	0.00%
1975	5.1%	271.63		0.00	271.63	19%	482.56	271.63	251.81	15%	798.0	208.00	12.01	0.07%	0.01%	0.16%	0.00	0.00%	0.00%	0.00%
1976	4.4%	301.93		0.00	301.93	25%	1019.54	301.93	365.53	18%	1235.0	452.00	235.42	1.40%	0.24%	5.04%	40.63	0.24%	0.04%	0.87%
1977	9.3%	948.51		0.00	948.51	28%	1391.10	948.51	554.39	18%	1835.0	1059.00	119.04	0.63%	0.12%	3.18%	10.27	0.05%	0.01%	0.27%
1978	6.9%	763.42	4.0%	442.56	320.86	23%	1193.04	763.42	558.54	18%	1991.0	524.00	20.89	0.09%	0.02%	0.59%	4.29	0.02%	0.00%	0.12%
1979	8.6%	1078.61	4.0%	501.68	576.93	23%	1609.43	1078.61	249.96	16%	2009.0	929.00	200.80	0.77%	0.20%	5.31%	56.23	0.22%	0.05%	1.49%
1980	8.6%	1040.94	4.0%	484.16	556.78	18%	903.02	1040.94	261.04	16%	1936.0	269.00	1600.11	6.63%	1.55%	34.11%	0.00	0.00%	0.00%	0.00%
1981	6.3%	864.55	4.0%	548.92	315.63	20%	1515.49	864.55	379.96	15%	2058.0	702.00	922.17	3.80%	0.88%	11.68%	315.56	1.30%	0.30%	4.00%
1982	10.0%	1625.00		0.00	1625.00	26%	2309.00	1625.00	338.00	15%	2437.5	1834.50	-4.04	-0.02%	0.00%	-0.07%	-0.40	0.00%	0.00%	-0.01%
1983	6.8%	1145.80		0.00	1145.80	20%	1858.85	1145.80	412.48	20%	3370.0	47.13	-43.62	-0.20%	-0.05%	-5.16%	0.00	0.00%	0.00%	0.00%
1984	7.4%	1423.39		0.00	1423.39	24%	2875.50	1423.39	356.11	20%	3847.0	808.00	743.54	3.53%	0.75%	28.57%	0.00	0.00%	0.00%	0.00%
1985	9.2%	1908.63		0.00	1908.63	22%	2225.86	1908.63	328.51	20%	4149.0	314.00	109.71	0.53%	0.11%	1.26%	0.00	0.00%	0.00%	0.00%
1986	11.0%	2980.78	6.0%	1625.88	1354.90	31%	5070.59	2980.78	276.63	20%	5420.0	2908.00	837.67	3.48%	0.74%	13.06%	369.86	1.54%	0.33%	5.77%
1987	10.4%	3141.22	6.0%	1812.24	1328.98	31%	6936.84	3141.22	-779.06	20%	6041.0	3258.00	-25.87	-0.10%	-0.02%	-0.50%	-9.97	-0.04%	-0.01%	-0.19%
1988	9.2%	2938.02	6.0%	1916.10	1021.92	24%	5274.04	2938.02	-603.06	20%	6387.0	1222.00	387.82	1.42%	0.32%	29.97%	15.29	0.06%	0.01%	1.18%
1989	9.1%	3321.41	6.0%	2189.94	1131.47	24%	7628.24	3321.41	-2062.65	20%	7300.0	1587.00	966.12	3.38%	0.77%	15.40%	61.36	0.21%	0.05%	0.98%
Average													434.51	2.06%	0.42%	10.89%	65.66	0.33%	0.06%	1.32%
Max													1600.11	6.63%	1.55%	34.11%	369.86	1.54%	0.33%	5.77%
Min													-43.62	-0.20%	-0.05%	-5.16%	-9.97	-0.04%	-0.01%	-0.19%
Std Dev													444.04	2.01%	0.43%	11.76%	112.24	0.55%	0.11%	2.02%

Note: [2] introduced Nov 71; suspended Mch 72; introduced June 78; suspended Apr 81; introduced Mch 86

Table 3.8

Total Inflation Tax and Financial Revenue

Year	Real Revenue (85 Kshm)	as % Rev	as % GDP	as % Deficit
	109.05	0.76%	0.14%	2.45%
1972	1287.05	8.75%	1.46%	29.75%
1973	1060.99	7.51%	1.19%	35.54%
1974	1698.02	9.07%	1.82%	53.97%
1975	1023.30	6.16%	1.16%	14.06%
1976	1248.71	7.40%	1.30%	26.72%
1977	733.01	3.86%	0.73%	19.59%
1978	1738.04	7.27%	1.78%	49.29%
1979	1182.06	4.55%	1.15%	31.25%
1980	2209.83	9.16%	2.14%	47.11%
1981	2312.60	9.54%	2.20%	29.29%
1982	810.26	4.04%	0.84%	13.04%
1983	1594.50	7.27%	1.68%	188.47%
1984	1386.86	6.58%	1.39%	53.29%
1985	745.67	3.62%	0.74%	8.54%
1986	1990.55	8.27%	1.76%	31.03%
1987	283.69	1.12%	0.24%	5.51%
1988	1092.61	4.00%	0.90%	84.43%
1989	1941.76	6.79%	1.54%	30.96%
Average	1352.20	6.39%	1.33%	41.77%
Max	2312.60	9.54%	2.20%	188.47%
Min	283.69	1.12%	0.24%	5.51%
Std. Dev	539.15	2.29%	0.51%	40.22%

However, for an economy which is prone to large external shocks, and where other revenue sources are, in the main, pro-cyclical and where open-market operations and reserve management have not been developed, these sources of revenue offer government an important degree of fiscal flexibility. As Figure 3.3 shows financial taxation has been relatively counter-cyclical and therefore (at least counterfactually) acts as form of revenue stabilizing mechanism. While the inflation tax and financial repression revenue accounted for only 6 per cent of total revenue on average, in the short run revenue from the taxation of financial assets could reach as high as 10 per cent of total revenue in any single year. Two important features emerge. The first is that, with the exception of a small number of years, the real value of the inflation tax has been an increasing function of the rate of inflation. Private agents remained willing to *increase*, or at least maintain, their real money balances in the face of inflation, which suggests that the economy was operating at or below the revenue-maximizing rate of inflation. This immediately begs the question: could even more revenue have been raised from the inflation tax over the period? On the other hand, the non-bank private sector has progressively reduced its holdings of government debt. This reduction, suggests that the "optimal" level of financial repression - in the narrow sense implicit in the foregoing discussion - may have been exceeded (if such a rate of taxation exists), and consequently a reduction in the implicit tax through increased domestic interest rates or external capital account liberalization, may be welfare enhancing to the government by increasing the demand for interest bearing securities by the non-bank private sector. In the next section we therefore examine the question of the optimal rate of taxation of non-bank private sector holdings of government liabilities.

3.3 The Revenue Maximizing Rate of Inflation and Financial Repression

In this section we pose the question: at what rate of taxation (ie inflation) will revenue from the taxation of financial assets held by the non-bank private sector be maximized? This is slightly different from the standard analyses of commodity taxation (see for example Atkinson and Stiglitz (1980) and Newbery and Stern (1987)) which generally take as the point of departure the Ramsey tax problem which derives the least-cost (ie welfare loss minimizing) method of raising a given level of revenue through taxation of commodities and incomes when lump-sum taxes are not feasible. Our approach, which is chosen for its tractability and direct applicability to concerns about the impact of programmes of financial reform and liberalization, employs the partial-equilibrium approach arising out of Friedman's (1971) optimal inflation framework and is developed in the context of a single-equation model of the demand for financial assets. We employ this approach to look at the non-bank private sector's demand for high-powered money balances and for government loan stock.

3.3.1. The Non-Bank Private Sector Demand for High-Powered Money

We commence by estimating the *sustainable*, or long-run rate of inflation which maximizes the inflation tax revenue to the government. Traditionally there are two methods for estimating this rate of inflation. The first fits a Laffer curve to data on the inflation tax revenue and the inflation rate, and solves for the revenue maximization inflation rate. The alternative approach, and the one which we shall concentrate on in this chapter follows a more conventional approach by estimating the inflation elasticity of the demand for money. It is instructive however to commence with the Laffer curve approach. We estimate the Laffer curve of the form

$$(3.9) \qquad I_t = a + b\pi + c\pi^2$$

where I is the inflation tax ($\pi(M/P)$), and π the inflation rate or, in the steady state, the growth in the nominal money stock. Inflation tax is maximized where $\delta I_t/\delta\pi_t = 0$, in other words, where $\pi^* = -b/2c$. Though it is a relatively straightforward exercise in principle to estimate this relationship, there are some quite severe drawbacks in relying heavily on this method, not least because of the generally weak statistical properties of the regression models. For example, equation (3.10) defines a Laffer curve for Kenyan (annualized) quarterly data from 1973(2) to 1989(2), where π^2 is the square of the inflation rate.

EQ(3.10) Modelling Itax by OLS : Sample is 1973(2) to 1989(2)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
Constant	.0007907	.00148	.00121	.53318	.0046
π	2.1346639	.01736	.01827	122.93122	.9959
π^2	-.0389686	.04003	.04099	-.97344	.0151

R^2 = .9994175 σ = .0041146 F(2, 62) = 53192.27 [.0000] DW = .579

LM Autocorrelation

F(5, 57) = 23.04 [.0000]

LM Autoregressive Distributed Lag

F(5, 52) = 1.53 [.1957]

White Heteroscedasticity Test F(3, 58) = 5.86 [.0014]

The revenue maximizing value of inflation derived from (3.10), π^*, is approximately 27 per cent per annum. However as the low value of the Durbin-Watson statistic, and the significant rejection of the LM test for higher order autocorrelation indicate, the equation exhibits high autocorrelation, reflecting the presence of a spurious correlation between $Itax_t$ and π_t, which are both I(1) series. This serves to upwardly bias the coefficient b, and thereby over-state the revenue maximizing rate of inflation. Not surprisingly the equation has extremely poor dynamic properties: estimation of the equation using a recursive estimator reveals a lack of parameter constancy in the equation. In the light of these poor statistical characteristics it is not possible to draw strong inference from the results.

The alternative, and preferred, approach flows from the money-demand work of Cagan (1956), Bailey (1956), Friedman (1971), and Auernheimer (1974). Given the monopoly supply of money, Cagan demonstrated that inflation tax is maximized when the actual inflation rate is equal to the inverse of the inflation elasticity of the demand for money. This result is derived using a simple exponential money demand function of the form $m = ce^{-a\pi}$, where real income is constant, c. Inflation tax is given as $I = \pi m = \pi ce^{-a\pi}$, and thus $\delta I/\delta\pi = ce^{-a\pi}(1-a\pi) = 0$, which implies a revenue maximizing value of inflation of $\pi^* = 1/a$.

Friedman (1971) and Auernheimer (1974) generalise the Cagan result by allowing money demand to grow in real income, such that $m = c(y)e^{-a\pi}$. Here we extend the simple Friedman seigniorage model slightly by allowing for the demand for money to be a function of both currency substitution effects and income in the long run. For simplicity we start by expressing the demand for money as

$$(3.11) \quad M^d/P = f(y,g_p,e)$$

where $g_p = \pi$ is the rate of inflation, and e the exchange rate with respect to the parallel foreign exchange market. Assuming first degree homogeneity in prices, this can be re-written as

$$(3.12) \quad M^d = Pf(y, g_p, e).$$

Letting g_i be the time derivative of i, and assuming that in the long run the acceleration in prices is zero (ie $dg_p/dt = 0$), we can rewrite (3.12) in terms of its growth rates as

$$(3.13) \quad g_M = g_p + \eta_{my}g_y + \eta_{me}g_e$$

where η_{my} is the income elasticity of the demand for money and η_{me} the elasticity of demand with respect to currency substitution. Seigniorage revenue in the steady state is then given as

(3.14) $R = m.g_M = M/P(g_p + \eta_{my}g_y + \eta_{me}g_e)$

$= f(y,g_p,e)(g_p + \eta_{my}g_y + \eta_{me}g_e).$

Solving for the value of g_p which maximizes R we get (after some simplification)[61]

(3.15) $M/P[1 + g_y(\delta\eta_{my}/\delta g_p) + g_e(\delta\eta_{me}/\delta g_p) + (g_p + \eta_{my}g_y + \eta_{me}g_e)(\delta m^d/\delta g_p)]$
$= 0$

If we assume that the derivatives of the elasticity of the demand for money with respect to income and currency substitution are zero with respect to inflation (ie $\delta\eta_{my}/\delta g_p = \delta\eta_{me}/\delta g_p = 0$), then this simplifies to

(3.16) $1 + (g_p + \eta_{my}g_y + \eta_{me}g_e)(\delta m^d/\delta g_p) = 0$

This solves for an expression for g^*_p, the revenue maximizing rate of inflation of the form

(3.17) $g^*_p = -1/(\delta m^d/\delta g_p) - (\eta_{my}g_y + \eta_{me}g_e)$

Using our exponential demand for money functional form $m = ky^\alpha g_p{}^\beta e^\epsilon$ where $\beta < 0$ this solution simplifies further to

(3.18) $g^*_p = 1/\beta - (\alpha g_y + \epsilon g_e)$

which states that the optimal rate of inflation is equal to the inverse of the inflation elasticity of the demand for money *less* the sum of the growth rate of income times the income elasticity of the demand for money and the rate of

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[61] $\delta R/\delta g_p = f(.)[1 + gy(\delta\eta_{my}/\delta g_p) + g_e(\delta\eta_{me}/\delta g_p] + (g_p + \eta_{my}g_y + \eta_{me}g_e)\ \delta f(.)/\delta g_p = 0.$ This simplifies to

$M/P\ [.] + M/P\ 1/f(.)(g_p + \eta_{my}g_y + \eta_{me}g_e)\ \delta f(.)/\delta g_p = 0.$

depreciation time the elasticity of currency substitution. Thus for a positive income elasticity of demand for money, the revenue maximizing rate of inflation lies below (above) the value in the case where income is constant by the extent of rate of growth (decline) in real income. Similarly the greater the elasticity of currency substitution, the lower the sustainable, revenue maximizing, level of inflation (for a given rate of depreciation in the currency).

As a caveat to this result, Brock (1989) notes that in a competitive economy where the government also extracts revenue through the maintenance of non-interest bearing reserve requirements, the Friedman-style calculation of the revenue maximizing rate of inflation will deviate from the true revenue maximizing value if government is constrained in its use of the reserve ratio. If a revenue-maximizing government is constrained in this way it will tax currency at a rate higher than that determined by the Friedman rule if the revenue loss from doing so is less than the revenue gain from the inflation tax on required reserves held by the banking sector. If on the other hand the government has control over both instruments (inflation and reserve ratio) then it will tax currency in terms of the Friedman rule and simultaneously set the reserve ratio at the rate which will maximize the total money base, given the inflation rate.

In Kenya, reserve requirements (defined here as non-interest bearing deposits) have only rarely been actively used as instruments of monetary policy, and when they have, it has been in the context of prudential regulation rather than as revenue raising instruments. As noted in Chapter 1, although the banking-sector holds till cash and balances with the central bank, strictly defined cash limits have only be operable occasionally during the period, and at no point were they binding. Cash balances held by the banking system averaged 8.6 per cent of total deposits: the cash limit was set at 4 per cent in the mid-1970s, and at 6 per cent since 1986. During this latter period cash balances averaged 10 per cent.

In the first part of this section we therefore concentrate on the revenue-maximizing taxation of base money in the hands of the non-bank private sector only. We do so by examining the notional steady-state, revenue maximizing, inflation tax inflation rate, and also examine in detail the short-run implications for the inflation tax of the demand for monetary base. We do so by drawing on the results from our empirical investigation of the demand for money in Chapter 2, to estimate the steady-state or long-run cointegrating relationship equivalent to (3.11) from which we may calculate the revenue maximizing rate of inflation. Although our exposition is based on a logarithmic demand for money function of the form

$$(3.19) \quad (m0\text{-}p) = \alpha_0 + \alpha_1(y\text{-}p) + \alpha_2(1+\pi) + \alpha_3(1+exb),$$

we noted in Chapter 2 that the long-run demand for M0 was best characterised where the restriction that $\alpha_3 = 0$ is imposed in the long run solution. Our analysis in this section proceeds under the imposition of this restriction.

Before we report the results for equation (3.19) we first address an argument advanced by *inter alia* Easterly and Schmidt-Hebbel (1991) that traditional derivations of the revenue maximizing rate of inflation are biased as the result of a specification error, deriving from the fact that the inflation elasticity is a non-linear function of the actual historical rate of inflation. In other words, if the actual rate of inflation is high then the apparent inflation elasticity of the demand for money will be equally high, and *vice versa*.[62] This hysteresis-style argument is used to explain the enormous deviations between revenue maximizing inflation rates calculated for Latin American economies and those for South East Asian ones.[63] The implication of this is that in countries where the inflation is high the optimal rate will be overstated by a standard Cagan model, and the estimated revenue maximizing inflation rate will be lower that its true value in countries where actual inflation is below its optimal level. To see this, consider the case where the true demand for money is of the form (excluding income, interest rate and other effects)

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[62] Intuitively beyond some level of inflation, but while the economy is a cash-economy and money remains the medium of exchange, the elasticity of substitution between money and other assets becomes virtually zero as all substitution opportunities for economizing on money balances have been exhausted. Consequently the apparent inflation elasticity of the demand for money tends to zero and the revenue maximizing rate of inflation.

[63] Revenue Maximizing rates are typically found to average up to 100% per annum for the former group, but less that 10% per annum in the latter group.

$$(3.20) \qquad \ln m = g(\pi)$$

but where $g(\pi)$ is non-linear. (3.20) can also be expressed in terms of a first-order Taylor expansion around π^*, the historical trend value of inflation

$$(3.21) \qquad \ln m = g(\pi^*) + g'(\pi-\pi^*).$$

where g' is the first derivative of g. This specification indicates the hysteresis effect and, since $g'(.) > 0$, indicates the extent to which the basic Cagan estimate over (under) estimates the true value of the coefficient g, which may be gauged by the size of g' and extent to which π is greater (less) than its mean value. In the case of a near hyper-inflation economy (such as those of Latin America in the 1980s) the deviation will be significant, principally since $\pi-\pi^*$ will be significant. In the case of low-inflation economies $\pi-\pi^*$ will be small and $g(\pi^*)$ will accurately reflect the true elasticity.

The problem identified here can also be couched in terms of the time-series characteristics of the inflation series. If the economy is in or near a hyper-inflation state, the second term in (3.21) will be large and generally non-stationary. In a more stable economy the term will be stationary and the extent of the bias is therefore likely to be quite small. Thus the problem can be reduced to a general econometric one of parameter non-constancy arising from non-stationarity. The foregoing argument by Easterly and Schmidt-Hebbel assumes also that the results had been derived from a simple Cagan money demand function which was developed specifically for the hyper-inflation case where it could be assumed that money holdings were a function only of inflation. However under different inflation regimes, prices are of different orders of integration. If the demand model is conditioned on inflation, which is in fact non-stationary, then the model will indeed be inconsistent and will exhibit non-constancy of the parameters, which, over the samples typically reported, would be consistent with the Easterly and Schmidt-Hebbel observation. In terms of the exposition above, non-stationarity in the inflation rate means, by definition, the persistent deviation of the actual value from its mean. If for example prices are I(2), in other words the *growth rate*, but not the *level* of inflation is stationary, estimating a Cagan-style regression model may be inconsistent, and thus OLS estimates will be biased, unless a cointegrating relationship can be identified between money and inflation, in which case the estimates of the inflation elasticity will be super-consistent (see Chapter 2). In a hyper-inflation environment, however, it may even be the case that prices are I(3) indicating that it is in fact only the *acceleration* in inflation which is stationary. In this case the levels equation would also be inconsistent. Models of money-demand, from which Cagan-style estimates of the revenue maximizing inflation rate derive, need therefore, to be appropriately specified in terms of the structure of the data series, particularly prices.[64]

In the case of the Kenyan money demand models estimated in Chapter 2, there is no evidence of a hysteresis effect of this kind. Although there is evidence of prices being I(2), in other words inflation is strictly non-stationary, a cointegrating relationship can be identified so that a stationary levels equation between real money, income and inflation is efficiently and consistently estimated. In addition, the stability of the coefficients was examined using a RLS estimator, and we are thus able to accept the estimated semi-elasticity as an unbiased estimate of the true relationship, for the period under investigation. We can therefore use the results from Chapter 2 to derive a consistent estimate of the revenue maximizing inflation rate. Clearly, however, in the light of the foregoing discussion, if Kenya were to enter a hyper-inflation such that the order of integration changed dramatically our existing model would be non-constant and inferences drawn from it on the inflation elasticity of the demand for money would be biased and invalid.

To recap on the results of Chapter 2, we report the significant cointegrating vector from the β' vector derived from the Π coefficients in the vector autoregression model for base money in circulation (m0-p) as calculated under the Johansen procedure. In that chapter we found a single significant cointegrating relationship for narrow money demand presented below:

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[64] It is possible that this fact alone explains, econometrically at least, the persistent failure to successfully model money demand and inflation in Latin American economies.

Standardized β' Eigenvector			
Variable	(m0-p)	(gny-p)	π
	1.000	-1.005	6.148

Standardized α Coefficients		
Variable	(m0-p)	-.1918
	(gny-p)	-.0708
	π	-.0302

Given an average real growth rate for gross national income of approximately 3 per cent per annum this yields a steady-state revenue maximizing rate of inflation rate of approximately 13.5 per cent per annum ($1/\alpha_2$ = 16.3 % - 3%). This rate is significantly lower than that inferred from the earlier Laffer curve analysis, and is perhaps lower than would commonly be thought. The long-run solution from which this result was derived was estimated using the Johansen (1988) procedure, principally because of concerns about biases in the use of the Engle-Granger procedure for identifying cointegrating relationships. However because the β' vector is not uniquely identified (see Chapter 2), it is not possible to construct an easily interpretable confidence limit for the value of the coefficients of the relationship. It is therefore useful to compare the result derived from the Johansen procedure with the long-run solution from an over parameterized dynamic model of the same form (Banerjee *et al.* (1992)). Doing so we derive a long-run solution of which implies the long-run inflation elasticity of inflation elasticity of 5.450, which suggests a slightly higher optimal rate of inflation, but also a higher income elasticity of 1.25. On the basis of the same average income growth rate of 3% this suggest a marginally higher revenue maximizing rate of inflation of 14.6% per annum.

These values represent the average revenue maximizing rate of inflation over the period as a whole. We can also look at the values for individual sub-periods. We assume that the inflation and income elasticities of demand for money are constant across the sub-periods (which is valid given our conclusions from Chapter 2). The results are presented in Table 3.9

Table 3.9
Revenue Maximizing Inflation Rates (RMIT)

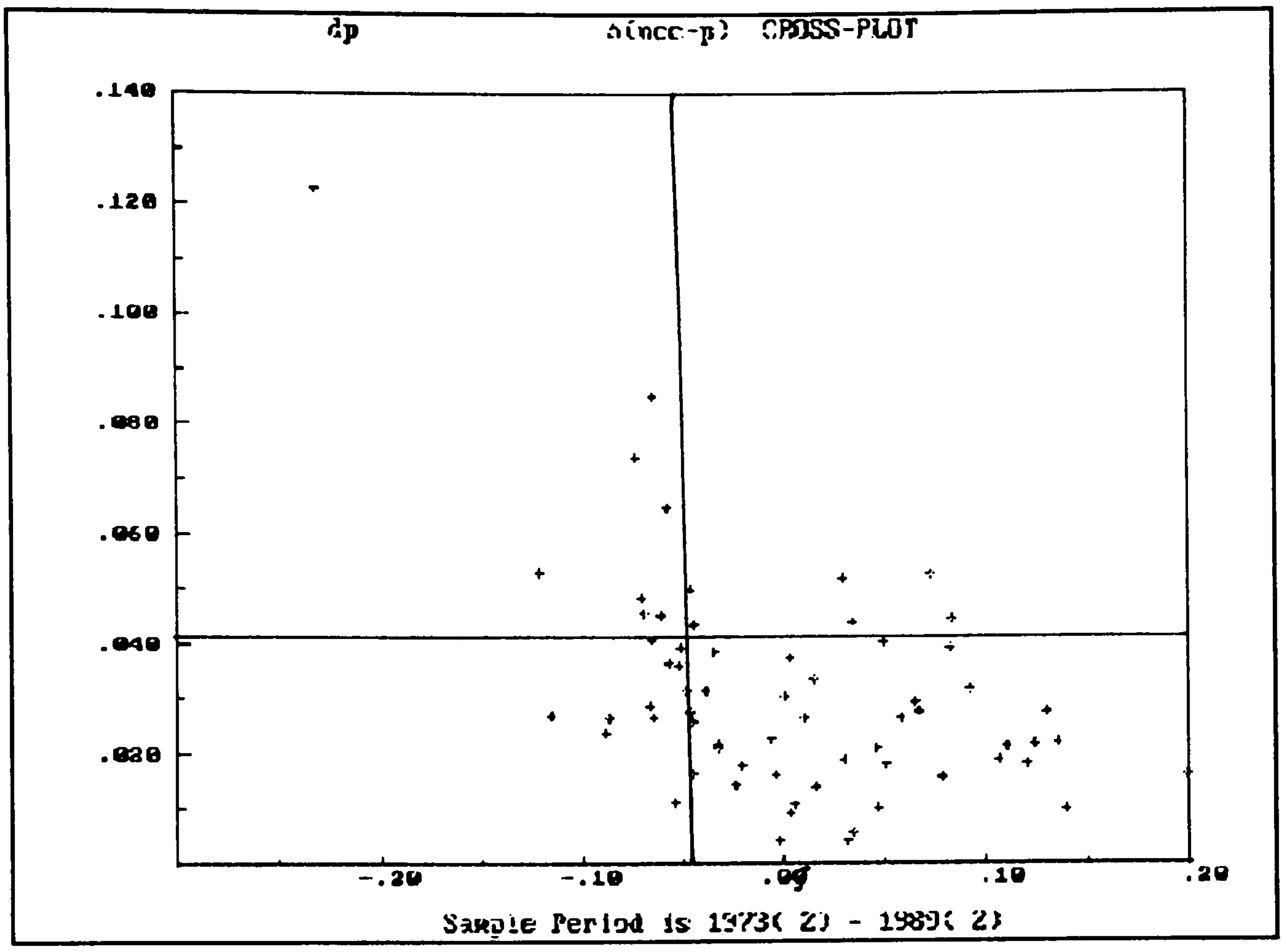
Period	Income Growth	RMIT	Actual
1974-79	2.5%	13.8%	14.1%
1980-83	-1.8%	18.1%	14.4%
1984-89	4.9%	11.4%	8.4%

It is noticeable that throughout the period of the estimated equation (1973 to 1989), actual inflation has move pro-cyclically with the long-run revenue maximizing value, but has only exceeded it twice, one during the coffee boom of 1977, and once in 1982 following the attempted *coup d'etat* against President Moi when annual inflation briefly touched 24 per cent. Throughout the recent period when a degree of stabilization was achieved (from 1983 onwards) actual inflation has remained below its revenue maximizing level.

This relationship is demonstrated clearly in Figure 3.4 which plots the change in the real money base against the rate of inflation. The economy has consistently operated at below the revenue maximizing level (ie most observations are in the south-east quadrant, although the effect of higher rates of inflation on the change in the money base are clearly visible.

Having established the steady-sate revenue maximizing rate of inflation it is instructive to examine disequilibrium behaviour. This has important implications

Figure 3.4
Cross-Plot of Change in Real Money Base and Quarterly Inflation



for the government's use of the inflation tax to meet short-run financing needs. As with the steady-state rate of inflation, the magnitude of the short-run revenue gains to inflation is primarily a function of the capacity of the private sector to substitute away from money balances. This is reflected explicitly in the size of the error correction feedback term in the dynamic demand for money function.

The dynamic demand for money around the estimated steady-state relationship was reported in detail in Appendix II (c), and can be summarised (excluding seasonal dummies) as

(3.22) $\Delta(m0\text{-}p)_t = 0.08 - 3.01\ \Delta^2 rtb_t + 0.54\ \Sigma 03\Delta(m0\text{-}p)_{t-1} - 1.20\ \Delta\pi_t$
$+ 0.18\ \Delta exb_{t-2} - 0.19\ ECM_{t-1}$

where ECM is the error correction term defined above.[65] We have discussed the economic interpretation of this model in Chapter 2 in some detail, including the analysis of the acceleration of prices as a possible indicator of uncertainty. Here we shall only focus on the issue of dynamic adjustment to the long run equilibrium. Auernheimer's (1974) analysis of dynamic adjustment and the inflation tax, considers the implications of relaxing assumptions about the instantaneous price-adjustment between long-run steady states upon the announcement of a new equilibrium inflation rate. Auernheimer devotes attention to a special case where government accrues or loses seigniorage revenue on the "sale" or "purchase" of real money balances to the private sector in order to ensure that the new equilibrium is reached through an instantaneous real stock-adjustment. The present value of revenue accruing to the government following the announcement of a new inflation level at time t=0 in this case is then given by

$$(3.23)\quad V_{t=0} = \int_{t=0}^{\infty} (\pi m)e^{-rt}\,dt + (m_{t=0+} - m_{t=0-})$$

where m is defined as equivalent to (m0-p) above and r is the rate of discount. The first term in (3.23) is the present value of discounted future real inflation tax revenue at the inflation rate announced at time t=0, and the second term is the real seigniorage gain (loss) to government on its sale (purchase) of real balances to the private sector to allow the latter to adjust instantaneously to the new equilibrium money demand. For example, if a government were to engineer a fall in the steady-state rate of inflation (assuming that $\delta m/\delta\pi < 0$) then private sector agents would demand more real balances and the government would earn revenue from the sale of these real resources at time t=0. The new value of real balances constitutes the tax base for the levy of inflation tax (the aggregate value of which may be higher of lower than before depending on the level of inflation relative to the optimal), but there is also a seigniorage gain from the initial sale of the real

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[65] Note that estimating this model within a dynamic FIML model reduces the coefficient on the current period inflation effect, and marginally lowers the coefficient on the error correction term from 0.19 to 0.14,

balances. Conversely, Auernheimer argues that in the case of instantaneous adjustment to a higher inflation rate, an "honest" government will offset the (possibly) higher inflation tax revenue by the cost of re-purchasing real balances from the private sector.

A more relevant case occurs when there is less than instantaneous adjustment (not analyzed by Auernheimer) where the government is not "honest" so that the private sector holds more, or less, real money balances than desired during the adjustment period. In this case the revenue earned by government consists, as before, of the tax accruing from the new steady-state level of real balances, but in addition there is the flow of revenue accruing throughout the period during which the private sector is in disequilibrium, which has as its direct analogue the error correction term. Thus in response to an increase in the rate of inflation at time $t=0$ from a rate π to π', the tax revenue to government can be expressed as

$$\int_{t=0}^{\infty} \pi' m' e^{-rt}\, dt + \quad (1-\alpha) \int_{t=0}^{\infty} \pi'(m_t - m') e^{-rt}\, dt \tag{3.24}$$

where α is the feedback coefficient on the error correction term. This measure nests the pre-Auernheimer literature when it is assumed that $\alpha=1$ so that there is an instantaneous adjustment of real money holdings conditional on the new rate of inflation. Clearly, however, the lower the feedback effect (ie the slower the speed of adjustment) the higher the revenue accrual to government. Stated in an alternative way, the lower the feedback effect the greater the potential for the government to raise inflation tax revenue by forcing the private sector off its desired money stock.

We can evaluate (3.24) using average figures for Kenya. Let real money balances equal Ksh 5bn (equivalent to the actual value in December 1985), assume the long run demand for money function defined above, and consider a 100 per cent increase in the inflation rate (ie from 5 per cent to 10 per cent). The result of this evaluation is shown in Table 3.10, for different values of α, where the rate of discount is 5 per cent per annum and the integral is evaluated over 25 quarters.

Table 3.10
Additional Revenue from Adjustment to New Equilibrium

Feedback per quarter α	% of Instantaneous Adjustment
5%	26%
10%	16%
15%	11%
20%	8%
25%	6%

Source: own calculations.

The actual estimate for the Kenyan economy lies between the 15 per cent and 20 per cent feedback values, which indicates additional present value real revenue of approximately 10 per cent will accrue to government over amount from the move to a new inflation level. More generally, the lower the feedback effect, the greater the short-run revenue gains to government can be significant. The implication of this model for inflation-tax policy of government are twofold. First when real money balances adjust slowly to their new equilibrium, one-off money supply shocks which force individuals to hold excess cash for some time (as was the case in 1977), can yield very sizeable inflation tax revenue to government. This produces potentially large incentive compatibility problems in the conduct of monetary policy, as discussed by Calvo (1978). This is particularly relevant in shock-prone economies such as those of Africa where the long-run optimal policy of sterilizing the monetary implications of temporary trade shocks is compromised by the incentives to earn short-run inflation tax. The second implication is that policies of financial liberalization which lead to greater substitution opportunities out of money will not only reduce the long-run sustainable rate of inflation, but, to the extent that they will tend to increase the error-correcting speed of adjustment agents will be more able to reduce excess money balances in the short-run, and thereby limit the capacity to expand the monetary base in the short-run.

3.3.2. Financial Liberalization and the Supply of Government Securities

In principal the same form of analysis can be employed to answer the question: what is the revenue maximizing implicit rate of taxation on government loan stock? The only substantive difference is that the only rate of return which is observed (and thus upon which the demand function is conditioned) is the tax-inclusive rate of return. However since the counterfactual rate of return (ie the domestic value of the SDR deposit rate) is pre-determined, then the estimation of the elasticity of demand with respect to the observed rate of return will determine the implicit (*ex post*) revenue-maximizing tax rate. Thus given $\max\{r_d, r_k\}$, estimating r_f will then determine the optimal rate of financial repression t_f. To maintain the similarity with the analysis of the demand for money we can define the demand for government stock as

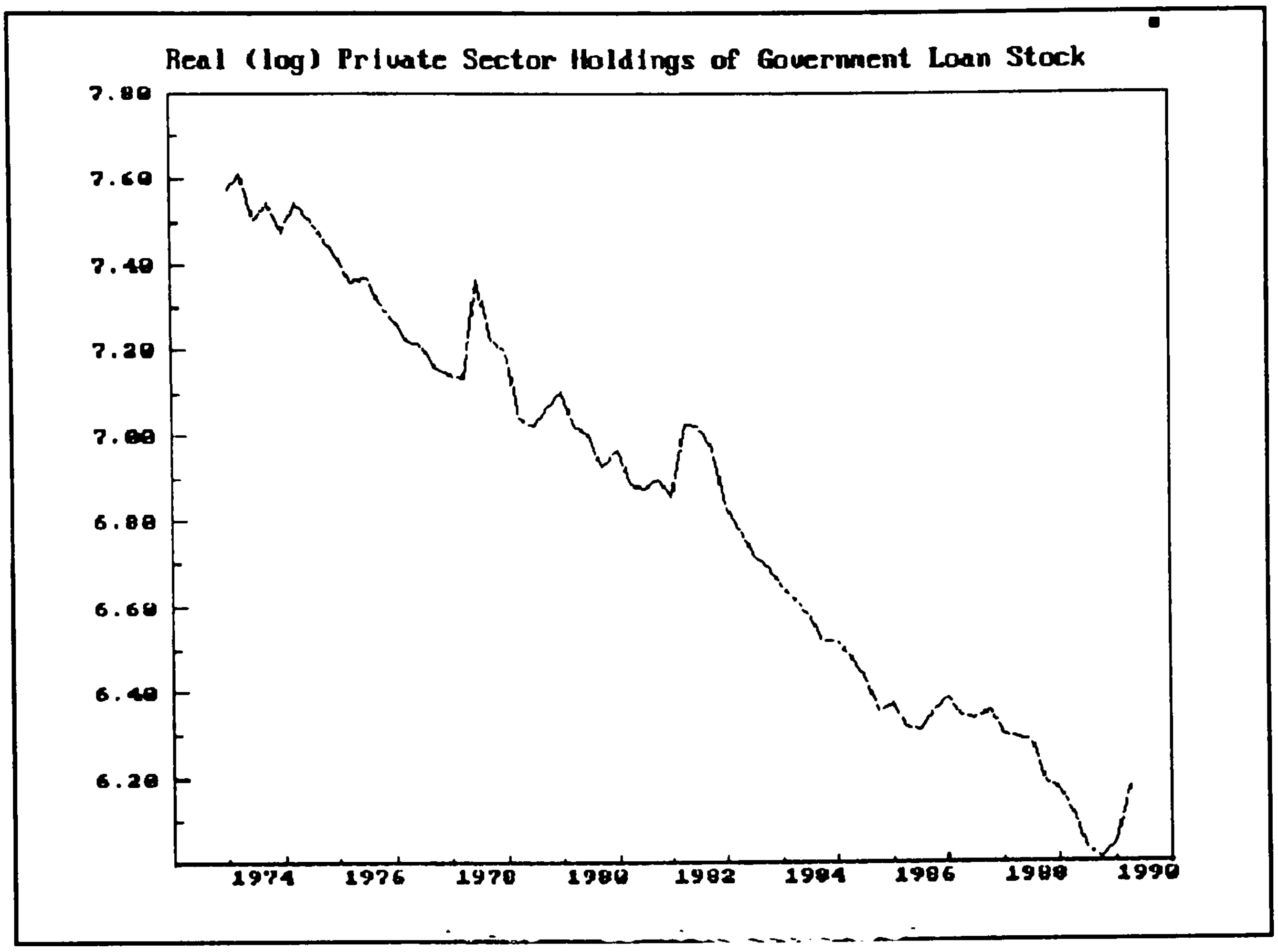
$$(3.25) \quad g^d = h(y, \pi, r_g, cg)$$

where y is real income, π domestic inflation, r_g the rate of return on government debt, and cg the expected one-period capital gain.[66] The interpretation here is directly analogous to the demand for money: the more inelastic the demand for government stock is with respect to its own price, the less the private sector will reduce their holdings in response to a decrease in the rate of return on debt, *ceteris paribus*. The main problem we face in trying to determine this elasticity is empirical, because it has proven difficult to specify a robust non-bank private sector demand function for government debt. As Figure 3.5 indicates, the real value of private sector government debt holdings have fallen precipitously since

[66] The detailed discussion of the specification of the capital gain term is deferred to Chapter 4.

the mid-1970s, both in absolute terms, and as a share to total private sector wealth.

Figure 3.5
Non-Bank Private Sector Real Holdings of Government Stock (log)



The magnitude of these changes cannot be adequately analyzed in terms of movements in the vector of explanatory variables. For the sake of completeness however we present the results from the estimation of the model since they indicate possible explanations for the empirical weakness.

Empirical Estimate of the Demand for Government Stock

The methodological approach adopted in Chapter 2 to estimate the demand for money is also employed here. As a result we shall only report the principal features of the estimation process. The model to be estimated is of the general form

(3.26) $(gs\text{-}p) = g((y\text{-}p), (w\text{-}p), rgs, cg, \pi)$

where (gs-p) is the real value of private sector holdings of government stock, (y-p) is real income, (w-p) total wealth of the private sector,[67] π domestic inflation, rgs the interest rate of return on government stock, and cg the *ex post* capital gain, proxied by the change in the real value of the Nairobi Stock Exchange index. All the variables are non-stationary in their (log) levels (Table 3.11), and we therefore test for the existence of a cointegrating relationship between them.

Table 3.11
Orders of Integration

Variable	SBDW	ADF (6)
L(gs-p)	0.027	-0.72
L(y-p)	0.364	-1.95
L(w-p)	0.293	-1.98
Lcg	0.119	-1.81
Lrgs	0.276	-0.74
Lπ	0.055	-1.85

The Johansen technique does not identify any significant multivariate cointegrating vectors across these variables over the sample period, while pair-wise analyses of cointegration were also not evident.[68] It is therefore not possible to define a long-run levels equation as we did with the demand for money. However we can estimate a general (stationary) logarithmic specification in the growth rates of the variables which still allows us to examine the relative price elasticity of the demand for government debt. The over-parameterized equation allows for 5 lags

[67] The definition of this term will be discussed in detail in Chapter 4.

[68] The only (nearly) significant relationship was the interest rate and inflation cointegration which was strongly identified in the demand for money relationships.

on all six variables, and is estimated over the period 1974 (1) to 1989 (2) by OLS. The derived long-run growth rate solution is reported in Equation (3.27).[69]

Equation (3.27)
Modelling Lgs: Long Run Solution

Variable	Coefficient	S.E	t-ratio
Δ4L(y-p)	0.097	0.752	0.129
Δ4L(w-p)	1.087	0.468	2.322
$\Delta\pi$	2.637	1.497	1.762
Δ4Lrgs	0.717	1.900	0.377
Δ4Lcg	-0.138	0.178	0.775
Constant	-0.112	0.031	3.163
Q1	0.005	0.030	0.166
Q2	0.016	0.030	0.533
Q3	-0.003	0.031	0.097

$R^2 = 0.784$ D.W. = 1.85 WALD Test $\chi^2(9) = 90.790$

The individual coefficients of the long-run solution, especially on the rate of return, are quite poorly specified. However the Wald test for the significance of the relationship as a whole is significant against a critical value of 21.67 for the χ^2 with 9 degrees of freedom.

The derived long run solution indicates that the demand for government security is increasing in real wealth and income but is subject to a strong, downward drift in real holdings as proxied by the constant. In terms of the price effects on the model the growth rate equation indicates that the demand for government debt is relatively inelastic with respect to its own rate of return. However the coefficient is quite poorly specified, and the capital gain effect is

[69] The long-run solution in the growth rates is derived as follows. If $A(L)y_t = B(L)X_t + \epsilon_t$ is the dynamic model, the static or long-run solution derived from setting all L = 1, is given by $y = [B(1)/A(1)]\,X = KX$. Derived standard errors and t ratios are calculated for the derived coefficients in K. The Wald test is a F equivalent test against the null that all the derived coefficients are zero.

incorrectly signed (although it is also not significant). The domestic rate of inflation, on the other hand, is relatively well specified and has a positive coefficient. This seems to indicate that government stocks are seen as a hedge against inflation, and, to the extent that the rate of inflation may serve as a proxy for the rate of return on real assets, a complement to real capital accumulation.

The model from which the long-run (growth rate) solution is derived is, however, highly over-parameterized. We therefore seek a more parsimonious and interpretable specification of (3.27). This is reported as (3.28). Although this model provides a reasonable fit of the data, and, indeed exhibits an acceptable level of forecast stability (Figure 3.6), it is still somewhat unsatisfactory. Though strictly stationary, the predominant explanatory power is derived from the autoregressive and drift components of the model, which account for approximately 65 per cent of the explanatory power of the model, rather than through any well-defined own price effect.[70] Not only was the capital gain component found to be insignificant and was therefore excluded, but it is only the *acceleration* in the own real rate of interest which is seen to be significant. Even so, it has a high heteroscedastic bias: if the coefficient on the own rate of return were evaluated at its heteroscedastic-consistent standard error, it would be strongly insignificant.

One explanation for the insignificance of the capital gain term is that though there is a market for government debt on the NSE, in reality it is rarely traded, either by the public sector institutions or by the private sector holders. Movements in the NSE index may not therefore be expected to adequately reflect the expected capital gains to holding government debt. On the contrary, the movement in the NSE index may in fact serve as a proxy of expected capital *loss* to holding government relative to equities induced by the low level of liquidity in the government debt market. The high significance of the negative constant term in the growth-rate model also serves to support the possibility of an omitted secular downward trend in the level of real government stock holdings.

[70] A similar problem is encountered in the models estimated in Chapter 4.

EQ(3. 28) Modelling $\Delta 4Lgs$ by OLS : 1975(3) to 1989(2)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
Δ4Lgs 1	.5043046	.09415	.10713	5.35637	.3693
Δ4Lgs 4	-.2678598	.09715	.12208	-2.75705	.1343
$\Sigma\Delta$4ly-p03	.1817543	.08217	.09396	2.21194	.0908
$\Delta\Delta$4Lw-p 1	1.0108835	.28395	.34008	3.56002	.2055
$\Delta\pi$ 1	1.2631906	.49999	.76758	2.52645	.1153
CONSTANT	-.0765947	.01756	.02070	-4.36249	.2797
$\Delta\Delta$4rgs	1.2640692	.93840	1.25433	1.34704	.0357

R^2 = .6466793 σ = .0676911 F(6, 49) = 14.95 [.0000] DW = 1.433

LM Autocorrelation — LM Autoregressive Conditional Heteroscedasticity
F(1, 48) = 6.24 [.0160]
F(4, 45) = 2.35 [.0686] — F(4, 41) = .28 [.8898]

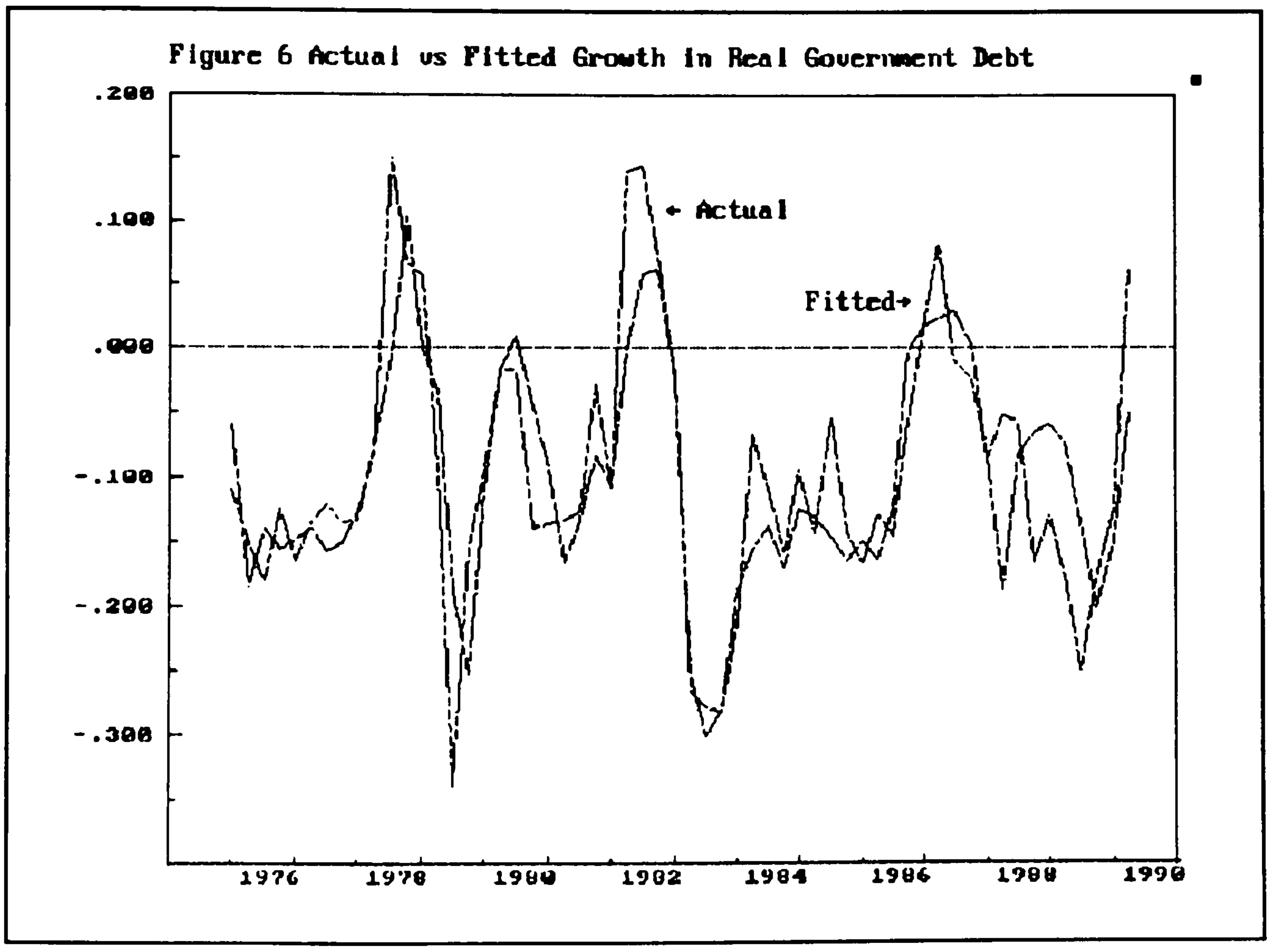
Jarque - Bera Test for Error Normality χ^2 (2) = 2.509

White Heteroscedastic Error Test F(12, 36) = .5496 [.8667]

Tests of Forecast Stability: 1985(3) to 1989(2)
Forecast χ^2 = 1.10
Chow Test F(16, 35) = 1.02

A more plausible explanation for the failure to identify significant own-price effects in this data is that the data do not identify a demand function, but are rather picking-up movements in the supply of debt, private sector access to which has been rationed. At an aggregate level this does not seem plausible since total domestic debt issued as proportion of GDP has doubled since 1971, from 12 per cent to 24 per cent. Most of this growth has come through the growth of the Treasury Bill market, but nonetheless government stock averaged approximately 11 per cent of GDP over the period. However if we examine the decomposition of total holdings of debt we note that the stock of debt is predominantly held by large public sector institutions, such as the National Social Security Fund. These institutions are legally required to hold a certain proportion of their assets in the form of long-term government debt (in the case of the NSSF the ratio is 70 per cent). The liabilities of these institutions have been growing more rapidly over the period than the growth of total income (reflecting the growth in public sector employment) which has therefore increased their demand for long-term debt. The dominance of these institutions in the bond market (as a result of their legislative requirements and their size) suggest that the non-bank private sector demand for gilts may have been progressively crowded out, with the roll-over of maturing debt stock being allocated primarily to the public-sector institutions. As a consequence there is excess demand for government debt, and observed holdings of debt identify the supply rather than the demand function of the model.

Figure 3.6
Actual vs Fitted Growth in Private Sector Stock of Real Government Debt



Conclusions

It has not been possible to establish a satisfactory demand function for the level of private sector debt holdings in which there is a well defined own-price elasticity of demand for government debt. As a consequence, although there is evidence that there are possibly quite powerful price effects in operation, concerns over the identification of the demand function means that it is difficult to evaluate with any confidence the elasticity of demand for this asset in respect of its own rate of return. As shall be noted, these concerns also plague the demand share model presented in the next chapter.

3.4 The Fiscal Implications of Alternative Monetary Regimes

We conclude this chapter by examining the extent of the counterfactual period-by-period revenue gains or losses of alternative monetary and financial policy stances. It is important to note that in doing so we abstract from the issue of whether, in fact, the monetary authorities do seek to use monetary instruments in pursuit of such fiscal objectives, although in Appendix 3(A) we present a weak test proposed by Mankiw (1987) of the hypothesis that the monetary authorities pursue an "optimal" inflation tax strategy.

We start by considering three alternative inflation-tax scenarios. The first is a situation where the domestic costs of inflation are perceived to be high, and the monetary authorities seek to maintain domestic price stability (regardless of fiscal policy considerations): this is effectively the case presented in section 3.2. Second we consider the case in which the domestic costs of inflation are perceived to be low and thus monetary policy is dominated by the maximization of inflation tax revenue. Consequently actual inflation would equal the rate determined by the inflation elasticity of the demand for base money as derived from the demand for money function, as adjusted for the real growth of the economy in accordance with Section 3.3.

A final alternative compares the actual outcome against a rate of inflation which stabilizes the exchange rate. In other words we consider a position where domestic inflation is set equal to the SDR-weighted world inflation rate. This scenario provides an indication of the implications for inflation revenue which would have accrued to the government had it joined a monetary union - in this case where the anchor currency is the SDR.[71]

In the absence of any reliable measure of the "optimal" level of financial repression taxation we restrict our examination of the impact of financial liberalization to the case in which the government fully liberalizes the capital account and that the demand for bonds is sufficient at that rate to ensure that the government is a price-taker at the world-equivalent interest rate.

Before we consider these alternative cases in detail it is important to enter some caveats so as to clarify what these measures represent. First, these measures cannot be taken as full scenarios or dynamic counterfactuals over the period, since they do not incorporate any information about the links between inflation, the structure of government revenue and expenditure and economic growth or the external account. Second, the scenarios do not capture possible feedback effects from actual inflation to government policy decisions. Thus the results presented below seek primarily to provide a simple *ex post* measure of the relative importance, *ceteris paribus*, of the contribution of inflation tax revenue. Finally, there is the issue of the effect of inflation on the budget deficit. While it is generally possible to assume that the primary government deficit is inflation neutral, it is less valid in the case of public debt service when domestic interest rates on debt are market determined. We discuss this issue below in the context of the budget implications of financial liberalization, but for the present we simply assume (as was broadly the case for most of the period) that nominal interest rates are not market-determined, so that debt service is counterfactually invariant to inflation.

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[71] It is important to note that this scenario concerns the revenue from inflation tax only and not from seigniorage itself. Under a monetary union, the issue of domestic currency generally assumes 100% backing by the anchor currency.

Results

Tables 12 to 14 calibrate the *ex post* gains or losses to the alternative inflationary trajectories. The original results presented above clearly represent the fiscal costs of obtaining domestic price stability, which, as we noted would have involved a reduction in inflation tax equivalent to approximately 0.8 per cent of GDP or almost 4 per cent of total revenue.

On the other hand, had the authorities decided to simply maximize the total revenue from the inflation tax the average rate of inflation would have risen from 12.2 per cent per annum over the period to the revenue maximizing average of 13.5 per cent. Real average revenue from the inflation tax would have increased by approximately Ksh 92 million per annum in 1985 prices, an increase of approximately 12 per cent over the actual value. This increase would represent an additional revenue enhancement of only 0.6 per cent of total revenue - less than 0.1 per cent of GDP, although this would have been somewhat greater in the latter part of the 1980s when inflation was significantly below the revenue maximizing rate. In other words, there would have been a very limited expenditure increase conditional on raising the inflation rate to the revenue-maximizing level.

Finally, if instead the objective was to not to eliminate domestic inflation entirely, but to maintain domestic prices at a level to ensure year-on-year relative price stability with the SDR during the period average inflation would have dropped by almost 50 per cent from 12.2 per cent per annum to 6.3 per cent. Average inflation tax revenue would have fallen by approximately 65 per cent from its actual level, and would on average have accounted for less than 0.5 per cent of GDP per annum, and only 2.13 per cent of total revenue. Public expenditure would therefore have had to be approximately 1.8 per cent per annum lower in order to maintain the level of deficit financing from non-inflation tax sources constant, although in 1978 and 1983 total revenue would have had to be 5 per cent higher maintain expenditure and/ or the budget deficit at the same level.

Table 12
Scenario I: Inflation Tax where Monetary Policy Stabilizes Domestic Prices

Year	Inf Tax per period	Real Inf Tax (85 Kshm)	Inf Tax as % Rev	Inf Tax as % GDP	Inf Tax as % Deficit
1972	83.47	489.90	3.33%	0.55%	11.33%
1973	41.36	210.72	1.49%	0.24%	7.06%
1974	203.92	896.01	4.79%	0.96%	28.48%
1975	274.05	1011.30	6.09%	1.15%	13.90%
1976	293.63	972.65	5.76%	1.01%	20.81%
1977	223.80	603.69	3.18%	0.60%	16.14%
1978	719.00	1712.87	7.16%	1.75%	48.58%
1979	420.38	925.04	3.56%	0.90%	24.45%
1980	318.56	609.72	2.53%	0.59%	13.00%
1981	635.28	1074.88	4.43%	1.02%	13.62%
1982	597.20	814.71	4.06%	0.85%	13.11%
1983	1328.30	1638.12	7.47%	1.73%	193.63%
1984	577.44	643.32	3.05%	0.65%	24.72%
1985	635.96	635.96	3.08%	0.63%	7.28%
1986	811.66	783.02	3.25%	0.69%	12.21%
1987	356.60	319.53	1.26%	0.27%	6.21%
1988	848.77	689.50	2.52%	0.57%	53.28%
1989	1235.66	914.28	3.20%	0.73%	14.58%
Average	533.61	830.29	3.90%	0.83%	29.02%
Max	1328.30	1712.87	7.47%	1.75%	193.63%
Min	41.36	210.72	1.26%	0.24%	6.21%
Std. Dev	351.75	374.19	1.71%	0.40%	41.90%

Table 13
Scenario II: Inflation Tax where Monetary Stabilizes Relative Prices

Year	Inf Tax per period	Real Inf Tax (85 Kshm)	Inf Tax as % Rev	Inf Tax as % GDP	Inf Tax as % Deficit
1972	84.85	212.34	3.39%	0.56%	11.51%
1973	63.37	147.13	2.28%	0.36%	10.81%
1974	104.33	215.74	2.45%	0.49%	14.57%
1975	211.20	388.73	4.69%	0.88%	10.71%
1976	190.08	321.67	3.73%	0.65%	13.47%
1977	172.00	271.16	2.44%	0.46%	12.40%
1978	231.61	342.92	2.31%	0.57%	15.65%
1979	205.87	281.98	1.74%	0.44%	11.98%
1980	312.22	382.43	2.48%	0.58%	12.74%
1981	501.71	556.53	3.50%	0.81%	10.75%
1982	474.38	492.71	3.23%	0.67%	10.41%
1983	375.95	374.75	2.11%	0.49%	54.80%
1984	228.15	217.64	1.21%	0.26%	9.77%
1985	267.30	267.30	1.30%	0.27%	3.06%
1986	-327.79	-323.05	-1.31%	-0.28%	-4.93%
1987	143.33	143.59	0.51%	0.11%	2.50%
1988	-180.12	-164.96	-0.54%	-0.12%	-11.31%
1989	1125.60	1022.44	2.91%	0.66%	13.28%
Average	232.45	286.17	2.13%	0.44%	11.23%
Max	1125.60	1022.44	4.69%	0.88%	54.80%
Min	-327.79	-323.05	-1.31%	-0.28%	-11.31%
Std. Dev	290.82	270.80	1.45%	0.29%	12.60%

Table 14
Scenario III: Inflation Tax where Monetary Policy set Inflation at RMIT

Year	Inf Tax per period	Real Inf Tax (85 Kshm)	Inf Tax as % Rev	Inf Tax as % GDP	Inf Tax as % Deficit
1972	157.86	867.05	6.30%	1.05%	21.42%
1973	172.93	833.15	6.23%	0.98%	29.51%
1974	187.68	793.17	4.40%	0.88%	26.21%
1975	240.73	892.45	5.35%	1.01%	12.21%
1976	215.56	700.99	4.23%	0.74%	15.28%
1977	274.84	784.00	3.90%	0.74%	19.82%
1978	441.48	1104.69	4.40%	1.08%	29.83%
1979	444.81	976.35	3.76%	0.95%	25.88%
1980	539.71	1039.16	4.28%	1.00%	22.02%
1981	594.23	1003.63	4.15%	0.96%	12.74%
1982	637.14	943.94	4.33%	0.91%	13.99%
1983	774.03	1005.94	4.35%	1.01%	112.83%
1984	761.21	867.78	4.03%	0.85%	32.59%
1985	832.42	832.42	4.04%	0.83%	9.53%
1986	996.02	873.70	3.99%	0.85%	14.98%
1987	1365.05	1050.36	4.84%	1.05%	23.78%
1988	1550.77	1046.73	4.61%	1.04%	97.35%
1989	1678.77	993.97	4.34%	0.99%	19.80%
Average	659.18	922.75	4.53%	0.94%	29.99%
Max	1678.77	1104.69	6.30%	1.08%	112.83%
Min	157.86	700.99	3.76%	0.74%	9.53%
Std. Dev	461.99	108.27	0.71%	0.10%	27.44%

The fiscal costs and benefits from alternative monetary policy regimes seem to be quite limited. On average the gains to pursuing a policy of maximizing the revenue from the inflation tax are relatively low, and it may be reasonable to expect that the effects of such fiscal gains may be virtually negligible or even negative if we were to relax the assumptions concerning the fiscal costs of inflation noted above. On the other hand, the inflation tax revenue foregone by a moderate inflation Sub Saharan African economy such as Kenya as a result of participation in an SDR-anchored monetary union would have been more substantial, although still lower than is often expected. On average, an additional Ksh 540 million of real revenue per annum (in 1985 prices), equivalent to 0.4 per cent of GDP would have had to be found from other sources to maintain expenditure at a constant level, and it may be reasonable to assume that this revenue loss would be offset by revenue gains accruing from other aspects of monetary integration. Given that the loss of inflation tax revenue is often cited as a cost of monetary integration, this result is quite important. However although in the long run this form of integration would involve a relatively small increase in tax effort on average, the short-run costs in terms of the loss of flexibility in the use of the inflation tax, is somewhat greater.

Inflation Neutrality and the Budget

The foregoing analysis still assumed that the total budget deficit is inflation neutral. While this may be tenable for the primary budget deficit, it is only so for the budget as a whole under restrictive assumptions about the debt service account. Moreover, to the extent to which we also seek to examine the consequences of financial liberalization (which in the case of the monetary union scenario would be inevitable), this assumption needs to be relaxed.

Analyzing the overall impact of inflation on the structure of the government budget, and on the size of the deficit is a difficult task, and depends greatly on the nature of the direct and indirect tax structures on the degree of indexation in expenditure, and on the inflation elasticity of private sector expenditure relative to that of the government. An analysis of this form is beyond the scope of this thesis, and here we consider only the effect of inflation on domestic debt service. We can define the budget deficit as:

$$(3.29) \qquad D_g = (G_p - R_p) + S_n i$$

where R_p is primary revenue, E_p primary expenditure excluding debt service, and i is the net interest rate payable on S_n the net stock of public debt outstanding.[72] Primary revenue broadly consists of grants from overseas, direct taxation of incomes, indirect taxation of tradeable and non-tradeable, and other income. Expenditure (both recurrent and capital) can be broken down into wages and salaries and goods and services, with transfers to other levels of government similarly decomposed into wage costs and goods and services. Debt service consists of service of the stock of foreign debt outstanding, which for Kenya, along with many sub-Saharan African economies, is fixed in the medium term, and predominantly is fixed rate debt.[73] Domestic debt is non-indexed, and since it consists predominantly of short-maturity debt, it is *de facto* floating rate debt.

The effects of inflation of the budget can be broken into two. The first concerns the primary deficit (G_p - R_p), and the second the debt service. While in the long-run the primary budget may be expected to be inflation-neutral, in the short run, nominal rigidities will ensure that the effects of inflation are not neutral. In general fixed nominal revenue and expenditure items will be reduced in real terms in response to inflation. On the revenue side this will consist of excise items (where the tax is levied in nominal terms) and on direct taxes where there are collection lags, and where the tax base itself is fixed in nominal terms such as in the case of contract labour. However in banded tax systems, such as the Kenyan system, the revenue loss is offset by the additional revenue earned through the effects of fiscal drag. Indexed items, or items which are budgeted on a zero-based basis and for which prices change contemporaneously with inflation (ie the are consumed in proportion to the components of the CPI) will, on the other hand, remain unchanged in real terms. On the expenditure side the same effects may be seen, with fixed contract wage costs falling in real terms, and other items being fixed. However, it is frequently convenient to assume that the

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[72] The total debt stock is the net of the outstanding stock of government debt and government holdings of the financial liabilities of the private sector, the latter consisting principally of deposits with the commercial banking sector.

[73] Thus the foreign exchange value of debt flows is fixed in advance through pledges by the country's bilateral and multilateral creditors.

short-run revenue "losses" and expenditure "gains" from inflation net out allowing us to assume that the primary budget deficit is in fact inflation neutral. In the case of Kenya this assumption is probably tenable, certainly for most of the period under review, although the increasing share of wages and salaries in expenditure, and the corresponding fall in dependence on excise taxes towards the end of the period means that the effect of inflation is progressively non-neutral.

The main impact of inflation on the budget works in terms of its the impact on public debt service. On non-indexed domestic debt, where nominal interest rates are determined according to the Fisher equation ($i = i^{*} + \pi^{e}$), then an increase in actual (or expected) inflation will raise the nominal interest charges on public debt, but by more than the increase of inflation.[74] As Tanzi *et al.* (1987) note however, the real impact of this increase depends on how holders of nominal debt respond. Strictly, with no money illusion, the effect of inflation is to erode the real value of the financial asset and thus the equivalent component of the interest charge is a "monetary compensation" for the erosion of the real value of capital, and should be treated as an "involuntary" amortization of the bondholders' real loan to government. Consequently, the bondholders' permanent income, and therefore consumption, will not alter. On this argument the amount of the amortization, should not be considered as part of the deficit (since it is a "below the line" financing item), and there is no inflation impact of the overall budget deficit. Alternatively, and as actually occurs with the measures of the budget deficit commonly used, the entire increase is treated as income to the bondholder and thus as a charge against the government's recurrent revenue. In such an environment if nominal interest rates are driven by the Fisher equation then an increase in inflation raises interest charges more than proportionally and thus leads to a greater increase in total budget expenditure. In both cases the increase will be determined by changes in the nominal interest rate and the outstanding stock of assets and liabilities. It is possible to assess which of these

[74] For example, suppose outstanding debt was Ksh 1 billion and was paying 5% when inflation was zero. Total interest costs (charged against government revenue) would be Ksh 500,000. An increase in inflation to 10% would increase the nominal interest rate to 15%, and would raise debt service to Ksh 1.5 million, a rise of 200%.

arguments holds, since the issue turns principally on the nature of the real demand for nominal interest-bearing government debt. If bondholders were rational in the sense described above then it would be possible to recover a stable demand for bond function in real terms which was independent of inflation both in the short and long term. If however this were not the case and changes in the nominal interest rate occasioned changes in the consumption behaviour of the bondholder then we must accept that the inflation will have real effects on the budget deficit through the debt service account.

Although our estimated private sector demand function was poorly determined, it was clear that the inflation rate was a significant determinant of the real demand for bonds,[75] and we therefore proceed to examine the implications of allowing the increased nominal cost of debt service to effect the budget through the removal of financial repression.

Financial Liberalization and the Deficit[76]

We consider solely the case of a commitment to monetary union with an SDR peg, but where capital account restrictions are lifted. We assume that the sole fiscal transmission effect of this financial liberalization is through the debt service account. Further we assume that the flow of foreign deficit finance is fixed, and given the inflation tax constraints from the currency peg, the residual deficit financing is through issue of floating-rate domestic debt. Financial liberalization can then be thought of in terms of allowing domestic bond rates to be determined by a Fisher equation of the form

(3.30) $i = (1+\pi)(1+r) - 1$,

[75] It may be argued that this positive inflation effect serves mainly to proxy the (omitted) real rate of return on other real assets, and consequently is consistent with an inflation-neutral real demand for government debt. As we shall show in Chapter 4, however, even once alternative real rates of return are explicitly included, the inflation rate is a significant determinant of the demand for debt.

[76] This section draws on Tanzi, Blejer and Teijero (1987).

where r is the real SDR deposit rate. For the sake of expositional simplicity we assumed that the domestic (and in this case world) inflation rate is constant. This restriction is for convenience only: relaxing the assumption in practice is relatively straightforward, but makes the exposition unnecessarily cumbersome. Under this assumption the evolution of the budget deficit is given by[77]

$$(3.31)\quad D_n = (G_0 - R_0)(1+\pi)^n + (S_0 + \Sigma D_{n-i})[\pi + r(1+\pi)]$$

If we assume that primary budget is inflation neutral and that the initial budget is balanced, then this can be simplified to

$$(3.32)\quad D_n = S_0\pi(1+\pi)^{n-1}$$

which describes the evolution of the budget deficit solely in terms of the initial stock of debt and the rate of inflation. We can, of course, further relax this structure to allow for the real primary deficit to be "inflation worsened" or "inflation improved".

Financial Repression Tax and Budget Scenarios

The static calculations reported earlier for the year-on-year average magnitude for inflation tax and financial repression tax could be viewed as single-period independent outcomes. However, these one-period measures of the gains from financial repression implicitly exclude the cost of servicing the existing stock of debt carried over from the previous period (and the cost of servicing borrowing required to finance that higher deficit): the gains from financial repression come not just from the lower cost of issuing new debt, but from the dynamic effect on the cost of rolling over the debt stock each period. Once dynamic considerations

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[77] Starting from a balanced budget we can represent the deficit as $D_0 = G_0 - R_0 + S_0r = 0$, and let $i = (1+\pi)(1+r) - 1 = \pi + r(1+\pi)$. In period 1 the budget will be $D_1 = (G_0 - R_0)(1 + \pi) + s_0[\pi + r(1+\pi)] = (G_0 - R_0)(1 + \pi) + s_0r(1+\pi) + S_0\pi$.

of this form are acknowledged, the viability of extending the static counterfactual analyses is weakened. However, from an illustrative point of view, it is worthwhile examining the implications for the budget if government had been obliged to issue domestic debt that yielded the same return as SDR deposits under a pegged exchange rate. To do so we make the following assumptions to generate a simple first-order approximation to the magnitude of the gains from domestic financial repression. First, it is assumed that the primary budget is inflation neutral. Second, we assume that there is no crowding out effect in the government bond market, and that the private sector demand for bonds is perfectly elastic over the relevant range, at the Fisher equation determined rate. This latter assumption ensures that there is no feedback from the bond market to the primary budget, either on the revenue account or on the expenditure account. Finally, it is assumed that there is no reverse causation from interest rates in the bond market to the rate of inflation.

Presentation of Scenarios

Tables 15 to 17 presents the structure of the budget under the alternative scenarios, and Figures 7 and 8 present the actual and counterfactual debt to GDP ratio and budget deficit to GDP ratios for the years from 1972 to 1989.

Table 3.15
Actual Budget Deficit and Domestic Debt

Year	GDP	CPI	Real SDR Interest	Primary Deficit	Domestic Interest	Foreign Interest	Total Interest	Budget Deficit	Debt Stock	Deficit/ GDP	Debt/ GDP
1972	15,050	17.04	-0.43%	(391)	65	110	175	(566)	2097.36	3.76%	13.94%
1973	17,570	19.63	0.22%	(689)	71	142	213	(902)	2614.30	5.13%	14.88%
1974	21,210	22.76	-3.62%	(347)	147	93	240	(587)	2840.07	2.77%	13.39%
1975	23,930	27.10	-6.03%	(860)	189	102	291	(1,151)	3624.85	4.81%	15.15%
1976	29,070	30.19	-3.58%	(1,318)	224	167	391	(1,709)	4620.06	5.88%	15.89%
1977	37,200	37.07	-2.18%	(848)	268	211	479	(1,327)	6442.75	3.57%	17.32%
1978	40,990	41.98	-0.43%	(971)	370	286	656	(1,627)	6956.12	3.97%	16.97%
1979	46,600	45.44	0.24%	(2,165)	386	464	850	(3,015)	7924.25	6.47%	17.00%
1980	53,910	52.25	-1.27%	(1,448)	534	427	961	(2,409)	8950.72	4.47%	16.60%
1981	62,020	59.10	1.27%	(2,641)	1,372	(11)	1,361	(4,002)	13723.62	6.45%	22.13%
1982	70,310	73.30	2.76%	(3,092)	1,396	975	2,371	(5,463)	10966.95	7.77%	15.60%
1983	76,990	81.09	2.97%	(919)	2,423	496	2,919	(3,838)	18380.75	4.99%	23.87%
1984	89,250	89.76	3.80%	(809)	2,399	1,073	3,472	(4,281)	20818.55	4.80%	23.33%
1985	100,750	100.00	12.04%	(2,326)	2,946	973	3,919	(6,245)	24018.73	6.20%	23.84%
1986	117,480	103.66	3.81%	177	3,211	2,110	5,321	(5,144)	27793.24	4.38%	23.66%
1987	130,470	111.60	6.76%	(2,325)	3,929	2,075	6,004	(8,329)	31834.37	6.38%	24.40%
1988	149,400	123.10	-3.52%	1,135	4,989	2,417	7,406	(6,271)	29493.70	4.20%	19.74%
1989	170,420	135.15	5.57%	4,905	6,137	3,131	9,268	(4,363)	29017.03	2.56%	17.03%

Table 3.16

Budget Deficit with Liberalization of Capital Account

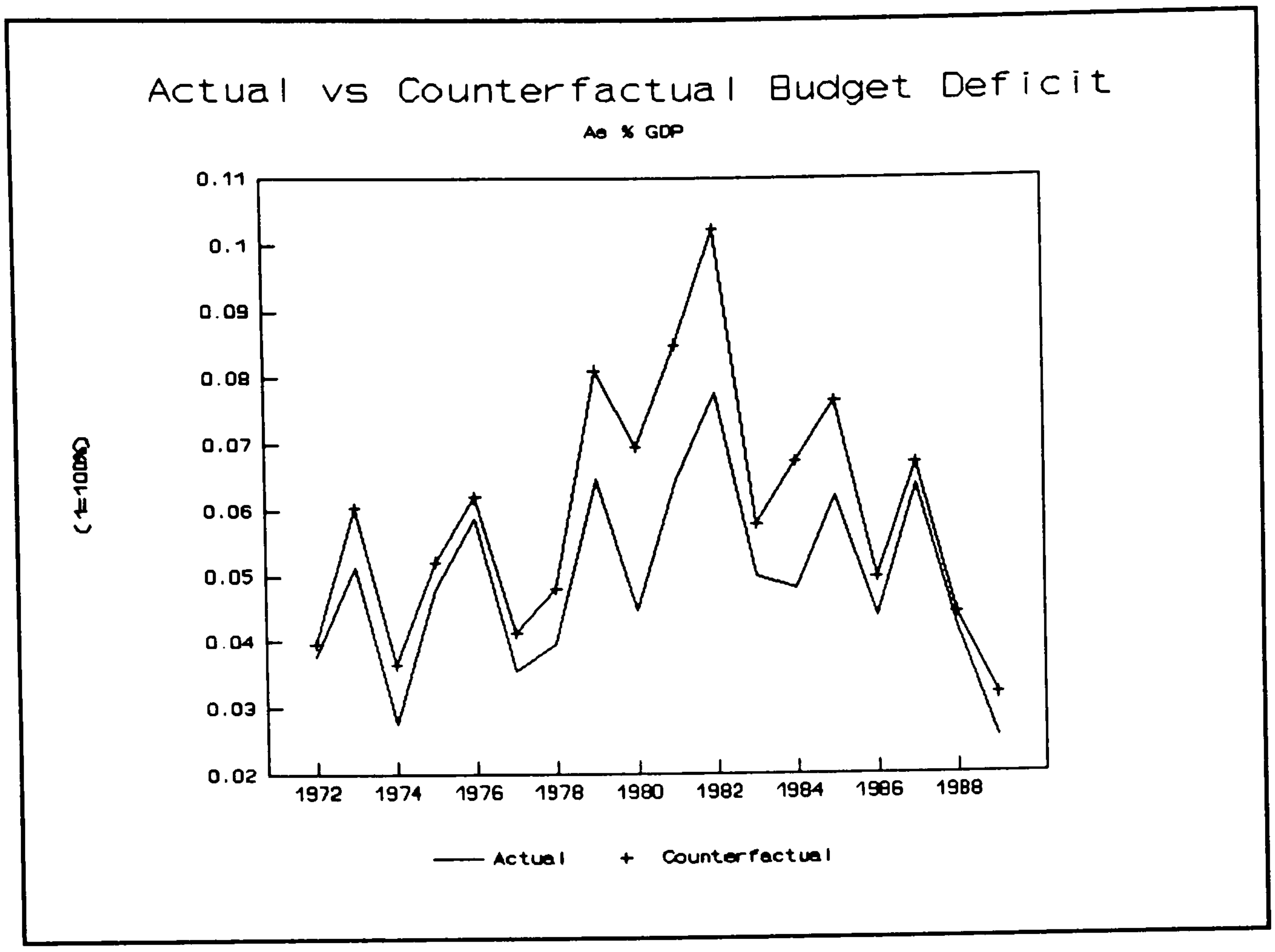
Year	GDP	CPI	Real SDR Interest	Primary Deficit	Foreign Interest	Domestic Interest	Total Interest	Budget Deficit	Deficit/ GDP	Debt/ GDP
1972	15,050	17.04	-0.43%	(391)	110	61	171	(562)	3.73%	13.94%
1973	17,570	19.63	0.22%	(689)	142	411	553	(1,242)	7.07%	15.13%
1974	21,210	22.76	-3.62%	(347)	93	458	551	(898)	4.23%	18.39%
1975	23,930	27.10	-6.03%	(860)	102	571	673	(1,533)	6.40%	20.06%
1976	29,070	30.19	-3.58%	(1,318)	167	470	636	(1,954)	6.72%	21.78%
1977	37,200	37.07	-2.18%	(848)	211	1,667	1,878	(2,726)	7.33%	22.27%
1978	40,990	41.98	-0.43%	(971)	286	1,403	1,690	(2,661)	6.49%	26.87%
1979	46,600	45.44	0.24%	(2,165)	464	1,165	1,629	(3,794)	8.14%	29.34%
1980	53,910	52.25	-1.27%	(1,448)	427	2,358	2,785	(4,233)	7.85%	32.40%
1981	62,020	59.10	1.27%	(2,641)	(11)	3,158	3,147	(5,788)	9.33%	34.99%
1982	70,310	73.30	2.76%	(3,092)	975	7,544	8,519	(11,611)	16.51%	39.10%
1983	76,990	81.09	.97%	(919)	496	5,438	5,934	(6,853)	8.90%	50.79%
1984	89,250	89.76	380%	(809)	1,073	6,848	7,921	(8,730)	9.78%	51.49%
1985	100,750	100.00	12.4%	(2,326)	973	13,572	14,544	(16,870)	16.74%	54.28%
1986	117,480	103.66	3.81%	177	2,110	5,442	7,551	(7,374)	6.28%	60.91%
1987	130,470	111.60	6.76%	(2,325)	2,075	11,793	13,868	(16,193)	12.41%	60.49%
1988	149,400	123.10	-3.52%	1,135	2,417	6,111	8,528	(7,393)	4.95%	63.67%
1989	170,420	135.15	5.57%	4,905	3,131	16,308	19,439	(14,534)	8.53%	60.15%

Table 3.17

Budget Deficit with Price Stability and Financial Liberalization

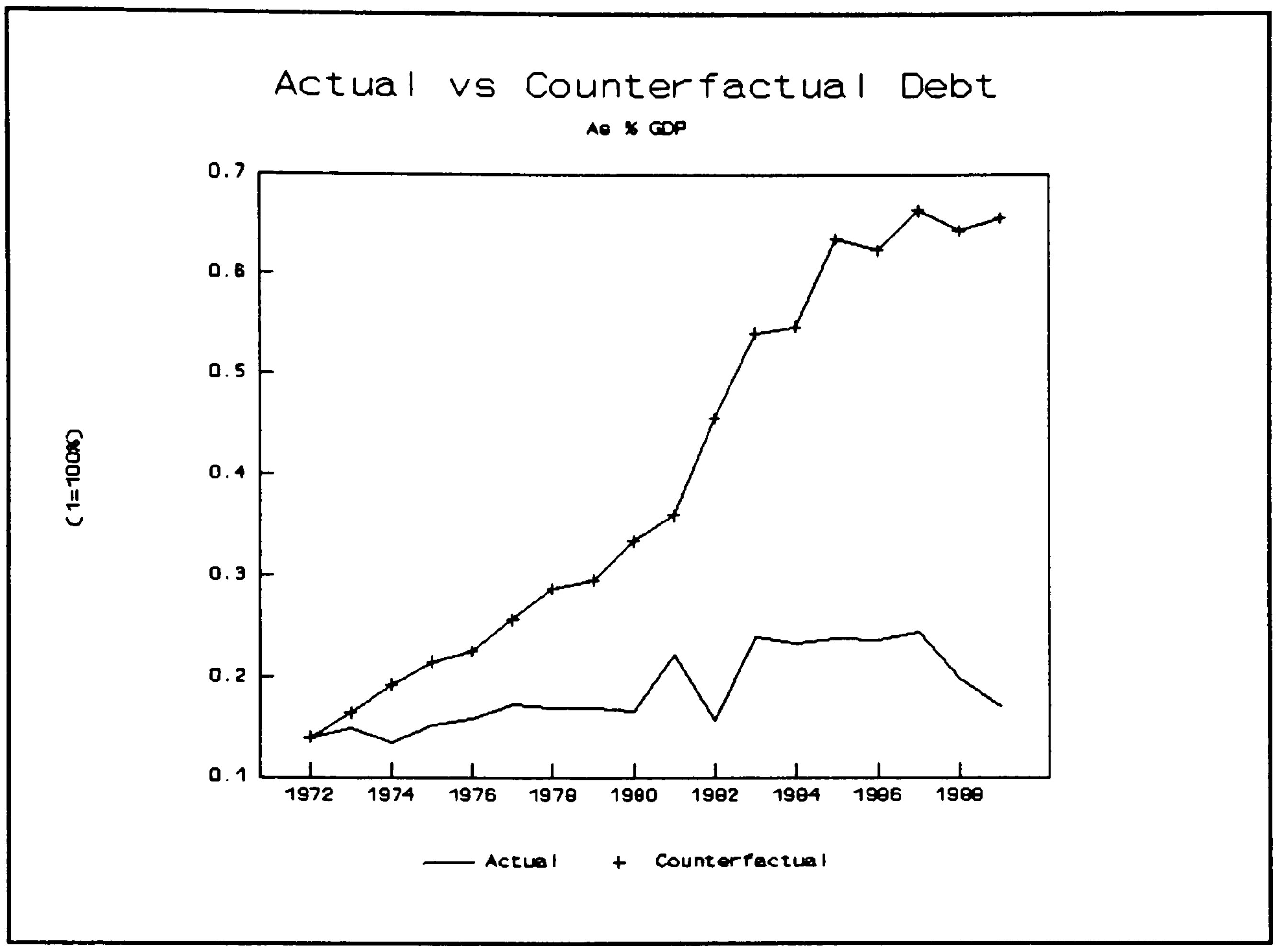
Year	Real GDP	SDR CPI	Real SDR Interest	Primary Deficit	Foreign Interest	Domestic Interest	Total Interest	Budget Deficit	Domestic Debt	Deficit/ GDP	Debt/ GDP
1972	35,297	39.96	-0.43%	(917)	258	224	482	(1,399)	4920.35	3.96%	13.94%
1973	38,550	43.07	0.22%	(1,512)	311	507	818	(2,330)	6318.98	6.04%	16.39%
1974	45,069	48.36	-3.62%	(737)	197	711	908	(1,645)	8649.05	3.65%	19.19%
1975	47,977	54.33	-6.03%	(1,724)	204	574	778	(2,502)	10294.30	5.22%	21.46%
1976	56,901	59.09	-3.58%	(2,580)	326	624	950	(3,529)	12796.43	6.20%	22.49%
1977	63,650	63.43	-2.18%	(1,451)	361	817	1,177	(2,628)	16325.88	4.13%	25.65%
1978	65,953	67.54	-0.43%	(1,562)	461	1,141	1,602	(3,164)	18954.05	4.80%	28.74%
1979	74,866	73.01	0.24%	(3,478)	745	1,849	2,593	(6,072)	22118.12	8.11%	29.54%
1980	84,239	81.64	-1.27%	(2,263)	667	2,930	3,598	(5,860)	28189.69	6.96%	33.46%
1981	94,600	90.15	1.27%	(4,028)	(17)	4,026	4,009	(8,037)	34050.03	8.50%	35.99%
1982	92,350	96.28	2.76%	(4,061)	1,281	4,101	5,382	(9,443)	42087.07	10.23%	45.57%
1983	95,252	100.32	2.97%	(1,137)	613	3,759	4,372	(5,509)	51530.21	5.78%	54.10%
1984	104,235	104.83	3.80%	(945)	1,253	4,830	6,083	(7,028)	57039.07	6.74%	54.72%
1985	100,750	100.00	12.04%	(2,326)	973	4,405	5,377	(7,703)	64066.71	7.65%	63.59%
1986	115,001	101.47	3.81%	173	2,065	3,829	5,894	(5,721)	71770.03	4.97%	62.41%
1987	116,698	99.82	6.76%	(2,080)	1,856	3,894	5,749	(7,829)	77490.61	6.71%	66.40%
1988	132,518	109.19	-3.52%	1,007	2,144	4,726	6,869	(5,863)	85319.65	4.42%	64.38%
1989	138,820	110.09	5.57%	3,995	2,550	5,876	8,426	(4,431)	91182.36	3.19%	65.68%

Figure 3.7
Actual vs Counterfactual Budget Deficit with Liberalized Capital Account



Contrast the actual outturn with a simple calculation of what the outturn would have been if the government paid the world rate of interest on domestic debt as described above, but that domestic inflation followed the same path as before, and all increases in the deficit as a result from this higher domestic debt service were met by issuing more debt (Table 16). This is equivalent to stating that at each period the implicit tax on domestic debt is set to zero. Strictly, to ensure that this additional debt issue is itself non-inflationary we must think of it as being issued solely to the non-bank private sector. Under this scenario, where domestic debt service is determined by a Fisher-equation and a liberalized capital account, the budget deficit would have been approximately 3.5 per cent of GDP higher per annum, averaging 8.4 per cent of GDP, although in two years (1982 and 1985) the deficit would have exceeded 14 per cent of GDP. The implication of this persistently higher budget deficit are cumulated in the evolution of the debt stock. If we take the actual 1972 stock outstanding as the initial stock, we find that the debt to GDP ratio rises from a relatively stable level of approximately 20 per cent of GDP to a upwardly trending rate which by 1980 stood at 40 per cent of GDP and by 1989 was in excess of 60 per cent.

Figure 3.8
Actual vs Counterfactual Debt with Liberalized Capital Account



A slightly more realistic scenario is where the liberalization of the capital account is accompanied by a move to peg the Kenyan Shilling to the SDR (Table 17). The external currency peg therefore restricts the inflation tax revenue options but, as was noted earlier, the domestic inflation rate would fall from an average rate of approximately 12.4 per cent to 6.3 per cent. Under these conditions the relaxation of capital account restrictions would still increase the real cost of debt service to the government, but by a lesser amount than in the previous scenario. The budget deficit would rise by just over 1 per cent of GDP per annum, from 4.9 per cent to 6 per cent. However this 1 per cent average increase would have been compounded in the domestic debt stock which would rise from the actual level of 20 per cent of GDP to approximately 50 per cent. Again, historically, a large proportion of this increase is accounted for by the combination in the early 1980s of the rapid widening of the domestic deficit combined with a sharp rise in world interest rates in the early 1980s which led to a rapid increase in the counterfactual cost of financing the deficit through non-inflationary domestic borrowing (as opposed to the use of inflation-tax financing as occurred in reality). In the later 1980s where world interest rates returned to more normal rates, and when the government progressively stabilized its fiscal position, the trajectory for the domestic debt stock levels out.

Although these scenarios incorporate some very restrictive assumptions, not least that expectations about future inflation are fully rational, and are immediately incorporated into the rate of return on domestic debt and that there is no feedback onto government revenue and expenditure policy, they do illustrate the principal public finance implications associated with programmes of financial liberalization. The relaxation of these assumptions, plus those relating to the neutrality of the primary budget, are unlikely to alter the results significantly. Since the direction of the effects is monotonic, and entirely dependent on relatively arbitrary parameter values, they need little discussion.

Given their purely illustrative nature, plus the restrictive assumptions on the second-order effects required to generate these calculations, it is not appropriate to draw any firm quantative conclusions from these results. However it is perhaps useful simply to draw out the fundamental implications. The first is that the magnitude of the implicit revenue from financial repression may be greater than is implied by our earlier simple calculations which calculated the static implicit tariff on the debt stock. If the cost of meeting this additional debt service had to be met out of additional borrowing, then the cumulative effect on the budget deficit is significantly greater. Second the scenarios emphasise the importance, even for a relatively moderate inflation economy such as Kenya, of ensuring that capital account liberalization is accompanied by domestic monetary and fiscal control. Finally, if this form of deficit financing were to be genuine non-inflationary, then domestic non-bank holdings of government debt would need to greatly exceed their current level. Whether this can occur is addressed in the final chapter of the thesis.

Conclusion

This chapter has attempted to quantify the static revenue gains from inflation tax and from the imposition, through controls on the capital account, of policies of domestic financial repression. Over the period since Independence Kenya has been a moderate inflation economy and, principally as a result of an exchange rate policy which has avoided excessive over-valuation of the real exchange rate, has maintained a similarly moderate level of financial repression. Our analysis has led to a number of conclusions. First, although the total revenue from the inflation-tax in Kenya has, historically, represented a relatively small proportion of total tax revenue - equivalent to less than 1 per cent of GDP per annum - the relative ease with which inflation tax can be levied compared with other forms of taxation, suggests that there may exist an important short-run role for inflation tax. Second, given this, while the steady-state revenue loss associated with moving to a regime of relative price stability required, for example, as a condition for monetary integration with the SDR is relatively low, the loss of short-run fiscal flexibility may be significant. Third, the presence of costs of adjustment faced by the non-bank private sector in adjusting towards their equilibrium levels of monetary holdings means that the conditions for time-inconsistency problems are present in the conduct of monetary policy, especially in the face of an uncontrolled, or unplanned fiscal deficit. While optimal medium-term monetary policy may require the maintenance of tight monetary rules, at each period of time the government has an incentive to finance additional expenditure through the inflation tax. Finally, while the revenue costs of reducing the rate of inflation are relatively moderate, the fiscal impact of full liberalization of the capital account may be significant.

APPENDIX 3(A)
DOES THE KENYAN GOVERNMENT FOLLOWING AN "OPTIMAL" MONETARY STRATEGY?

An important feature of these results is how closely actual inflation tax revenue tracks the calculated notional revenue maximizing level: only once has actual inflation exceeded the revenue maximizing level, that being in 1977. A natural question is thus whether there is evidence that the authorities are employing monetary policy within the framework of an optimal taxation regime. A recent series of papers have attempted to test the hypotheses that monetary policy is conducted in terms of the tax implications of inflation so that its use is determined as the joint outcome of process through which the government seeks to minimize the cost of tax distortion across all its tax instruments subject to its budget constraint (see, for example, Mankiw (1987)). This theory of monetary policy assumes that the inflation tax outcome is determined by the fact that though it is a lump-sum tax on all holders of money, and is therefore less distortionary than output or sales taxes, the inflation itself also has costs. The optimal rate of inflation is determined within a generalised Ramsey tax allocation process in which government seeks to minimize the welfare loss involved in raising a given tax revenue to cover exogenous public expenditure. Specifically, the inflation tax will be used to the point to which its marginal cost (in terms of the distortions caused in the economy) is equal to the marginal cost of other tax instruments (such as trade or output taxes). The problem facing the government is thus an application of the standard optimal inter-temporal indirect tax problem (see Atkinson and Stiglitz (1980)). Abstracting from the inter-temporal issues associated with the problem, an important implication of the model is that any increase (decrease) in the level of taxation should be financed from both sources (tax and inflation) in relation to the marginal cost of each form of taxation. This, so-called "covariance" result is a readily testable implication, which is derived from the simple one-period model developed by Mankiw (1987) and Porterba and Rotemberg (1990).

Government can raise tax revenue from either taxes on output or through the inflation tax: both sources of tax carry social costs. Taxes on output raise income τy where y is real income, and the deadweight loss associated with this is given by $f(\tau)y$, where $f' > 0$ and $f'' > 0$. The social costs of inflation are similarly denoted $h(\pi)y$ where $h' > 0$ and $h'' > 0$. Thus both tax-cost functions are increasing and convex in the rate of tax. Inflation tax revenue is determined, as before, by the demand for real (narrow) money balances:

(A3.1) $m = y^{\alpha}\pi^{\beta}$

The revenue from the growth of the real money stock is then given by $(\pi + g)m$, where π is the rate of inflation and g the real growth of income. Total tax revenue is $T = \tau y + (\pi + g)m$. Government then seeks to minimize the social costs of taxation defined as $(f(\tau)y + h(\pi)m)$ subject to raising a certain level of revenue defined by the autonomous level of government spending, G.[78] Thus the one-period loss function is defined as

$$\text{(A3.2)} \quad L = [f(\tau)y + h(\pi)m] - \lambda[\tau y + (\pi+g)m - G].$$

Mankiw (1987) simplifies the analysis by assuming that $\alpha=1$, and $\beta=0$ so that the demand for money function can be represented as a simple Cambridge-style money demand function. Under these conditions the first-order conditions for the minimization of L gives the result

$$\text{(A3.3)} \quad kf'(\tau) = h'(\pi),$$

indicating that, since k is positive, an increase in the government financing requirement will be require the use of both instruments, determined by the functional form of f'(.) and h'(.) and the velocity of circulation, k. This suggests a simple, if very weak, test of optimal seigniorage policy, namely whether the two tax instruments co-vary over time. Relaxing the form of the demand for money function, and particularly the assumption that $\beta = 0$, allows us to re-write the loss function as

$$\text{(A3.4)} \quad L^* = [f(\tau)y + h(\pi)m(\pi,y)] - \lambda[\tau y + (\pi+g)m(\pi,y) - G].$$

The corresponding first-order conditions for the minimization of L^* are

$$\text{(A3.5)} \quad \Theta + \Psi h'(\pi) = f'(\tau)$$

where $\Theta = h(\pi)m'(\pi)$ and $\Psi = m(\pi)/[\pi m(\pi) - (\pi+g)m'(\pi)]$.

Since $m'(\pi)$ is negative the Ψ is positive (for positive values of inflation), then the same result holds as for the simple form of the demand for money function. Mankiw (1987) tests this relationship for the US economy, and finds weak evidence in support of the hypothesis, using a simple linear regressions. For the Kenyan data we therefore test for the existence of long-run relationships of between the inflation rate, aggregate tax rate for Kenya and its decomposition of

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[78] Again this is a simplification which allows us to eliminate considerations of the dynamics of government debt.

annual total tax revenue into direct, indirect (VAT and Sales taxes) and trade taxes.[79] Formally, following Porterba and Rotemberg (1990) we assume constant elasticity forms for the functional form of both f(.) and h(.),[80] and estimate the following model (where all variables are in natural logs)

(A3.6) $\ln\pi_t = \alpha_0 + \alpha_1 \ln(m/y)_t + \alpha_2 \ln\tau_t + \epsilon_t$.

Under the null we anticipate that the $\alpha_2 > 0$. The most obvious way to address the Mankiw hypothesis is to examine directly the covariance of the data. This is reported in Table (A1).

Table A3.1
Simple Correlation Between Tax Instruments

	Δp	t/y	dt/y	vat/y	exc/y
Δp	1.00	-.34	-.19	-.30	.05
t/y		1.00	.31	.98	-.08
dt/y			1.00	.11	.05
vat/y				1.00	-.34
exc/y					1.00

Note: Δp = quarterly inflation;
t/y = aggregate tax to GDP ratio;
dt = direct taxes;
vat = sales taxes and value added tax;
and exc = excise duties.

From this table it is noted that though direct and indirect taxes have a positive co-variance with each other (and with total tax), excise tax (which account for only a small proportion of the total) is negatively correlated with indirect taxes. However the aggregate tax to GDP ratio (t/y) is *negatively* correlated with the inflation rate, which immediately contradicts the implications of the theory. Correlation coefficients between the growth rates of inflation and tax rates, and between the detrended levels of the data do not alter the conclusions, and thus in terms of this preliminary

[79] Reliable quarterly data are not available for the components of total tax revenue, but are available for annual data. The annual results presented in the text have also been replicated using quarterly data for aggregate tax only. The results from the quarterly model do not lead to a re-assessment of the results presented here.

[80] Specifically we let $h(\tau) = \kappa_1\tau^{\alpha+1}$ and $v(\pi) = \kappa_2\pi^{1-B}$.

data the Mankiw hypothesis concerning the covariance of inflation and other tax instruments is not supported. We need go no further in testing the model.

The rejection of this hypothesis is not particularly surprising, principally because the test is so weak. A more relevant model would allow for the additional short-run buffer-stock role played by the inflation tax in many developing economies. Thus it would be necessary to investigate whether the determination of the level of output or sales taxation to be determined by *planned* expenditure, and the inflation tax and/or financial repression tax in response to *unanticipated* expenditure. In other words monetary policy fulfils a purely accommodating role, but that this role is bounded by the limit at which the pure inflation tax effect is outweighed by the fall in the real monetary depth in response to inflation.

4

THE ANALYSIS OF SUBSTITUTION EFFECTS BETWEEN REAL AND FINANCIAL ASSETS USING A NEO-CLASSICAL DEMAND SHARE MODEL

Introduction

This chapter seeks to extend the analysis of the previous two chapters by placing the discussion of the demand for money in the wider context of the private sector's overall asset allocation between alternative financial assets and between (and within) financial and real assets. The motivation for this approach stems from a number of factors. First, although the analysis of the demand for money in the previous chapters is satisfactory, not least to the extent that the models successfully encompass existing Kenyan demand for money models, by design it provides only a partial insight into the process of asset allocation. Implicitly single-equation models of money demand rely on the validity of conditioning on the broader, but unspecified, wealth allocation process. As a result such models generally condition on income and take the domestic rate of inflation to proxy the rate of return on real assets. However, while an analysis of the demand for money itself is necessary to address aspects of monetary policy, an understanding of the likely effects of broader issues of financial policy seems to require a more general examination of the asset portfolio allocation process. For example, it seems pertinent to consider the nature of asset-switching between not just real and financial assets, but also whether there is any particular pattern of switching between types of real assets (tradeable, non-tradeable, and inventories), as well as between different forms of financial assets (for example, government securities and banking sector liabilities). Clearly there is some overlap with the single equation modelling approach and, as we shall demonstrate later in the chapter, the results from the two approaches can be reconciled. This chapter employs one applied econometric approach to this question, by drawing on the tradition of demand-systems modelling, and in particular the Deaton and Muellbauer (1980a) model.

The model presented in this chapter therefore seeks to address a number of specific issues. First, and most generally, the model attempts to characterize the way in which the private sector in Kenya manages its aggregate asset portfolio in the face of proscriptions on the private holdings of foreign denominated assets and, at least until recently, under a regime of domestic interest rate repression. In this respect we seek to examine: (i) the role of relative prices in determining asset switching; (ii) the specific impact of inflation on the asset portfolio, and, in particular, the extent of the "flight from money" in response to rising inflation; and (iii) the relative speed of adjustment between different types of real and financial assets towards their long-run target levels. Second we seek to identify the theoretical implications concerning assets substitution effects flowing from recent analyses of temporary trade shocks (for example, Bevan, Collier, and Gunning (1990)), and of trade liberalization (for example, Dixit (1989)). As with the literatures from which these implications arise, we do not seek to model the fixed capital formation process itself, but rather consider the nature of the substitution effect between assets at the margin. Finally, we seek to use this model structure to offer some quantification of the effects of monetary policy and interest-rate liberalization on asset composition. In this chapter we shall focus only on the first set of issues: in Chapter 5 we return to the issue of financial policy evaluation. The chapter is set out as follows. Section 4.1 reviews the literature on asset substitution, and considers a number of theoretical and empirical problems associated with estimation models of this form. In particular in this section we discuss the effect of credit rationing in the model. Section 4.2 describes the data and its construction, and provides a description of the economic environment which this model attempts to describe. Section 4.3 reviews the time-series characteristics of the model, reports the long-run solutions, and tests the theoretical implications of the demand system. Section 4.4 presents the results from the estimation of the dynamic models, which are discussed in detail in Section 4.5. Section 4.6 attempts to reconcile the results of this chapter with those from the single-equation demand for money models in Chapter 2, and Section 4.7 concludes.

4.1 Models of Asset Substitution - Review of the Literature

A number of recent papers in monetary economics have attempted to move away from the traditional single-equation approaches to modelling the demand for financial assets towards broader models of portfolio composition. The earlier literature on portfolio choice models concentrated on the issue of portfolio composition predominantly through the mean-variance models developed by Markowitz (1959), Tobin (1965), Samuelson (1969), and Merton (1969). This approach was integrated with mainstream demand for money analysis by Ando and Shell (1975) who developed a set of portfolio separability results which allow the transactions and precautionary aspects of the demand for money to be modelled separately from speculative considerations, with the former being a function of the income or transactions factors, and the latter being conditioned on portfolio considerations in the markets for other financial and real assets. This result, which was extended by Spencer (1986) is implicitly used in much of the demand for money studies discussed in Chapter 2.[81] More recently, however, an alternative to these portfolio-choice models has been developed which models the financial sector of the economy in terms of the two-stage budgeting problem as analyzed by Deaton and Muellbauer (1980a) (see Taylor and Clements (1983), Perraudin (1987), and Barr and Cuthbertson (1989a), (1989b), (1989c), (1990), (1991)).[82]

The two-stage budgeting approach is based on the simplification that a representative agent faces two (or more) separate resource allocation decisions and

[81] The separability results derive from a model where broad money deposits are determined as a buffer stock asset between transactions-determined narrow money balances on the one side, and speculative demand for gilt-edged securities and other financial and real assets on the other.

[82] Large scale econometric simulation models also model the financial sector to some degree, although it has been noted however that, in general, these models have tended to be poorly grounded in the data, and generally do not have firm micro-foundations (see Wallis 1984).

that the outcome of the two-stage process is consistent with what would have occurred had the allocation decision been made as a one-stage decision. In the case of asset demands, the first stage involves the labour supply/leisure and consumption/saving decisions which determine the total asset portfolio, while the second stage considers how the portfolio is allocated between different groups (ie money, bank deposits and loans (the latter being treated as negative assets), real assets, bonds, bills, equity, foreign exchange, etc). Implicit in the two-stage budgeting problem is the idea that only information relevant to each stage is required in each allocation decision. In other words, the allocation of assets across a portfolio depends only on the relative prices and quantities within the group of assets in the portfolio, and does not require information on the higher level processes (i.e. the consumption/saving decision).[83]

This form of applied demand analysis considers the utility maximization problem in the dual, by minimizing the cost function subject to some budget constraint, where the cost function used is generally of the form

(4.1) $\ln c(u,p) = a(p) + ub(p)$,

where $u = u(x,p) = (\ln x - a(p))/b(p)$ is the indirect utility function, x is total expenditure, and a(.) and b(.) are functions of prices, p. By using a second-order Taylor approximation to the cost function (4.1) of the PIGLOG form[84], we let

(4.2) $a(p) = \alpha_0 + \Sigma\alpha_i \ln p_i + \frac{1}{2}\Sigma\Sigma\gamma_{ij}\ln p_i \ln p_j$

and

(4.3) $b(p) = \beta_0 \Pi\, p_k^{-\beta k}$.

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[83] This has the additional implication that demand share models can be, and generally are, estimated conditional on the current period value of wealth. This procedure is adopted here, although we also investigate the implications for simultaneous equation bias that may arise.

[84] The PIGLOG or price-independent generalized logarithmic linear specification is chosen for its analytical manageability, and importantly, for its desirable aggregation properties. (See Deaton and Muellbauer (1980b) Chapter 6.2).

Substituting these values into the cost function (4.1) and using Sheppard's Lemma which states that $s_i = \delta ln c(u,p)/\delta ln p_i$, where s_i is the share of the ith good in total expenditure, x, gives demand functions of the form

$$(4.4)\quad s_i = \alpha_i + \Sigma\gamma_{ij} ln p_j + \beta_i ln(x/P)$$

where

$$(4.5)\quad lnP = \alpha_i + \Sigma\alpha ln p_i + \tfrac{1}{2}\Sigma\Sigma\gamma_{ij} ln p_i ln p_j.$$

Deaton and Muellbauer(1980b) argue that when price movements are relatively collinear within the group (as in the case with the price vector considered in the subsequent asset demand models), then (4.5) can be replaced by a weighted price index defined over all the elements of the price vector, of the form $\Sigma s_i ln p_i$. Calculating this index prior to estimation ensures that (4.4) is linear in the parameters and is thus easily estimated. Much demand analysis research consists principally in testing the basic premises of consumer theory, namely that cross-price elasticities are symmetric, demands are homogeneous of degree zero in prices, and that the (Hicksian) demand functions are downward sloping (i.e. the own-price effects are negative). In terms of the above model homogeneity implies that $\Sigma\gamma_{ij} = 0$ for all j; symmetry implies that $\gamma_{ij} = \gamma_{ji}$; and negativity requires that the Slutsky matrix is negative semi-definite. We shall consider these issues in Section 4.3

Employing this approach to model asset (including money) demands is motivated by the desire to examine the individual role of relative prices in the asset accumulation process. Taylor and Clements (1983) and Barr and Cuthbertson (1991) estimate demand-share models for capital-certain liquid financial assets (principally cash in circulation, sight and time deposits and national savings certificates) for Australia and the UK respectively, finding that relative price effects within the asset portfolio can be identified. Taylor and Clements estimate a long-run, static model, while Barr and Cuthbertson employ a two-stage dynamic error-correction model (see Section 4.3 below). Perraudin (1987) also models the UK personal sector for the same period (1977-86), but uses a broader classification of demand shares, including real assets, capital uncertain financial assets and also financial liabilities (treated as negative assets), but within a stock-adjustment dynamic specification. In each case the data conclusively reject long-run homogeneity and symmetry, although Barr and Cuthbertson impose long-run symmetry and homogeneity in the dynamic model. Short-run homogeneity and symmetry are however not rejected in their model. In general the authors conclude that the models successfully describe the data and, in the case of Barr and Cuthbertson (1991), are consistent with results from single-equation demand for money models estimated for the UK.

This approach, which places the demand for money function within a broader utility-based framework, may also cast light on the dynamics of a number of important theoretical results from the literature on the effects of temporary trade shocks and uncertainty on the process of capital accumulation. For example, Dixit's (1989) generic two sector capital allocation model examines the effect of uncertainty about the permanence of price shocks on the speed of capital re-allocation between sectors. Bevan *et al.* (1990) develop this notion with a specific focus on the conditions under which a temporary trade shock may lead to differential responses in the formation of tradeable and non-tradeable capital when capital markets are imperfect. In their study of Kenya, they suggest that in the presence of controls on private holdings of foreign assets, the positive terms-of-trade shock accompanying the coffee boom was translated rapidly into a construction sector boom with private agents initially increasing their stock of financial assets, principally commercial bank deposits, followed by a switch into real capital accumulation, which, given lagged supply responses persisted until late 1981. A testable implication of the model is thus to see whether it can identify differential processes of dynamic adjustment between real and financial asset, and between type of real assets.

Furthermore, in the area of trade liberalization, research by Calvo (1988) considers models in which the private sector accumulates inventories of durable goods in anticipation of future liberalization-reversing tariff increases. Again Kenya offers a case where episodes of trade liberalization were met by considerable uncertainty, and we can examine whether the model captures patterns of inventory accumulation associated with "credible" and "incredible" trade liberalization.

Adapting the Demand Model for Kenyan Asset Holdings

As noted, the Deaton and Muellbauer form for modelling asset demands has tended to concentrate principally on financial assets, although Perruadin (1987) also includes analysis of real capital accumulation for the UK. Broadening the framework, as we do here, to consider not only the wider asset choice decision, but also choices made within an economy where formal asset markets are thin and/or non-existent, raises a number of quite serious problems for estimation and inference. Four issues may be noted. The first, and most intractable, concerns the question of whether the representative-agent structure employed by the Deaton-Muellbauer model is capable of adequately explaining the structure of demands. It is clear that the model is unlikely to encompass conditional models designed to capture purely the investment behaviour with respect to the individual asset shares separately (such as the demand for money models in Chapter 2). Nor is it likely to provide a deep insight into the dynamics of aggregate inventory accumulation. However, the objective for which we use this model here is to characterise, relatively broadly, the extent of relative price effects on the decision of agents to allocate their aggregate wealth. More specifically, from the point-of-view of the analysis of the impact of monetary policy (see Chapter 3) we are able to examine more closely the effect of inflation, not just on holdings of financial assets, but also on the form of real asset accumulation. Finally, it remains of interest in assessing the results from the single-equation estimates of Chapter 2 whether, in the light of the model of this section, they are consistent with underlying notions of utility maximization.

Second is the problem of incorporating the joint decision by private sector agents to hold both financial assets and liabilities concurrently. Clearly the main reason for simultaneous holdings of assets and liabilities is that agents differ in their preferences, their income, and their stock of wealth. In the light of this the Deaton and Muellbauer model which derives its consistency with individual maximization behaviour through the use of a "representative agent" aggregator function may be thought to be inconsistent with such a world where assets and liabilities with the banking sector are held concurrently. However it is clear that even a representative agent may rationally hold both assets and liabilities simultaneously. More generally, if assets and liabilities generate different flows of utility, then the representative-agent structure can still be maintained. This may arise as a function of the term structure and tax regime between different debt and savings instruments,[85] but may also reflect divergences in perceptions of risk and risk aversion.[86] It is therefore possible to define the model in terms of the stocks of *gross* assets and *gross* liabilities,[87] and maintain the representative-agent structure.

Third, and integral to their definition, is the issue of the durability of assets. The standard neo-classical approach to this particular problem uses the assumption that the indirect utility function (from which the cost function is derived) is defined inter-temporally over the flow of utility produced from holding the asset, where prices can be defined in a manner analogous to the user cost, or the rental-equivalent price, of durable goods. This implicit structure can be illustrated using a simple two-period inter-temporal utility maximization model in which the utility of an asset is proportional to its stock, and where the rate of return is the inverse of the rental equivalent price of an asset (including any capital gain or loss that may arise).[88] For simplicity we assume that there are

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[85] In many countries, for example, the presence of tax relief on mortgage payments, means it is rational to finance house purchases through borrowing while simultaneously accumulating savings deposits.

[86] The preparedness of investors to finance equity investment (particularly in privatization share issues) through bank credit is a further example.

[87] An alternative approach would however be to consider the demand over *net* assets only. This simplification however assumes that credit/loans are weakly separable from the other assets in the portfolio. Since there are plenty of *a priori* reasons for assuming that this separability is not valid we do not explore this option.

[88] This is simply the basic model of consumption of durable goods presented in Deaton and Muellbauer (1980b), Chapter 4.2.

no consumer goods,[89] there is an initial endowment of W_0, and that terminal wealth is zero. The (sub-) utility function is defined as

$$(4.6)\quad u = \nu(A_1;\ A_0, W_0)$$

and the period-by-period budget constraint as

$$(4.7)\quad W_t = W_{t-1}(1+r_t) + y_t - vd_t, \quad t = 0..2$$

where period 0 values are predetermined, W is total wealth, y is income, r the rate of interest (or discount), d, asset purchases, and v the "price" of the asset. We further assume that

$$(4.8)\quad A_t = d_t + (1-\delta)A_{t-1}$$

where δ is the rate of depreciation of the asset, A. Strictly, δ captures the change in the value of the asset A, and therefore includes not only physical deterioration, but also an revaluation (or devaluation) of the existing asset stock. Thus letting $W_2 + v_2A_2 = 0$ be the terminal wealth constraint, and substituting for d_t from (4.8) in the budget constraint, we can define the single budget constraint as

$$(4.9)\quad W_0(1+r_1) + y_1 - v_1[A_1 - (1-\delta)A_0] + y_2(1+r_2)^{-1} - v_2(1+r_2)^{-1}[-(1-\delta)A_1] = 0$$

which simplifies to

$$(4.10)\quad [v_1 - v_2(1-\delta)(1+r_2)^{-1}]A_1 = y_1 + y_2(1+r_2)^{-1} + W_0(1+r_1) + v_1(1-\delta)A_0$$

The left-hand side of the equation is simply the stock of the asset times the one-period rate of return, which consists of the one-period yield on the asset, plus the

[89] In other words, we assume that we are already operating at the lower level of a two-stage budget process.

discounted capital gain or loss. This simplification thus allows the problem to be treated as a simple neoclassical model of constrained optimization.

From an empirical perspective, however, the issue of durability may not be so easily solved. A number of problems arise. First, the presence of stocks of assets create strong inter-temporal links which impart significant persistence effects in the data. This has important implications for the dynamic specification of an empirical model (see below). Second, since certain assets are capital uncertain the expected rate of return must include the expected capital gain to holding the asset as well as its yield. Third, the asset accumulation process (especially for real assets) is asymmetric: whereas agents can choose to accumulate assets at any rate, the absence of perfect asset markets induces a "putty-clay" effect through which fixed capital, when installed, is sector specific. As a result, decumulation of assets is not possible beyond the rate of physical depreciation without active destruction of the capital stocks. Again, this asymmetry may impart biases into the estimates of the relative price elasticity of demand for assets. Moreover this form of selling constraint in markets for real assets, which may also flow from the presence of Akerlof-style informational constraints, may severely dampen the response of asset accumulation to changes in (capital-gain inclusive) changes in asset prices. However it may be noted that the severity of this effect may be offset somewhat in the current instance by the fact that the period under investigation is one where in aggregate the net capital stock has been non-decreasing through time.

Finally, the presence of liquidity constraints in the form of credit rationing provides further restrictions on the simple demand model described above. If agents are unable to borrow (i.e. accumulate a stock of credit) then they will be unable to alter their asset holdings as quickly in response to relative price changes as would have occurred in an un-rationed context. Thus in the face of credit rationing, the estimated relative price elasticities from an un-restricted demand share model may be biased.[90]

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[90] Note that the same form of argument holds for considerations of collateral requirements.

Credit to the private sector may be rationed for two main reasons. The first is the existence of aggregate and sectoral lending ceilings imposed on the financial sector by government, as were operated periodically in Kenya throughout this period (see Killick and Mwega (1990)). Second, is the existence of market-based credit rationing as described by Stiglitz and Weiss (1982). The evidence that rationing exists can be adduced in a number of ways, but even casually, the facts that though real interest rates on loans were negative throughout most of the period yet borrowing did not "explode", and the persistence of excess liquidity in the banking system, suggest that the rationing hypothesis may be valid. The plausible notion can be supported by more formal Granger causality tests for credit rationing (see Section 4.2 below).

Amending the Model for Credit Rationing

The basic Deaton-Muellbauer model has been used in its un-rationed form in all the above-cited papers. Since both Taylor and Clements (1983) and Barr and Cuthbertson (1991) consider the accumulation of only gross assets the issue of credit rationing did not arise, while Perraudin (1987) estimates the demand for credit explicitly within an un-rationed framework. Introducing rationing in the demand system does not, however, fundamentally alter the specification of the model (see Deaton (1981)), although the implications of the adjustment are important. If preferences can be assumed to be weakly separable over the rationed and un-rationed goods and the ration is binding, then the demand shares in (4.4) are unchanged save for the reduction in the total outlay available on the un-rationed goods.[91] However credit is not, in general, weakly separable from

[91] The standard analysis of this case proceeds by assuming that good 1 is rationed so that $q_1 = z$, where z is fixed, or at least pre-determined in the current period. Letting p^* and q^* denote the price and quantity vectors for the un-rationed goods the restricted cost function can be expressed as

$$c^*(u,p,z) = \min_{q} [p.q \ ; v(q_1,q^*) \geq u, \ q_1 = z]$$

$$= p_1 z + \min [p^*.q^*; v(z,q^*) \geq u]$$

Differentiating with respect to p_i generates the Hicksian demands the other assets in the portfolio. It is therefore necessary to introduce credit rationing more explicitly, and to do so we can follow Deaton's (1981) general model for rationed demands, which defines the cost function with one rationed good, z, as

$$(4.11)\quad ln\ c(u,p,z) = \alpha_0 + \Sigma\{\alpha_k + \eta_k z\} ln p_k + \tfrac{1}{2}\Sigma\Sigma\gamma^*_{kj}\ ln p_k ln p_j$$

$$+ \beta_0 \Pi p^{\beta k}_k \{u + \theta_0 z + \tfrac{1}{2}\theta_1 z^2 + \tfrac{1}{2}\theta_2 uz\}.$$

where θ_i are the parameters of the generalized restricted utility function.

The demand shares from this equation are then

$$(4.12)\quad s_i = \alpha_i + \eta_i z + \Sigma\gamma_{ij} ln p_j + \beta_i ln\{(x-p_0 z)/P\}$$

where

$$(4.13)\quad lnP = \alpha_0 + \Sigma\{\alpha_k + \eta_k z\} ln p_k + \tfrac{1}{2}\Sigma\Sigma\gamma_{ij} ln p_i ln p_j.$$

As before $\gamma_{ij} = \tfrac{1}{2}(\gamma^*_{ij} + \gamma^*_{ji})$, the adding up restriction $\Sigma\alpha_i = 1$, $\Sigma\gamma_{ij}=0$, $\Sigma\beta_i=0$, and, additionally, $\Sigma\eta_i = 0$. In this model, then, the effect of the ration is via the total expenditure effect as before, $(x-p_o z)$, but also in each share equation through the η_i term, and in *ln* P. Since we still employ a non-parametric index for *ln* P, so as to render the model linear in its parameters, this latter effect is however not explicit.

Finally, we adopt the suggestion of Barr and Cuthbertson (1991) by amending the model (4.12) by a flow-variable to indicate the expected volume of transactions per period (Barr and Cuthbertson (1991) p.858). The reason for doing so is that a model in which assets are modelled in terms solely of total

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(7) $\delta\ ln\ c^*(u,p,z)/\delta ln p_i = h_i^*(u,p^*,z)$

which, crucially, do not depend on the price of the rationed good, p_1.

wealth captures only the portfolio motives in the demand function. However since asset stocks also provide an intermediate input into the aggregate production function, it seems advisable to model the individual demand shares both in terms of their stock elasticity with respect to total wealth, and their flow elasticity with respect to aggregate demand. Thus the income elasticity of the demand shares will reflect the liquidity of each asset relative to the level of transactions in the goods market. Adding this term we get

$$(4.14) \quad s_i = \alpha_i + \eta_i z + \Sigma\gamma_{ij} ln p_j + \beta_i ln(Wz/P) + \delta_i ln y$$

where $ln(Wz/P)$ is the log of real rationed wealth and $ln y$ is the log of real total final expenditure as defined in Chapter 2.

The Barr and Cuthbertson approach to augmenting the wealth-based model with a term in income raises the issue of the reconciliation of this form of model in which monetary assets are modelled as a function of both wealth and income, with the single equation model of Chapter 2 in which no role was admitted for wealth. In addition it highlights the more general biases which may arise in the use of the demand share functional form. We shall discuss the question of the reconciliation between the two rival approaches for modelling broad money demand in section 4.6, but shall consider the functional form issue here.

If, as in the case of Chapter 2, we sought to estimate the demand for a single asset we would probably use a general log-linear functional form such as

$$(4.15) \quad ln a^*_i = \alpha_i + \Sigma\gamma_{ij} ln p_j + \beta_i ln w + \delta_i ln y.$$

where w is the real value of rationed wealth (Wz/P), and a^*_i is the nominal value of asset i.[92] To derive the price, income and wealth elasticities from the demand share formulation in (4.14), which expresses the nominal value of the asset as a share of total nominal wealth, we first multiply both sides of the equation by real wealth, as follows:

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[92] For convenience of exposition we exclude the ration term.

(4.16) $(Wz/P).(a_i/Wz) = a^*_i = \alpha_i w + \Sigma\gamma_{ij} w \ln p_j + \beta_i w \ln w + \delta_i w \ln y$.

Differentiating (4.16) we derive the price elasticities of demand as

(4.17) $E_{pij} = (\delta a^*_i/\delta p_j).p_j/a^*_j = \gamma_{ij}/s_i$,

the income, or transactions, elasticity as

(4.18) $E_y = \delta_i/s_i$,

and the wealth elasticity as

(4.19) $E_w = (\beta_i/s_i) + 1$.

Using this demand share functional form, the price and income terms are not separable from wealth, and thus if w is non-constant over the period the derived elasticities of demand will themselves be non-constant and may be dominated by movements in w. The model will thus be biased in favour of finding significant price effects. Only when the real value of rationed wealth is constant will the derived elasticities from the demand share model be equivalent to those from a log-linear demand function in which prices and income are estimated separably from wealth. It is clear therefore that the constancy of real wealth needs to be examined prior to estimation of the demand share model. In the case of the Kenyan data over the period of investigation, the real value of rationed wealth is relatively stable: the annual standard deviation of real wealth is approximately 6%, and throughout the period the series has never strayed further than 10% above or below its mean value. As a result, in this case modelling the demand for assets using either a log-linear functional form or a demand share form where assets are conditioned on wealth will generate the same elasticities in the long-run. In Appendix 4(A) we tabulate the long-run elasticities from the log-linear demand models (4.15), and plot the residuals from the preferred long-run specifications using the two approaches (the coefficients and residuals from the demand share model are those generated by the equations reported in Table 4.4(b) below). It is clear that there is no systematic deviation in the residuals from either functional form. We therefore use equation (4.14) as the basic model of the net asset portfolio demand, and specify the demand (share) for each asset, $s_{i,}$ in terms of its own price elasticity, γ_{ii}, all cross price elasticities, γ_{ij}, real wealth, β_i, liquidity δ_i and the movements in the quantity of rationed credit, η_i. [93]

Econometric Specification of the Model

The demand share model we use here can be broadly stated in the form:

(4.20) $\mathbf{A}(L)s_t = \mathbf{B}(L)\mathbf{X}_t + \epsilon_t \quad \epsilon_t \sim \text{IN}\,(\mathbf{0},\Sigma)$

where s is a (nx1) vector of asset shares, **X** is an (nxm) matrix of explanatory variables (real prices, income, wealth etc), and **A**(L) and **B**(L) are appropriately dimensioned polynomial coefficient matrices. Early demand system models tended to estimate the system in the static levels of the variables (ie **A**(L) = **A**(1), **B**(L) = **B**(1)), thereby admitting no dynamic adjustment process (see for example Taylor and Clements (1983)). It is clear however from the foregoing discussion that an adequate dynamic specification of the model is essential to capture at least some of the inter-temporal effects of durability. Anderson and Blundell (1982) consider the identification issues relevant to this form of singular equation system when dynamic adjustment is present. The general autoregressive distributed lag representation of the form (4.20) can be re-parameterized in a familiar manner (see Hendry (1989)) to yield an error-correction dynamic specification of the form

[93] There are however problems with the aggregation properties of the model if the ration affects agents differently. In particular if the rationing envisaged is of the Stiglitz & Weiss type, so that with sufficient collateral or security certain individuals are un-rationed (over a reasonable range), then the ration is not fully binding in aggregate. This situation is difficult to reconcile with a representative agent model, and for simplicity, in the estimation which follows we assume that the credit ration binds for the private sector as a whole (or in its representative agent form).

(4.21) $\Delta s_t = \mathbf{A(L)}\Delta s_{t-1} + \mathbf{B(L)}\Delta \mathbf{X}_t + \mathbf{C\Pi}_{t-1} + \mu_t, \quad \mu_t \sim \text{IN}\,(\mathbf{0},\boldsymbol{\Sigma})$

where s and **X** are as before, **C** is a (nxm) vector of coefficients and **Π** is the long-run solution to (4.20) defined as:

(4.22) $\mathbf{\Pi}_t = s_t - [\mathbf{A}^*(L)]^{-1}[\mathbf{B}^*(L)]\mathbf{X}_t.$

$\mathbf{A}^*(L)$ and $\mathbf{B}^*(L)$ are defined respectively as

$\mathbf{A}^*(L) = \mathbf{I} + \mathbf{A}_1 L + \mathbf{A}_2 L^2 + \ldots + \mathbf{A}_p L^p$s, and $\mathbf{B}^*(L) = \mathbf{I} + \mathbf{B}_1 L + \mathbf{B}_2 L^2 + \ldots \mathbf{B}_p L^p$s.

The presence of lagged dependent variables as regressors in (4.21) however means that not all the parameters of the singular system (ie the long-run and dynamic parameters) can be estimated (Anderson and Blundell (1982)). They can however be recovered by estimation of (4.21) subject to the deletion of the i-1th row of the lagged Δs vector and the error-correction vector, **Π**. The parameters on the deleted variable are then recovered through the adding-up conditions on the singular system.

As Barr and Cuthbertson (1991) note, however, direct estimation of (4.21) subject to the Anderson and Blundell caveats renders the search for an efficient data representation difficult, especially if at the same time we are interested in examining the long-run properties of the demand system. In this chapter, therefore, we try to avoid this problem by first investigating the structure of the long-run solution to the model, to test for cointegration between the demand shares and the explanatory variables. Subject to testing and the imposition of theory-based restrictions, the long-run solutions can then be incorporated in the general dynamic specification. This approach, which follows the Engle-Granger two-step procedure (1987) has, in principle, the advantage of identifying "super-consistent" estimates for the parameters of the long-run solution if cointegration exists[94], although the relatively small sample used here may mean that biases in the static Engle-Granger regression coefficients may be significant (see Banerjee *et al.* (1992)). On the basis of Monte Carlo evidence, Banerjee *et al* (1992) suggest as an alternative that the long-run solution be derived from the equivalent, but over-parameterized, dynamic representation. This latter approach is adopted here.[95] We therefore commence by examining the order of integration of the data and proceed to estimate the long-run relationships in the data using both the Engle-Granger (1987) static regression and more general dynamic cointegrating regressions. We then re-estimate the long run model using a systems estimator and sequentially impose restrictions on the coefficients to test the theory-based restrictions of symmetry, and homogeneity of the static, long-run, demand functions. The validity of the restrictions is tested using standard likelihood ratio statistics. Finally, having identified the long-run matrix and its restrictions these are built into the dynamic systems equations (4.21) through pre-defined error-correction terms, where **C** is now constrained to be a diagonal matrix. This implicitly imposes the restrictions which deny any cross-share disequilibrium feedback from the long-run solution in share s_i on the current demand for s_j. The decision to impose this condition was taken on the grounds of analytic tractability, although initial experimentation using a simplified structure indicated that in general the own error-correction effect significantly dominated the cross-effects. This restriction then reduces the number of parameters to be estimated, and allows the short run dynamics of the model to be examined in detail.

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[94] Stock (1987) demonstrates that if there is a cointegrating relationship between two variables then the estimated coefficient of the static cointegrating regression will converge to its true value more rapidly that under a standard OLS regression. In other words the regression will be "superconsistent".

[95] An alternative approach would be to employ the Johansen procedure. However it was found that the dimensions of the problem (the initial VAR would have 14 endogenous variables) rendered this approach very problematic.

4.2. The Distribution of Asset Holdings in Kenya

The salient features of the economic history of this period in Kenya were discussed in detail in Chapter 1. However for this analysis of asset substitution we need to recall a number of key features which may be expected to shape the results. The first are obviously the two coffee booms in 1976/7 and 1986. The first coffee boom generated a terms-of-trade gain to Kenya of approximately 24 per cent of GDP over its lifetime,[96] and was accompanied (with a lagged effect) by a growth in fixed capital formation (both tradable and non-tradable) which rose from 22 per cent of GDP in 1974 to 29 per cent in 1978,[97] and a surge in public sector employment towards the end of the coffee-boom period, this latter period being the period of the so-called "construction sector boom" in Kenya.

The 1986 boom was of shorter duration and lesser magnitude. The terms of trade rose by 20 per cent from 1985 to 1986, but by the next year had fallen below pre-boom levels. Moreover, unlike the earlier period, the 1986 boom occurred during a period of a relatively strong adjustment programme, and was not accompanied to the same extent as before by a surge in investment. Whereas gross domestic investment rose in the two years following the first coffee boom by 35 per cent and 24 per cent respectively, the corresponding growth in 1987 and 1988 was 16 per cent and 9 per cent respectively.

The second feature has been the continued programmes of economic reforms instituted (with various degrees of rigour) during the period under examination. Of particular note are the programmes of trade and financial liberalization which accompanied the ongoing World Bank and IMF supported stabilization and adjustment programmes. Thus from 1982 to 1984 a series of

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[96] Bevan *et al.* (1990, Chapter 5.)

[97] Estimated by Bevan Collier and Gunning (1990) to be approximately 4% of GDP above "counterfactual" investment levels in 1978. Note that because of the rapid rise in non-tradable capital prices over the period, the *ex post* real capital stock increase was lower than *ex ante* nominal investment would indicate.

attempts were introduced to liberalize trade restrictions,[98] initially through removal of QRs, and subsequently through general tariff reductions.

Following initial liberalization during the 1976/77 boom years, the economic down-turn saw trade policy tightened again (see Bevan *et al*'s (1990) discussion of endogenous trade policy). IMF supported attempts commenced in 1980 to reduce tariff rates, liberalize licensing and replace certain quantitative restrictions (QRs) with tariffs, but this liberalization episode was not sustainable, and tariff rates rose again. Fresh liberalization attempts in 1982 and 1983 were more successful, and by late 1983 tariffs had been reduced to 1981 rates again. Trade liberalization and domestic price liberalization continued throughout the latter half of the decade under the auspices of the 1986 World Bank Agricultural Credit and IMF Structural Adjustment Facilities in 1988 and 1989. These later reforms have met with more success, but since they occurred after the end of the period under investigation, they shall not be discussed in this chapter.

Liberalization in the financial sector has proceeded gradually over the period, although progress has accelerated somewhat since 1986, leading to the eventual removal of all interest rate controls by mid-1991. In general domestic real interest rates became less negative over the period (becoming *ex post* positive in the late-1980s), while financial deepening increased, principally as a result of the rapid growth throughout the period in the activities of the Non-Bank Financial Institutions (NBFIs).[99]

Nonetheless, however, as in many developing countries, the access of the private sector to financial assets has been limited by the thinness of financial markets, high transactions costs, and extensive market regulation, the most obvious forms of which were (until the late 1980s), the repression of nominal interest rates (for both deposits and loans), and the proscription on holding foreign financial assets by parties other than the Central Bank of Kenya.[100]

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[98] See Bevan *et al* (1991, Chapter 5) and Mosley *et al* (1991 Chapter 10).

[99] See Killick and Mwega (1990) for a discussion of the NBFIs in Kenya.

[100] Commercial Banks are allowed to hold small foreign exchange balances to facilitate authorised exchange transactions with the private sector.

The most liquid assets are obviously cash and non-interest-bearing money. Other financial assets, which are slightly longer-term in nature and consequently less liquid, are available to domestic investors, the most common being the interest-bearing deposits with the banking system (commercial banks and non-bank financial institutions (NBFIs)). Beyond this however, the range of financial assets is limited. The capital and government bond markets, are dominated by the Central Bank and other public-sector institutions, with the private sector holding on average only 7 per cent of total stock over the period from 1973 to 1989, although this mean value masks a steady decline in the private sector's share from around 15 per cent in 1975 to only 4 per cent in 1986.[101] There is virtually no secondary trading in government paper, and the bulk of the debt issued by the Government is held by the initial purchaser (the biggest of whom is the National Social Security Fund) until maturity. The result of this lack of secondary market trade means that though government stock is, *de jure*, a liquid, capital-uncertain asset, *de facto* it is more like a fixed-term, capital-certain asset, but of a correspondingly lower liquidity.

The equity market is similarly limited. Market capitalization has averaged only marginally over 2 per cent of GDP throughout the 1980s (although there has been some increase since 1986 following the decision by the three main commercial banks, Barclays, Standard Chartered and the Kenya Commercial Bank to issue equity through the Nairobi Stock Exchange). Turnover in the market is, however, virtually non-existent, representing only approximately 0.1 per cent of capitalization.[102] Financial asset holding are thus confined principally to cash and interest-bearing deposits as well as to an unspecified volume of illegal cash and foreign exchange holdings.[103] On the liability side, the only widely

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[101] Although there has been some reduction in the real value of government stock in the hands of the non-bank private sector, the major reason for the fall in this share is due to the dramatic increase in government debt financing directly from the Central Bank which increased its share of total issued stock from only 4% in 1973 to almost 40% by 1986.

[102] IFC Emerging Markets Yearbook (1991).

[103] We noted in Chapter 2 that though there is a discernable currency substitution effect detectable in terms of the demand for money study, the magnitude of the effect is relatively small. Since it is not possible accurately to assess either stocks or flows of illegal foreign currency in Kenya we are obliged to exclude this asset from the analysis in this Chapter.

available debt instrument available to the private sector is floating and fixed term lending from the commercial banks and the NBFIs. Again there is, in general, no access to the foreign debt market for the domestic private sector.[104]

Agents however also hold real assets. In the light of the theoretical implications of the trade-shock literature, we decompose total real asset holdings of the private sector into three principal components. Fixed capital accumulation is classified into tradeable capital (ie exportable or, more commonly, importable capital goods), consisting principally of plant, machinery and machine tools and transport-related capital goods, and non-tradeable capital. The latter consists almost entirely of land and buildings, and is what Bevan *et al.* (1990) refer to as the output of the "construction sector". The third component of real asset accumulation is inventory accumulation, which though principally a working-capital item may also be profitably examined within an asset framework as discussed above (see Calvo (1988) and Dixit (1989)).

We therefore define the wealth portfolio to consist of a total of six assets. Initially, however, we had decomposed total private sector financial wealth into 5 assets and 2 liabilities, namely, notes and coin; non-interest bearing deposits with the commercial banks; deposits with the commercial banking sector; deposits with the NBFIs and other financial institutions; and private sector holdings of government securities. The financial liabilities of the non-bank private sector are loans and advances from the commercial banking sector, and from the NBFIs. However due to the almost perfect collinearity between the rates of return on different classes of deposit (because of the administration of interest rates) it has proven difficult (and uninformative) to attempt to estimate a model at this level of disaggregation.[105] We were therefore obliged to aggregate over the private sector's net assets with the domestic banking system by combining all total private

[104] A significant inflow of private sector foreign capital does exist, although this is concentrated in the hands of multi-national corporations.

[105] This arises because it has only been possible to use the data on deposit interest rates with various institutions as reported by the Central Bank of Kenya. These consist of only the maximum allowable deposit rate. In reality the use of commission and other charges has allowed commercial banks, and especially the NBFIs to vary their lending and deposit rates outside the officially reported values. It has not however been possible to secure these data.

sector deposits with the banking sector and have constructed an appropriate weighted price index for the aggregate (see below). For the same reason we also aggregate over total loans and advances to the private sector from the banking system. Our estimated model thus consists of 3 financial assets (notes and coin in circulation (denoted NC), private sector deposits with the banking system (D) and government stock held by the non-bank private sector(GS)), one financial liability (TL), and three real assets. The real assets are: traded capital (defined as manufacturing and transport equipment and denoted TK); non-traded capital (principally construction, denoted NTK);[106] and manufactured inventories (I). Details of the construction of the stock and flow data and the calculation of the rate of return on each asset is deferred to Section 4.3, while here we confine attention to the main trends in the data. Table 4.1 reports summary statistics on the shares of each asset (where the share of asset X is denoted sX), while Figures 4.1(a) to (h) plot (the log of) total rationed wealth, the individual asset shares as a proportion of the total non-rationed expenditure, and (log) real income. In each case the asset share is reported as a proportion of total net wealth, where liabilities are recorded as negative assets.

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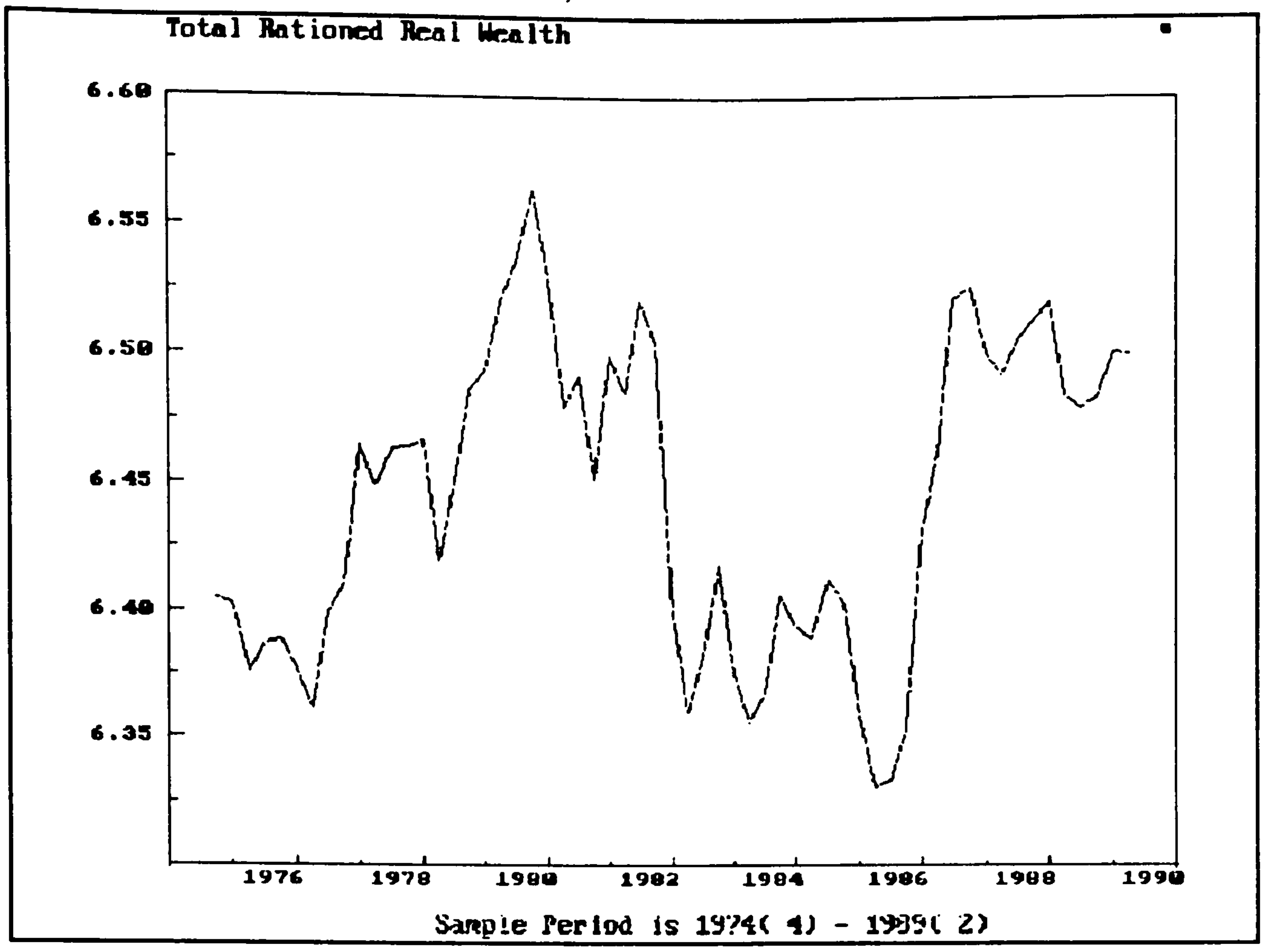
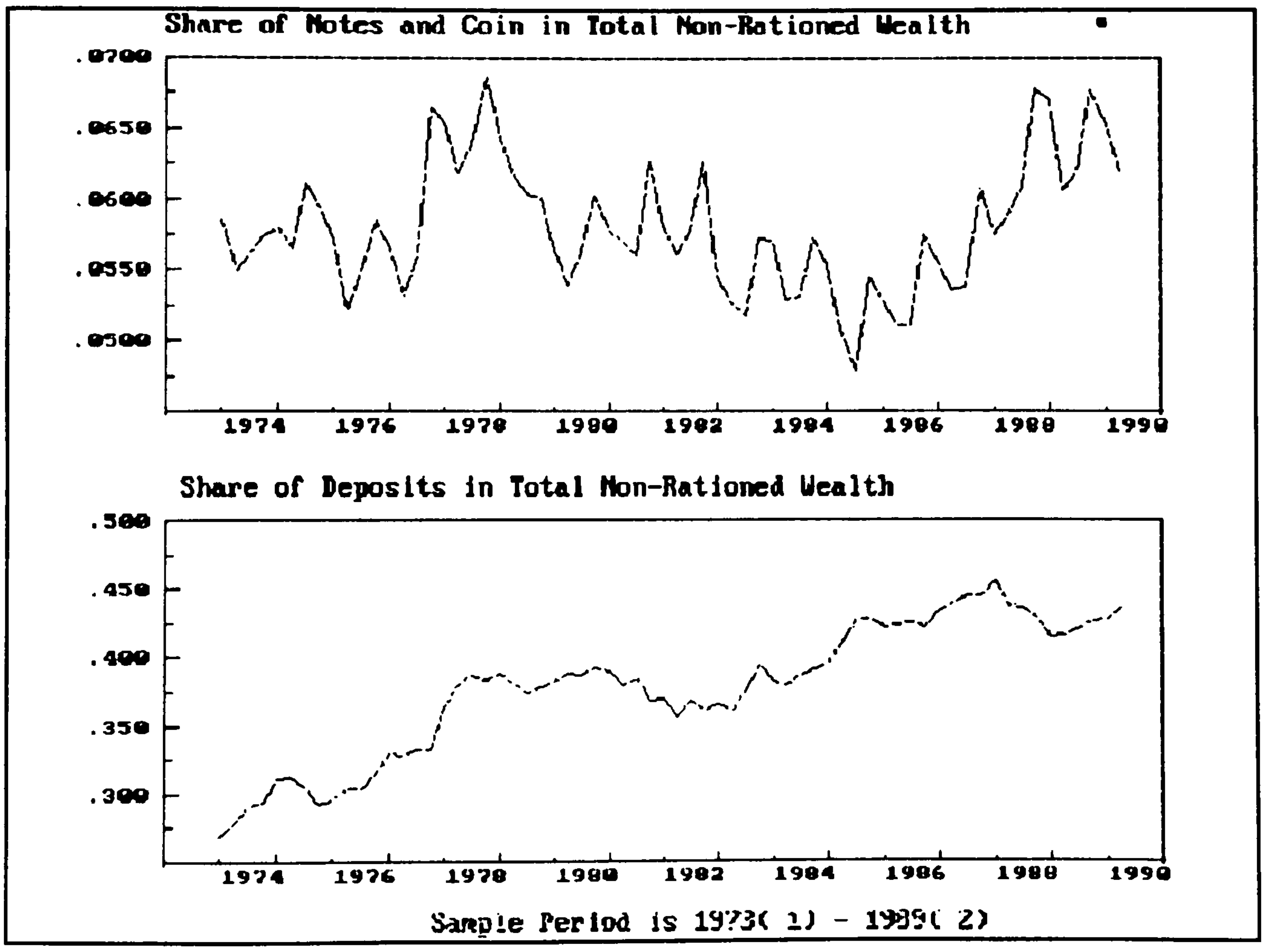
[106] As shall be discussed in the next section defining the variables this figure is based only on formal, "registered" construction activities and therefore excludes the real value of the stock of dwellings in the non-monetary economy.

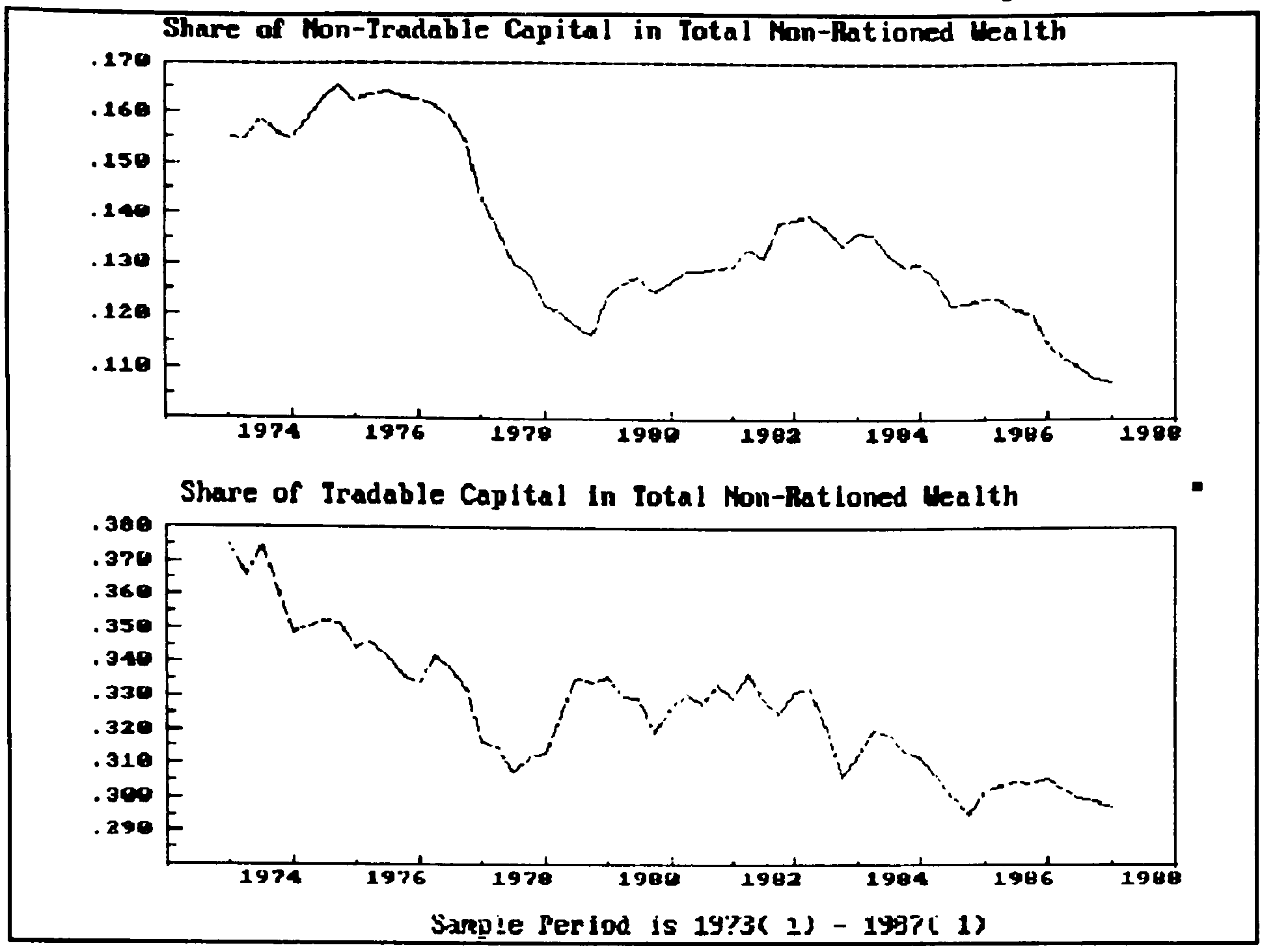
Figure 4.1(a)
Total (Rationed) Private Sector Wealth



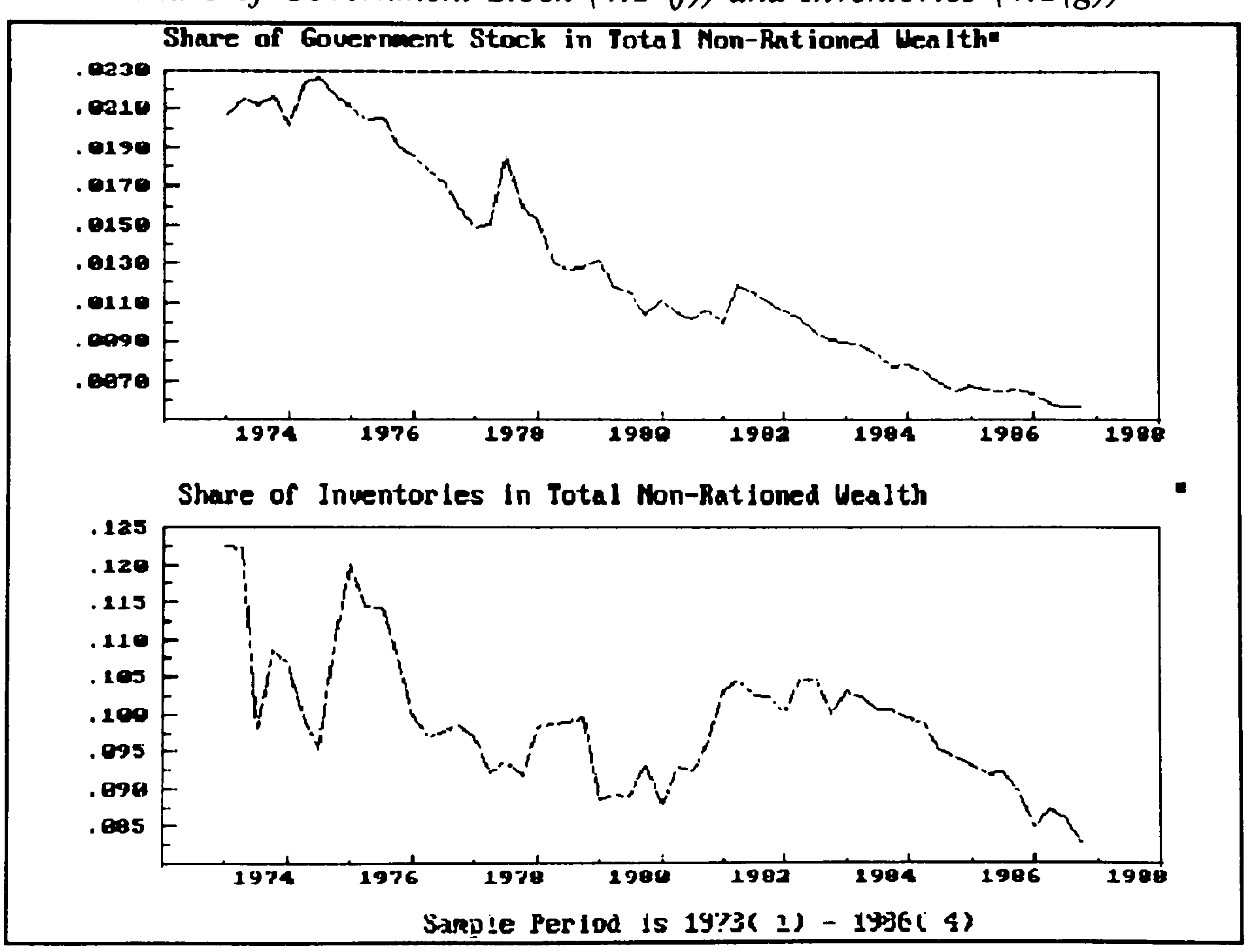
(b) Share of Notes and Coin (4.1(b)) and Deposits (4.1(c))



Share of Non-Tradable Capital (4.1 (d)) and Tradable Capital (4.1(e))



Share of Government Stock (4.1 (f)) and Inventories (4.1(g))



4.1 (h) (Log) Real Income

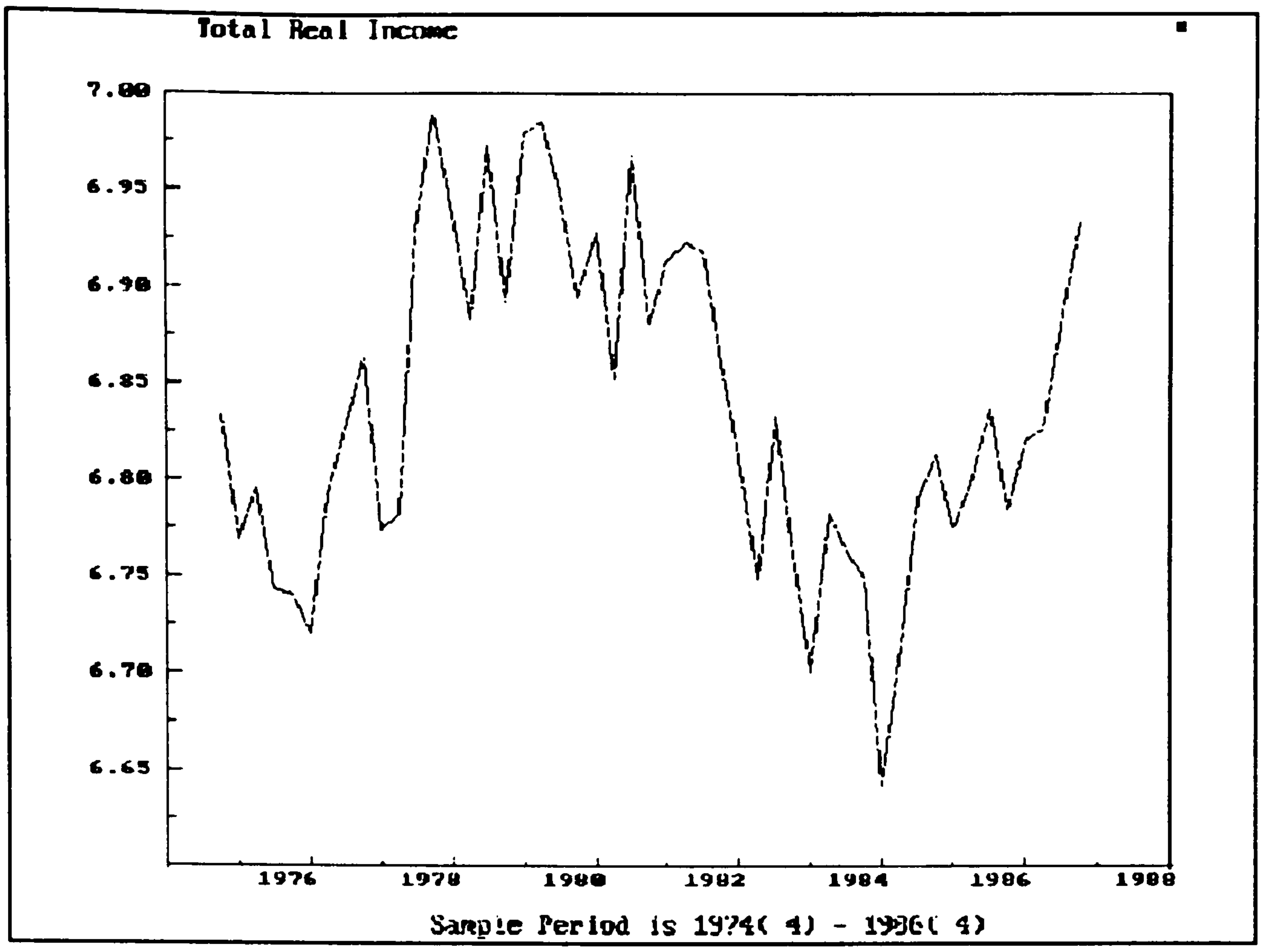


Table 4.1
Asset and Liability Shares and Descriptive Statistics

Share	Mean	Min	Max	Std.Dev.
sNC	0.0805	0.0665	0.0928	0.0063
sD	0.5231	0.3216	0.6758	0.0929
sTL	-0.4125	-0.1989	-0.5582	0.0916
sGS	0.0178	0.0085	0.0303	0.0063
sNTK	0.1919	0.1628	0.2215	0.0157
sTK	0.4601	0.4106	0.4984	0.0186
sTI	0.1391	0.1205	0.1583	0.0103

Note: (1) All data are quarterly. (2) $\Sigma s_i = 1$.

The wealth portfolio is clearly dominated by real assets, principally fixed capital which combined account for 65 per cent of total wealth. Net claims on the banking sector account for 11 per cent on average, and claims on the government in terms of base money and government stock for approximately 10 per cent of wealth. The balance is held in terms of inventories of manufactured goods. Movements in the asset shares over time are, as expected, relatively small with the average standard deviation per quarter ranging between 1 per cent and 2 per cent of the total stock.

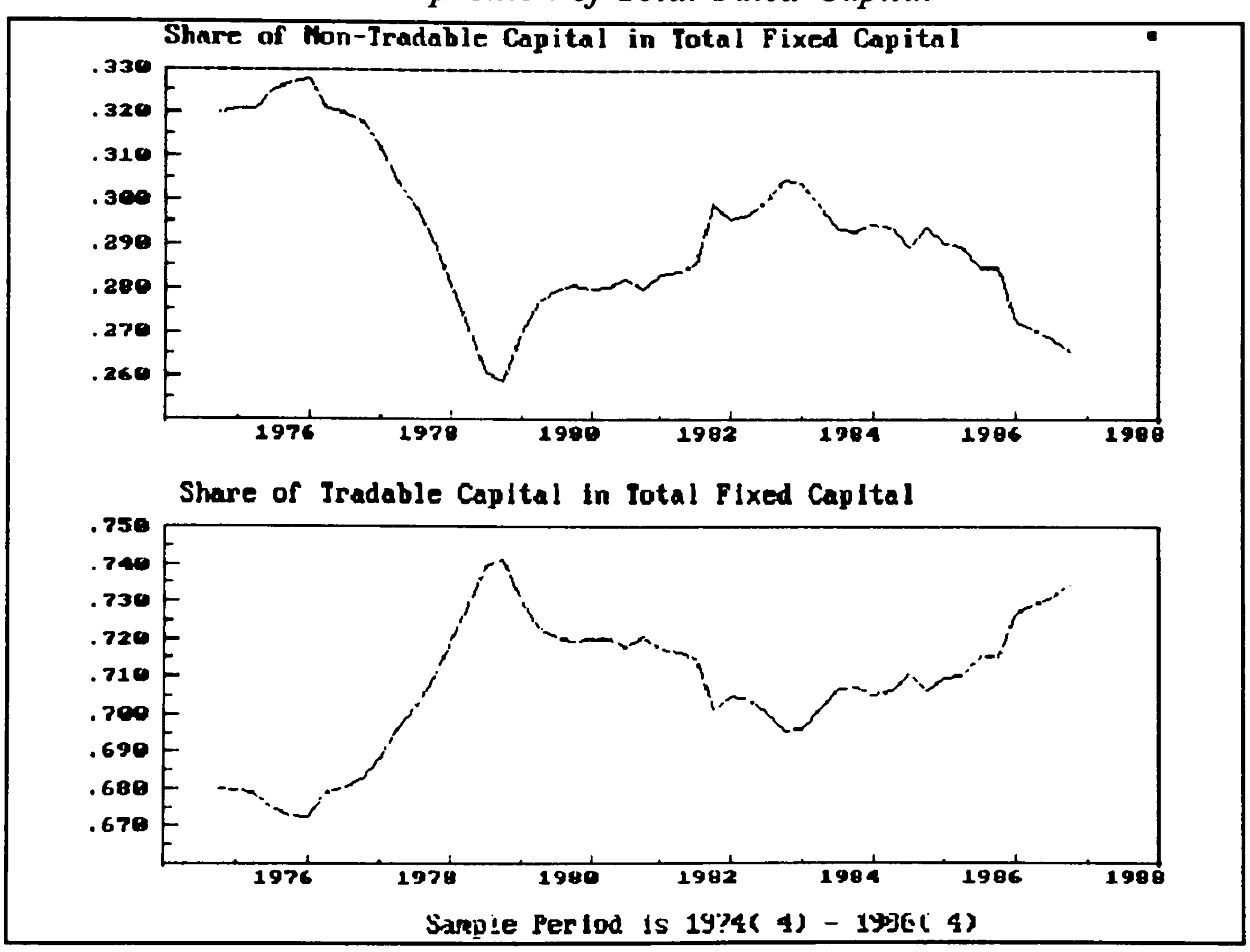
Net financial assets account for approximately 21 per cent of the total net asset stock. Over the period however there has been a discernable pro-cyclical shift from real to financial assets. This is particularly marked at the onset of the two temporary trade shocks where instantaneous asset accumulation occurs almost exclusively through holdings of inside and outside financial assets, which are only gradually dissipated as agents return to their portfolio balance. As income rises the short run effect has been a relative shift out of real capital and inventories into financial assets in the short run, followed later by a movement back into real assets. However there has, in addition, been a trend increase in financial assets over the period with holdings of net financial assets rising from around 20 per cent of the total in 1974 to 25 per cent by the end of the period. Excluding the period of the first coffee boom, this growth has been accounted for principally by the rise in net interest-bearing assets, and within this most of the growth came from deposits with the NBFIs, which rose from around 15 per cent of all deposits in 1973 to almost 52 per cent by 1986.[107] The growth of the NBFIs owes much to two factors. The first was the encouragement by government of the growth of indigenous African financial institutions which, though generally under-capitalized, rapidly acquired a large share of the market. From 1976 onwards the NBFIs became increasingly important deposit-takers, although this dramatic

[107] Killick & Mwega (1990) discuss the growth of the NBFI sector in some detail. In particular they note "On paper, the institutions in question appear to be constituted as merchant or investment banks...We understand, however, than in practice they operate at least as much at the short end of the market as the banks, taking deposits and making loans..." [p13]. Moreover, the 1989 Banking Act further brings the NBFIs within the supervisory ambit of the Central Bank of Kenya, thereby further reducing the distinction between commercial banks and NBFIs.

growth slowed markedly in the late 1980s following the collapse of a significant number of institutions. Recent moves to recapitalize the NBFIs has led to their rehabilitation. The second fact determining the growth of the sector was its successful evasion of regulation and particular of IMF-supported ceilings on domestic credit expansion imposed on the commercial banking sector. As a result not only did the volume of intermediation through the NBFIs increase, but their numbers also proliferated as the commercial banks acquired NBFIs so as to maintain lending to the private sector.

The relative split between stocks of tradeable and non-tradable capital has remained virtually constant over the entire period, although the dynamics of capital accumulation vary substantially, especially over the period of the coffee boom (Figure 4.2).

Figure 4.2
Decomposition of Total Fixed Capital



Tradable capital formation increased rapidly during the period of the boom, while non-tradable accumulation was slightly slower, but more long-lived, partly as a result of the lower elasticity of supply associated with capital formation in the construction sector.[108] However over the period of the boom and its immediate aftermath, from 1977 to 1981, the real value of the private sector non-traded capital stock increased by 22 per cent as opposed to the tradable capital stock where the increase was approximately 17 per cent.

As Figure 4.1(a) indicates, although real (rationed) asset accumulation is broadly constant over the period and there is no discernable trend in the series, there is a clear boom-bust-boom cycle. Total real asset accumulation rose rapidly in 1976 and 1977, and although it faltered slightly in 1978, a second, and more prolonged growth in accumulation occurred from 1979 to 1982. Asset accumulation fell off sharply during the 1982 to 1986 period of adjustment, but by the end of the period had begun to increase again in response to the 1986 coffee boom.

Construction of Data Series[109]

In order to estimate the demand for assets we must first define the relevant price and quantity vectors. Consider the one-period sub-utility function[110] defined over the real value of financial assets as:

(4.22) $u = u[a^*_{1t}, a^*_{2t}\ a^*_{3t}, \ldots a^*_{nt}]$.

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[108] This effect is compounded by the fact that the series used for the stock of non-tradable capital was constructed on the basis *inter alia* of data on the flow of reported building completions. This imported bias in the stock data however has not been adjusted.

[109] All data are presented in Table A4.2 in Appendix 4(D).

[110] That is the utility function applicable to the second stage of the two-stage budgeting process.

This utility function is identical to that defined in (4.6), except that here we have disaggregated A_t into its portfolio constituents. a^{*}_{it}, the real asset value, can be defined as

$$(4.23) \quad a^{*}_{it} = p_{it}a_{it}$$

where a_{it} is the nominal value of the asset (see below), p_{it} is the inverse of the real one-period expected rate of return to holding the asset i, defined as

$$(4.24) \quad p_{it} = [(1+r_{it})/(1+g_{it})]^{-1}.$$

The expected nominal return (including any expected capital gain) on asset i over the period is denoted r_{it}, and g_{it} is the expected rate of inflation appropriate to the asset.[111] p_{it} is thus the real "rental price equivalent" of asset i. Note that in the model we have maintained the consistency with consumer theory by using the inverse of the rate of return for each asset as its "price". Thus when it comes to interpretation of the results, for example, a rise in the rate of interest on deposits represents a fall in the price of deposits.

Given the relatively collinear behaviour of asset prices in general, we follow Deaton and Muellbauer and proxy the price (4.13) by:

$$(4.25) \quad \ln P = \Sigma s_i \ln p_{it}$$

The Definition of Asset Stocks

Data on the stocks of financial assets are readily obtained from monetary sector data published by the Central Bank of Kenya, and these data have been discussed extensively in Chapter 2. The construction of the data series for real assets is, however, more complex, and involves a possibly arbitrary process of

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[111] In defining these series we are obliged to proxy g_{it} by the rate of consumer price inflation for all assets, g_t.

decomposition of the total fixed capital stock into tradable and non-tradable components. In each case the nominal value of the stock of real assets is defined as

$$(4.26) \quad a_{it} = 1/p_k[(1-\rho)a^*_{t-1} + k_t]$$

where k is the current period physical investment in the capital stock, ρ the rate of physical depreciation of the existing real capital stock, a^*_{t-1} and p_k is the current price of capital. (4.26) thus defines the current period nominal value of the stock of asset i inclusive of revaluation. While flow data are generally widely available on capital formation, stock data is less common, and the three series for tradable and non-tradable stock as follows.

Private sector non-tradable capital stock accumulation consists principally of commercial and residential buildings. The stock data was therefore constructed from official quarterly data on (marketed) private sector buildings completions reported to the Nairobi and other municipal councils (see Data Appendix 4(D)). An initial value for the non-tradable capital stock in 1973 was obtained from a Government of Kenya/World Bank estimate,[112] and the series was computed using an annual depreciation rate of 4 per cent. Revaluations of the non-tradable capital stock were computed using a Property Value Index (PVI).[113] The final series was then compared to, and found to be consistent with, the independent Government/World Bank estimate of the non-tradable capital stock for 1986.

The tradable capital stock series was constructed in a similar manner. Starting from the decomposition of total tradable capital into public sector and private sector by Bevan *et al* (1990b), the quarterly series was then constructed using data on imported manufactures and transport equipment for the imported component of the capital stock, and quarterly industrial production data for the

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[112] Kenya: Industrial Sector Policies for Investment and Export Growth. World Bank Report 6711-KE (1987).

[113] This was computed from data on property values per square foot published in the Kenyan Statistical Digest. The index was then weighted to account for differences in Nairobi building values and those in the other Municipalities.

domestic production. To avoid double-counting with inventories, data the value of stocks reported in the Business Expectations Enquiry (see below) were netted out from this data. As with non-tradable capital, the data series was scaled against the Government of Kenya/World Bank capital stock estimate, and was found to be consistent when a physical depreciation rate of 8% per annum was imposed.

Finally, the stock of inventories (in the manufacturing and commerce sectors) is derived from the Kenyan Business Expectations Enquiry (BEE), a survey-based analysis of sales, employment and investment data. The BEE, dates from 1973 and based on a regular survey of 1400 firms in the private sector. The sample represents all firms employing more than 50 persons and a 25 per cent systematic sample of firms employing 20-49 persons. Firms employing less than 20 persons are excluded from the coverage. Data are collected quarterly, principally at ISIC division level, and response rates over the period have averaged 80 per cent of total survey requests. Missing data are interpolated by the Central Bureau of Statistics for non-responding firms. The data are, however, not exact analogues of the usual economic interpretation of the terms, especially for inventories which includes both finished goods and work-in-progress. This will systematically overstate inventory accumulation.

Rates of Return

For each asset a total quarterly rate of return is constructed in terms of (4.24). For nominally capital-certain assets, namely notes and coin and interest-bearing deposits the rate of return is simply the one period interest rate. For capital-uncertain assets a measure of the expected capital gain is required. The nominal rates of return are defined as follows:

(i) Notes and Coin

Notes and coin do not earn interest and therefore their nominal rate of return is zero. The real price of this asset is simply the inverse of the domestic inflation rate, taken to be the quarterly growth in the consumer price index. Although, as noted in Chapter 2, the CPI is the only quarterly price index published for Kenya, there are considerable problems with its use as the appropriate deflator for this demand share model. While the CPI was justifiable in the case of the demand for money, where the transactions motive dominates all but the broadest aggregates, its deficiencies are more clearly highlighted in the asset model where the "ideal" price index would be an index of expenditure defined over both current consumption and investment. There is thus a bias in the use of the CPI to the extent that it fails to reflect movements in the general price of non-consumption goods.

(ii) Interest-Bearing Deposits

Since we have aggregated all deposit accounts with the banking sector, the (quarterly) nominal rate of return on total deposit account assets at the margin is a weighted rate of return defined as

$$(4.27) \quad (1+r_{Dq})_t = \Sigma d_i rdq_i$$

where d_i is the share of the ith class of deposit in total deposits, and rdq_i the rate of interest on that class. We consider three classes of deposits: demand deposits with the commercial banks; savings deposits with the commercial banks; and deposits with the NBFIs. The interest rates used are the official rates published by the central bank.

Capital-Uncertain Assets

In calculating the rate of return on capital-uncertain assets we must define the point at which the capital gain is realized, and also the basis upon which the current yield is calculated. Here we assume that the yield is calculated on the start-of-period value of the asset, and the capital gain on the change in the value of the asset over the period. Finally we assume that the total one period rate of return is additive and is of the form:

$$(4.28)\ (1+r)_t = [(1+x)_t + (1+\Delta y)_{t+1} - 1]$$

where x is the rate of interest based on the beginning of period value of the asset, and Δy_{t+1} the *ex post* actual change in the value of the asset between the beginning and end of the period. This method clearly creates endogeneity problems for the price series since the current price of the asset is simultaneously determined by the value, which may be a function of the demand. It may be possible to avoid this problem by proxying the expectations process using a generalised VAR (see previous chapter and the discussion on forward-looking models of money demand). An alternative approach is to re-estimate the model allowing for the endogeneity of prices by using an Instrumental Variable estimator. Prior to estimating the full model we tested for this form of simultaneity in the demand-share equations for the real assets using a Generalized Instrumental Variable Estimator in which the rates of return on capital-uncertain assets were assumed to be endogenous. The results did not differ substantially from those reported below.

(iii) Government Stock

As noted above, though government bonds are *de jure* capital uncertain, they retain, *de facto*, a degree of apparent capital certainty. Consequently we examined the model using two alternative scenarios for the determination of the rate of return on Government stock. The first treated the asset as capital certain and thus the rate of return was defined solely in terms of the average yield on stock as calculated by the Bank of Kenya. The second assumed that the limited secondary market in government bonds on the Nairobi Stock Exchange was active, and the *ex post* actual change in the NSE index was used to proxy the expected capital gain to holding government stock. In the results reported below it is this latter, possibly too volatile, series which is used. It is defined as follows:

$$(4.29)\ (1+r_{gsq}) = [(1+i_{gsq}) + (1+\Delta NSE) - 1]$$

where NSE is the Nairobi Stock Exchange share index.

(iv) Traded Capital

The rate of return on traded capital has two components. The first is the real yield as measured by the current period marginal efficiency of investment. The second is the expected capital gain and is proxied by the actual change in the real traded capital price deflator. The total rate of return is defined as

$$(4.30)\ (1+r_{TKq})_t = [(1+\lambda*0.25)_t+(1+\Delta p_k)_{t+1}\ -1].$$

where λ is the annual marginal efficiency of investment,[114] and Δp_k, the nominal expected capital gain, is measured by the one period change in the price deflator for tradable capital defined by Bevan *et al* (1990b).

(v) Non-Traded Capital

The current rate of return on non-traded capital is the sum of the rental rate plus the capital gain. The rental rate is constructed by taking the real rate of return as at end-1977[115] (3 per cent per annum = 0.75 per cent per quarter) and extrapolating forwards and backwards using the change in the rental cost index relative to the building cost index. In other words if the rental index is rising faster than the cost of replacement of buildings then the implicit rental of return is increasing and vice versa. The capital gain is defined as the change in the property value index, as discussed above. The final expression for the rate of return on non-traded capital is thus:

$$(4.31)\ (1+r_{NTKq})_t = \{[1.0075*((1+\Delta(RCI/BCI)_t)]+[(1+\Delta PVI_{t+1}]-1\}$$

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[114] The marginal efficiency of investment is calculated as $\delta \log Y/\delta \log K$, where Y is real GDP and K is net traded capital stock. This real rate of return is then adjusted for the difference between the CPI and the gross traded fixed capital deflator to express the rate of return in terms of consumption prices.

[115] The rental cost index is built up from the survey of rents published in the 1982 Kenya Statistical Digest for the period from 1977 to 1981.

where RCI is the rental cost index, BCI the building cost index, and BVI the building value index (see Data Appendix, 4(D)).

(vi) Inventories

Most work on inventories considers the problem in terms of a production-smoothing model. Inventories are also used for hedging purposes and to facilitate inter-temporal substitution of production and consumption. It is this latter context which we consider here, and thus the one period rate of return on such inventories is the expected capital gain (ie the rise in the market price for the goods between the beginning and end of the period) less the working capital costs of holding the inventories (equal to the overdraft or lending rate). We can assume that storage costs are negligible, or at least constant, and hence the rate of return on inventories can be defined as

$$(4.32)\ (1+r_{lq})_t \ = [(1+cg)_{t+1}-(1+rlq)_t+1]$$

Ideally the capital gain would be defined in terms of the local price index for the composite basket of inventories (principally manufactures). This price would represent a c.i.f. price. Unfortunately no such series exists at a quarterly frequency. An alternative is to use an exchange rate-adjusted import unit value series. We therefore use the industrialised countries export unit value series published in the IMF's International Financial Statistics adjusted for the official US$/Ksh exchange rate. This series is however an f.o.b series, and will fail to pick up accurately the effect of changes in the tariff regime. Though clearly important we cannot hope to tackle this issue at present.

Credit Rationing

Before the final model is estimated, however, we briefly return to the issue of credit rationing to test the hypothesis that the private sector is rationed in the credit market. Killick and Mwega (1990) examine the extent of crowding out of credit to the private sector, concluding that pre-emption by public and parastatal sectors within agreed credit ceilings has rationed the extent of credit to the private sector. We can support this evidence by testing one the principal implication of credit rationing, namely that the interest elasticity of demand for credit is zero, since if the private sector's access to credit is rationed, then a marginal change in the cost of credit will have no impact on the demand. We test this hypothesis by using a series of Granger non-causality tests to evaluate the marginal significance of the commercial bank lending rate on total lending to the private sector. We conduct these tests using sixth-order autoregressive and distributed lag processes to allow for lagged effects. The tests are run using: (i) the nominal value of the two variables; (ii) their real values; and (iii) the first difference in both nominal and real terms. The results are presented in the Table 4.2

Table 4.2
Granger-Causality Test for the Marginal Significance of Interest Rates on Lending to the Private Sector

Dependent Variable	Explanatory Variable	Granger Non-Causality Test
TL	(1+RLQ)	$F(7,36) = 0.31$
tl	(1+rlq)	$F(7,35) = 1.75$
ΔTL	Δ(1+RLQ)	$F(7,35) = 0.16$
Δtl	Δ(1+rlq)	$F(7,34) = 1.71$

Key: TL = total lending to private sector; RLQ = quarterly lending rate; lower case denotes real values. The 5% critical value for $F(7,35) = 2.30$.

The null that the interest rate has no marginal significance in the determination of the level or change in lending either in nominal or real terms cannot be rejected. An alternative test of the hypothesis consists in estimating an un-rationed version of the demand share model and include the share of credit as a separate (negative) asset. The full model is not be reported but we again cannot reject the null that the own-price effect nor any of the cross price effects in the equation (in terms of the rate of return on other financial or real assets) are significant. The only significant determinants of the share of total liabilities are the constant and time trend. Although it is clearly possible to examine this issue further by using a more robustly-specified model of the determinants of credit to the private sector, this is beyond the scope of this chapter. For the present we cannot conclude that there is no rationing in the credit market, and, given the evidence provided by Killick and Mwega (1990), this allows us to proceed to estimate a model of the form (4.14) above.

4.3 Cointegration and the Long-Run Solution

Though this model framework provides a valid theoretical structure for examining demand behaviour, the asset shares plotted in Figure 4.1 indicate that the principal data series in the model are probably non-stationary, and consequently standard asymptotic estimation theory may not be satisfactory, since the demand share model requires to be estimated within a stationary stochastic model. However if the variables are cointegrated then the residuals from the long-run relationship (which define the deviation from the long-run relationships) will be stationary and can be combined in the dynamic demand system. It is therefore necessary to examine the time-series nature of the data before we proceed with the full estimation of the model, so as to test for cointegrating relationships which may exist between the variables, and to transform the model appropriately into a stationary form. Table 4.3 reports the results of three unit root tests, the Sargan-Bhargava Durbin Watson (SBDW) test, the Dickey Fuller (DF) and a sixth-order Augmented Dickey-Fuller (ADF(6)) test.

Table 4.3
Unit Root Tests for Demand Share Model Data

Series	SBDW	DF 't'	ADF(6) 't'	Longest. Sig.Lag	Order of Integ.
sNC	0.656	-3.31	-2.38	4	I(1)
sD	0.043	-1.29	-1.64	-	I(1)
sGS	0.033	-2.01	-2.60	3	I(1)
sNTK	0.044	-1.23	-2.25	1	I(1)
sTK	0.115	-1.55	-1.56	-	I(1)
sI	0.403	-2.18	-1.62	-	I(1)
LpNC	1.056	-4.58	-2.22	-	I(0)
LpD	1.325	-5.27	-3.30	4	I(0)
LpNTK	0.822	-7.22	-4.85	6	I(0)
LpTK	0.374	-2.39	-3.53	2	I(0)
LpTI	2.371	-8.93	-3.07	-	I(0)
Lwz	0.233	-1.98	-2.11	2	I(1)
Ly	0.371	-2.23	-1.53	4	I(1)
z	0.005	-1.18	-1.63	-	I(1)

Notes: DW, ADF and ADF tests described in Chapter 2.
Critical Values where T=50 for rejecting the null of I(1) under the DF and ADF tests is -2.93; critical value for rejecting the null of I(0) under the Sargan-Bhargava DW test is 0.78.

Considerable problems exist with this form of unit root testing, for two reasons. The first concerns the prevalence of small-sample biases in the tests. Monte Carlo analysis by Banerjee *et al.* (1986), (1992) suggest that such biases in both tests can be significant in small sample models, and this likelihood is exacerbated in the current instance by the presence in the sample of a large, temporary (and thus "stationary") shock to the economy. Given that this shock is the dominant feature of the data, it is likely to result in too high a probability that we reject non-stationarity in the data, and we therefore interpret these statistics in that knowledge. Secondly there is a more fundamental statistical problem arising from the fact that these series are strictly bounded, and, at least in the region of the upper and lower bounds, will not have the properties of an I(1) series defined under the null in the ADF tests. With the exception of the sGS variable however none of the series approach the bound, and thus, at least over the sample, it may be a reasonable approximation to test their order of integration against the null of a genuine random walk model.[116]

However, these problems notwithstanding, the data seem to describe a vector of non-stationary asset shares, transactions, wealth, and ration variables, combined with a relatively stationary vector of prices. Only the sNC share seems to be almost stationary, but this is due principally to the presence of high stochastic seasonality in the series, and the de-seasonalized share is more clearly non-stationary. What is clear is that the data set *as a whole* is not stationary, and it therefore is necessary to proceed further with the identification of possible co-integrating relationships. The theory of consumer behaviour provides us with a long-run theoretical relationship which may be expected to underpin the dynamic model, and in which we may expect to find evidence that long-run demand equation solutions are cointegrating.

We therefore estimate un-restricted Engle-Granger OLS equations based on (4.14), the results of which are contained in Tables 4.4(a). The estimates impose no restrictions on the data, although it may be noted that, as expected, the adding-up restrictions, $\Sigma\alpha_i = 1$, $\Sigma\eta_i = \Sigma\gamma_{ij} = \Sigma\beta_i = \Sigma\delta_i = 0$, are automatically satisfied.

[116] It is possible however to test the structure of the data under two alternative transformations which result in the series being theoretically unbounded. The first is to consider a logistic transformation of the form $s_i^* = ln[\, s_i/(1-s_i)]$, while the second tests the individual series jointly with lending as shares of the gross, rather than rationed expenditure. In the latter case since lending is treated as a negative asset this allows the asset shares to individually exceed 1. Under both transformations, the results remain virtually unchanged.

Table 4.4(a)

Unrestricted Long-Run Demand Share Estimates (Granger-Engle Static Equations)

Sample 1974:1 to 1986:4 | Diagnostic Statistics

Share	Si	(CNST)	(z)	(LPNC)	(LPND)	(LPGS)	(LPNTK)	(LPTK)	(LPTI)	(Lw)	(Ly)	DW	R2	S.E	S.D
sNC	0.057	-0.101	0.000	-0.301	0.367	-0.041	0.001	-0.011	0.001	0.011	0.004	1.528	0.740	0.003	0.004
		(1.08)	(0.05)	(1.55)	(1.84)	(3.93)	(0.37)	(0.75)	(0.13)	(1.09)	(0.47)				
sD	0.374	-2.260	-0.096	2.488	-2.351	-0.346	0.003	0.304	-0.080	0.046	0.100	0.839	0.825	0.019	0.041
		(3.17)	(2.03)	(1.68)	(1.54)	(4.38)	(0.20)	(2.80)	(1.16)	(0.60)	(1.49)				
sGS	0.012	0.156	0.022	-0.090	0.067	0.024	0.000	-0.027	0.003	0.004	0.004	0.886	0.937	0.001	0.005
		(2.91)	(6.31)	(0.81)	(0.59)	(4.12)	(0.82)	(3.29)	(0.63)	(0.62)	(0.72)				
sNTK	0.135	1.575	0.057	-0.229	0.184	0.125	0.006	-0.091	0.012	-0.017	-0.059	1.038	0.831	0.008	0.016
		(5.62)	(3.07)	(0.39)	(0.31)	(4.02)	(0.86)	(2.14)	(0.45)	(0.58)	(2.23)				
sTK	0.323	0.851	0.007	-1.572	1.439	0.190	0.000	-0.117	0.036	-0.026	-0.014	0.909	0.787	0.008	0.016
		(2.77)	(0.36)	(2.46)	(2.19)	(5.59)	0.00	(2.51)	(1.20)	(0.79)	(0.47)				
sI	0.098	0.784	0.009	-0.295	0.294	0.047	-0.011	-0.058	0.028	-0.017	-0.036	0.915	0.508	0.006	0.008
		(2.50)	(1.45)	(1.99)	(1.75)	(1.51)	(1.07)	(1.45)	(0.93)	(0.31)	(0.01)				
Adding-up	1.000	1.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				

Table 4.4(b)

Revised Long-Run Demand Share Estimates

Sample 1974:1 to 1986:4

Share	Si	(1-LDV)	(CNST)	(z)	(LPNC)	(LPND)	(LPGS)	(LPNTK)	(LPTK)	(LPTI)	(Lw)	(Ly)	Net Monetary Impact	DW	R2	s.e	s.d
sNC	0.057	0.613	-0.004	0.000	-0.449	0.347	-0.065	0.004	0.008	0.032	-0.017	0.022	-0.103	2.315	0.895	0.002	0.004
			(0.04)		(3.00)	(2.93)	(4.49)	(1.37)	(2.45)	(2.66)	(2.06)	(2.67)					
sD	0.368	0.136	-0.948	0.545	0.919	-1.427	-0.403	-0.064	0.291	0.412	0.219	-0.104	-0.507	2.148	0.988	0.005	0.039
			(2.02)	(2.03)	(1.92)	(2.21)	(2.27)	(1.54)	(1.19)	(2.37)	(5.54)	(0.75)					
sGS	0.013	0.300	0.173	0.015	-0.253	0.299	0.023	0.004	-0.036	0.021	0.022	-0.022	0.046	2.224	0.979	0.001	0.005
			(1.32)	(1.61)	(1.18)	(1.10)	(1.78)	(1.65)	(2.01)	(1.77)	(1.56)	(2.51)					
sNTK	0.137	0.054	-3.826	0.235	4.293	-2.360	1.173	-0.153	-0.232	-0.331	-0.067	-0.104	1.933	2.131	0.992	0.002	0.016
			(1.35)	(1.97)	(3.37)	(3.72)	(2.87)	(2.21)	(2.00)	(2.12)	(2.63)	(1.97)					
sTK	0.327	0.515	1.416	-0.069	-3.940	3.327	0.080	-0.014	-0.175	-0.065	-0.033	-0.068	-0.613	2.097	0.969	0.003	0.015
			(3.80)	(3.47)	(6.31)	(5.58)	(2.25)	(2.25)	(4.61)	(2.52)	(3.16)	(2.60)					
sI	0.099	0.470	-0.184	0.057	1.818	-1.327	0.072	-0.003	-0.046	0.086	0.114	0.037	0.491	2.160	0.856	0.004	0.008
			(0.41)	(1.85)	(1.35)	(1.44)	(1.93)	(1.77)	(1.96)	(2.87)	(2.68)	(1.35)					

Notes: [1] Coefficient on z in Equation for sNC imposed to zero.
[2]Because of differences in the dynamic specification of each long-run equation, adding-up does not hold.

Demand Elasticities Evaluated at Mean Share

	(CNST)	(z)	(LPNC)	(LPND)	(LPGS)	(LPNTK)	(LPTK)	(LPTI)	(Lw)	(Ly)
Ep(sNC)	-0.079	0.000	-7.868	6.071	-1.130	0.068	0.139	0.560	0.705	0.392
Ep(sD)	-2.578	1.482	2.500	-3.879	-1.096	-0.174	0.791	1.121	1.595	-0.282
Ep(sGS)	13.411	1.183	-19.610	23.178	1.786	0.317	-2.811	1.628	2.687	-1.674
Ep(sNTK)	-28.009	1.717	31.427	-17.276	8.591	-1.118	-1.701	-2.426	0.510	-0.761
Ep(sTK)	4.336	-0.212	-12.063	10.186	0.246	-0.042	-0.534	-0.198	0.890	-0.208
Ep(sI)	-1.867	0.573	18.424	-13.444	0.733	-0.028	-0.469	0.875	2.159	0.377

Testing Symmetry and Homogeneity

An immediate question to be asked of these results is whether the long-run properties of the asset demand model are consistent with the demand theory. From Table 4.4(a) it is immediately clear that only three of the six own-price effects are negative, which provides an initial indication that the Slutsky matrix will not be negative-semi definite, and thus will violate the negativity condition. We can, nonetheless consider whether the system as a whole accepts the imposition of homogeneity and symmetry. Following Deaton and Muellbauer(1980a) and Anderson and Blundell(1982) we estimate the long-run model using a simultaneous estimator (FIML) on n-1 equation shares, first without imposing any restrictions on the coefficients and then proceed to test the impact of imposing conditions of homogeneity and symmetry. Tables 4.5 reports the results of the tests for the static equations presented in Table 4.4(a). We test the imposition of the restrictions sequentially using the standard likelihood ratio test of the form $-2\lambda(x) \sim \chi^2(r)$ where r is the number of restrictions, and $\lambda(x)$ is defined as $\lambda(x) = Ln((\mathbf{X},\theta)/(\mathbf{X},\theta'))$.

Table 4.5
Testing the Restrictions of Demand Theory

Model	$Ln(\mathbf{X},\Theta)$	$-2\lambda(x)$	Restrictions	C.V. (1%)
<u>Static Model</u>				
Unrestricted	1122.66	-	-	-
Homogeneity	1121.10	- 3.10	5	15.09
Symmetry	1094.40	-56.40	10	23.21
Homog & Symmetry	1093.44	-58.43	15	30.58

We note that while the homogeneity restriction is comfortably accepted by the data, those for symmetry (and thus homogeneity and symmetry combined) are not.[117] The failure to accept the symmetry condition seems to be determined to a significant degree by problems of the high correlation between the LpNC and LpD variables, and indeed the data will accept symmetry restrictions imposed over the reduced set cross-price effects. The successful acceptance of the homogeneity restriction is welcome in the light of Muellbauer's (1981) comments concerning models of consumer durables, and since the un-rationed form of the model accepts neither symmetry or homogeneity of the system, indicates the validity of employing the Deaton's (1981) treatment of rationing.[118]

Despite acceptance of homogeneity, the statistical properties of these equations are poor, and examination of the residuals indicates that the equations cannot be interpreted as well-defined cointegrating regressions. Banerjee *et al* (1992) report critical values for the stationarity of residuals from cointegrating regressions of this form. For a sample size of 50 and five regressors, the 5% critical values for the DW and ADF tests are 1.28 and -4.15 respectively. Given that we are estimating long-run regressions with a greater number of regressors the critical values will be somewhat higher and lower respectively for the two tests. Given these critical values, the Augmented Dickey Fuller and Durbin Watson tests on the residuals of the equations (based on an 4th order lag) reported in Table 4.4(a) suggest that the residuals for all the equations, possibly with the exception of the sNC equation are strongly non-stationary. The rejection of stationarity, and thus cointegration is particularly marked in the case of the sD and sTK equations (those which account for the major proportion of the portfolio) where there are indications of possibly spurious correlation.[119] The equations themselves are quite poorly specified, particularly in respect of the income and wealth terms: the wealth term is found to be significant for none of the equations, while the income effect enters only the sNTK equation with any significance. In

[117] Although it may be noted that the presence of some degree of non-stationarity in the residuals of the share equations may bias the estimates.

[118] The un-rationed model is not reported.

[119] Spurious correlation is suspected in cases where $R^2 > DW$, see Granger and Newbold (1974).

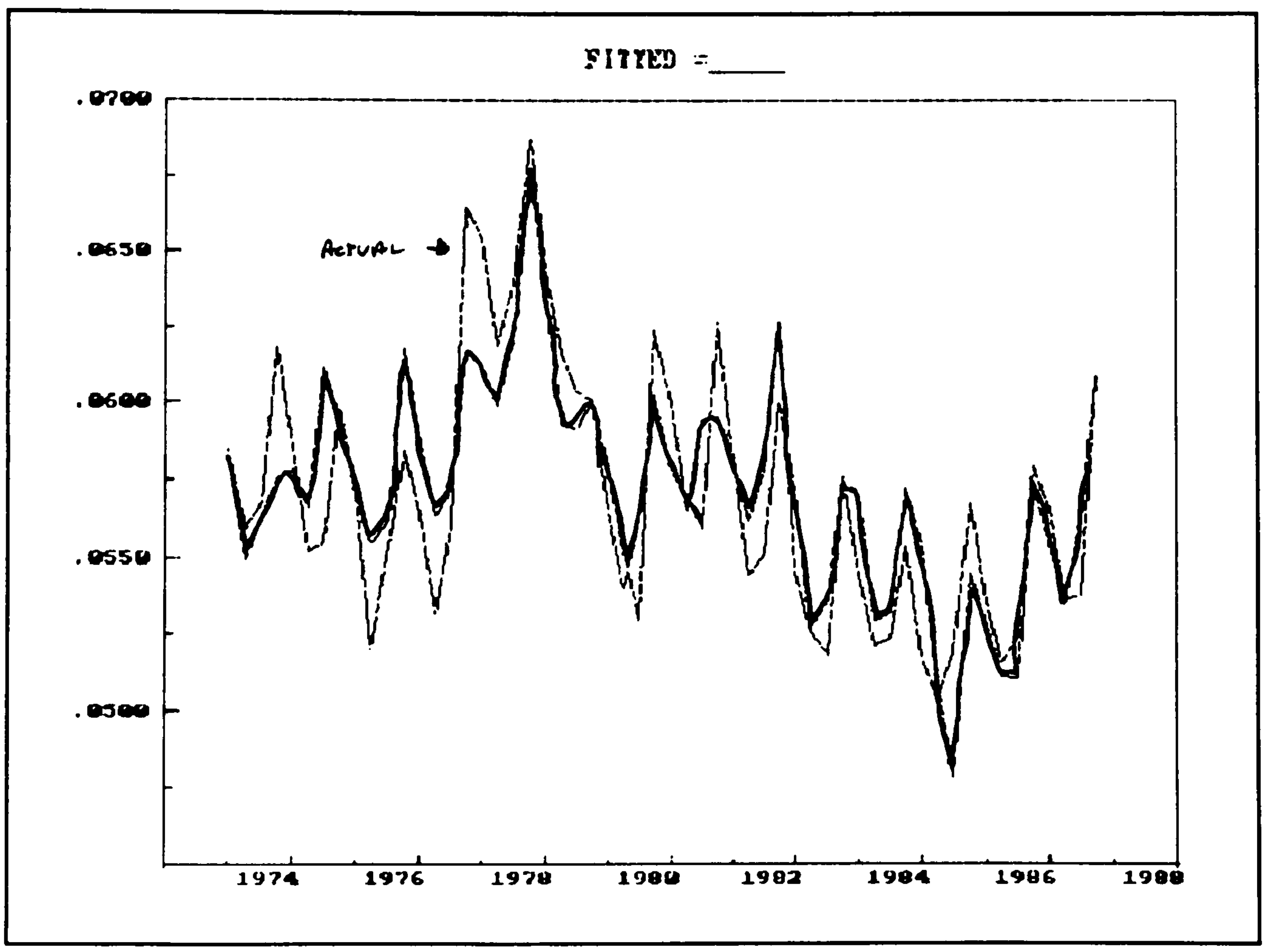
view of these statistical weaknesses it is not possible to draw any strong inference from the equation coefficients.

While these results may indeed indicate a genuine lack of cointegration in the data, concerns about the possibly large biases associated with the static regressions of this form suggest that the long-run solutions may be more clearly identified using an dynamic version of (4.14) which by capturing the short-run dynamics in the cointegrating regression may avoid inconsistency in the Engle-Granger estimates (see Banerjee *et al* (1992)).[120] The revised preferred long-run share equations are reported in Table 4.4(b) along with the implied price, wealth and income elasticities, evaluated at their mean share value (calculated in terms of (4.17)-(4.19) above).

Figure 4.3

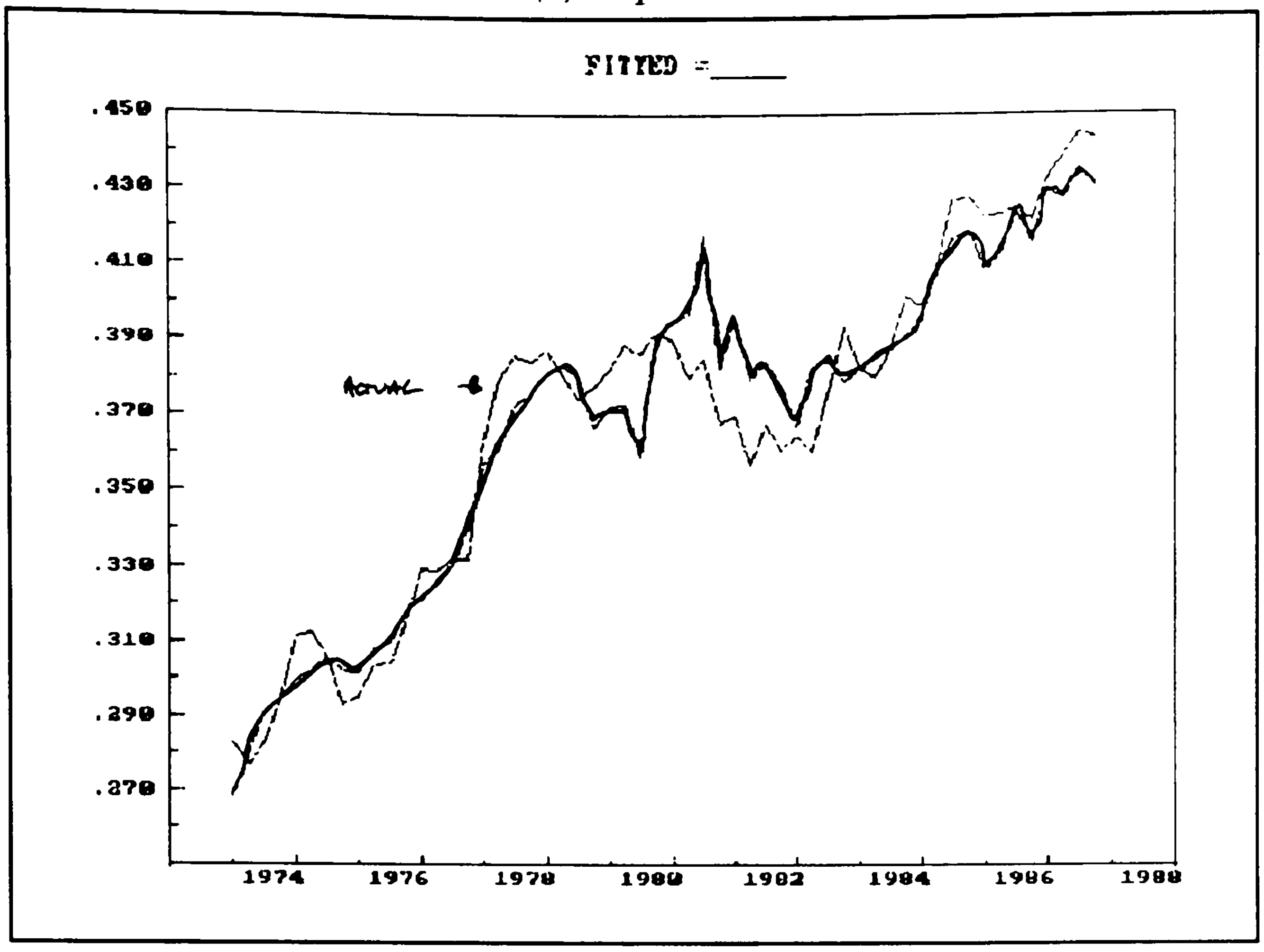
Long-Run Actual vs Fitted Demand Shares

(a) Notes and Coin

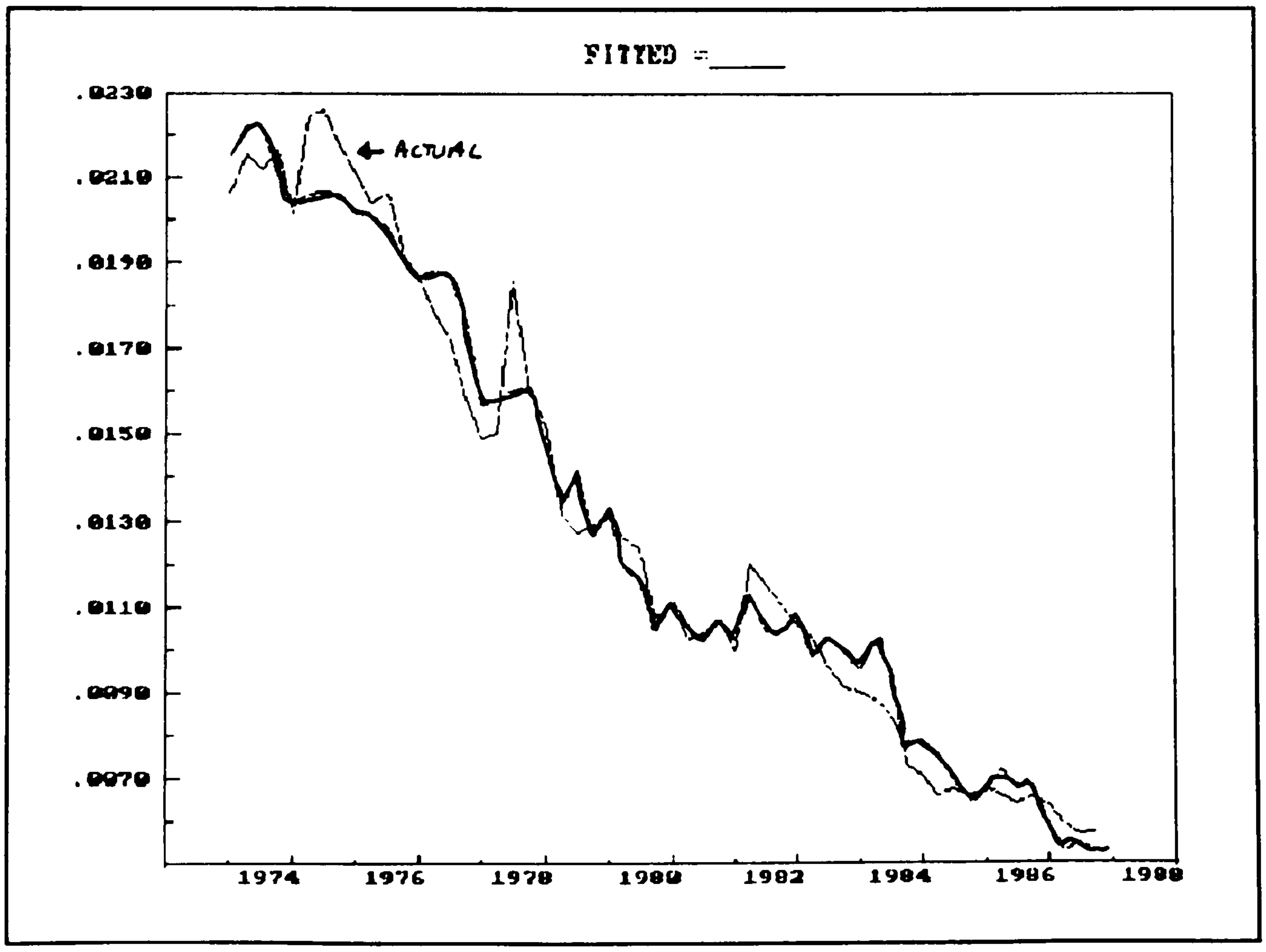


[120] The individual equations (4.14) were estimated using up to a fourth order lag on each variable and progressively simplified to eliminate unwanted dynamics. It was found throughout that second-order lags captured the full extent of the dynamic processes for all the asset shares.

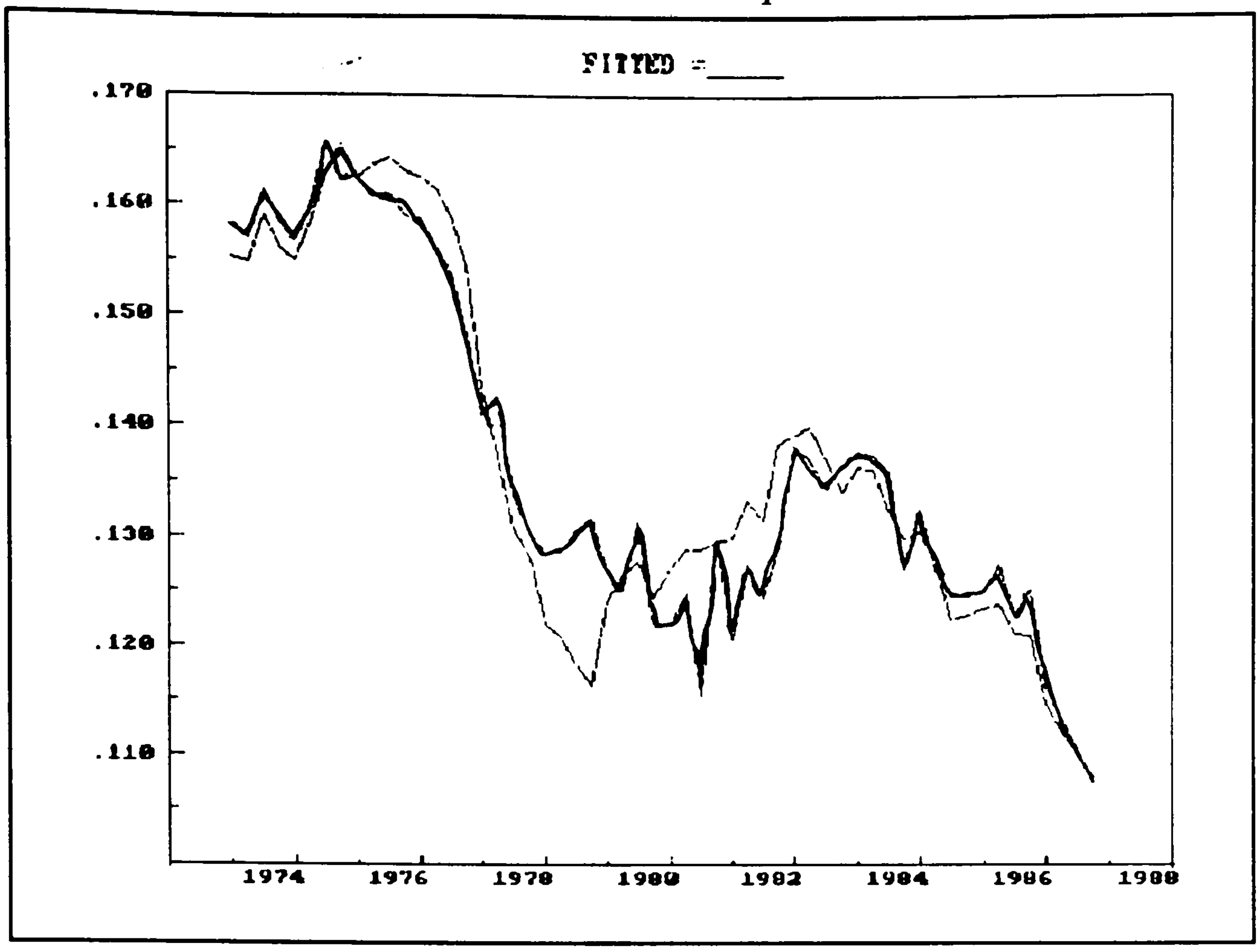
(b) Deposits



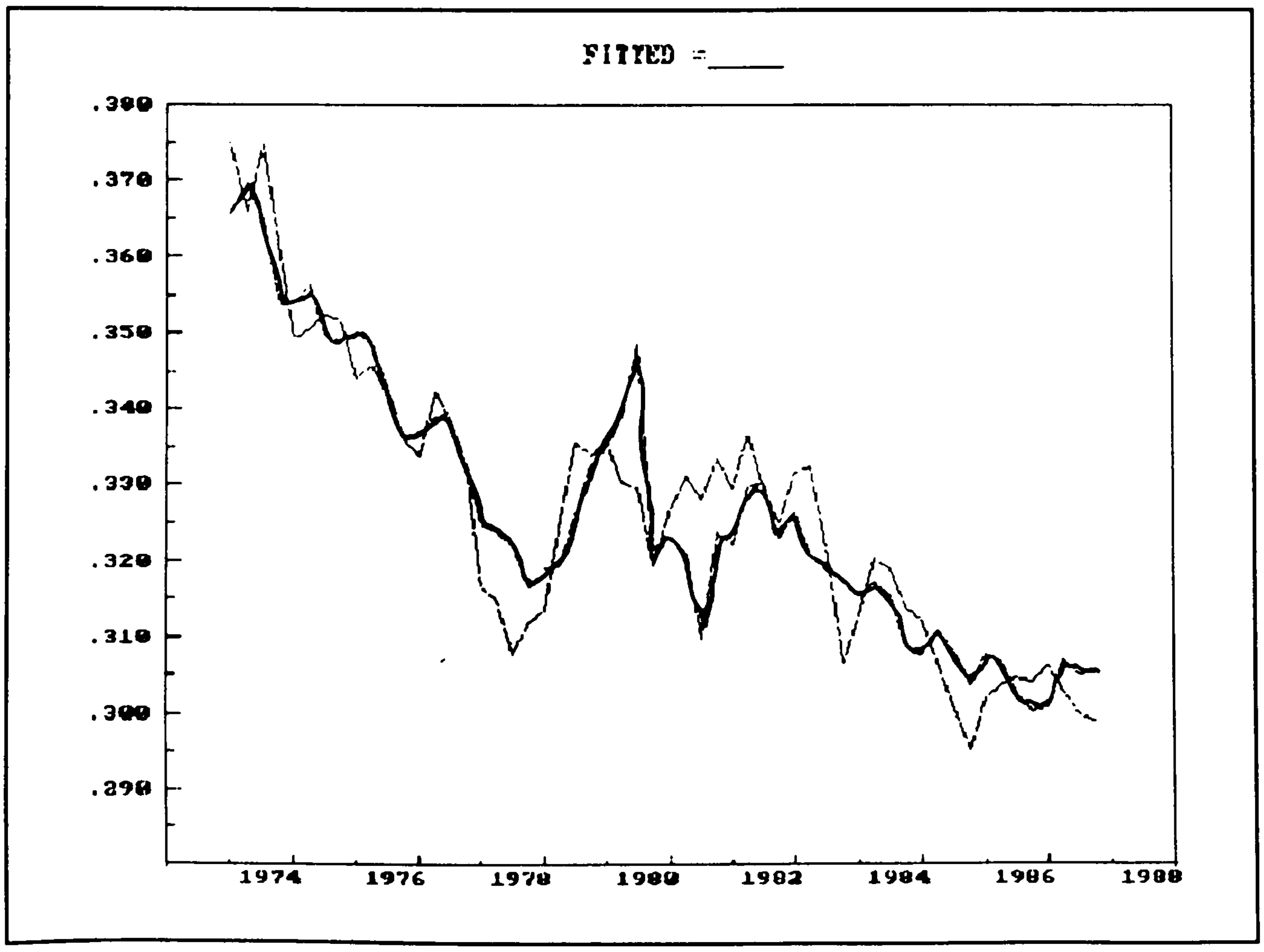
(c) Government Stock



(d) Non-Tradable Capital



(e) Tradable Capital



(f) Inventories

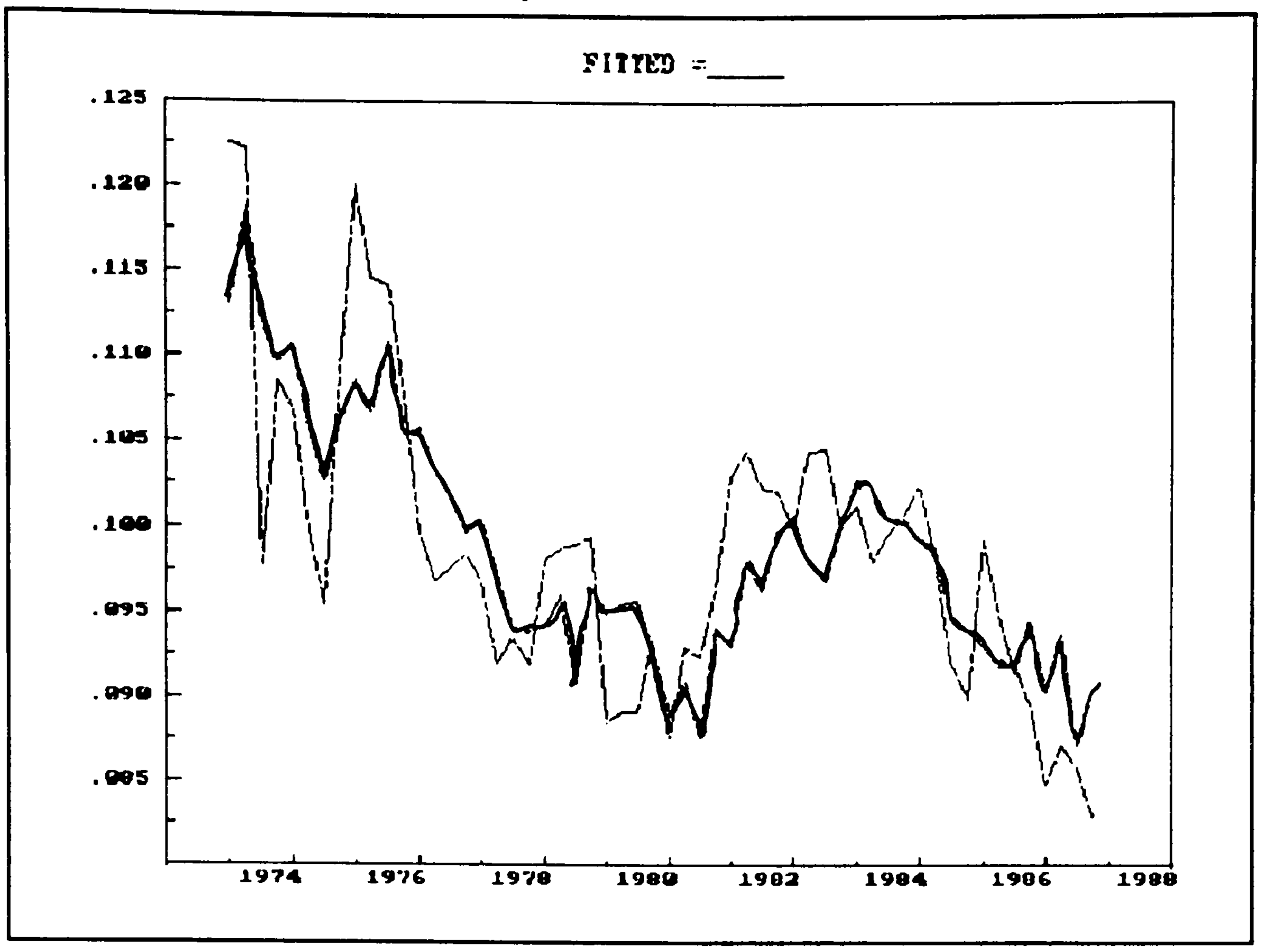
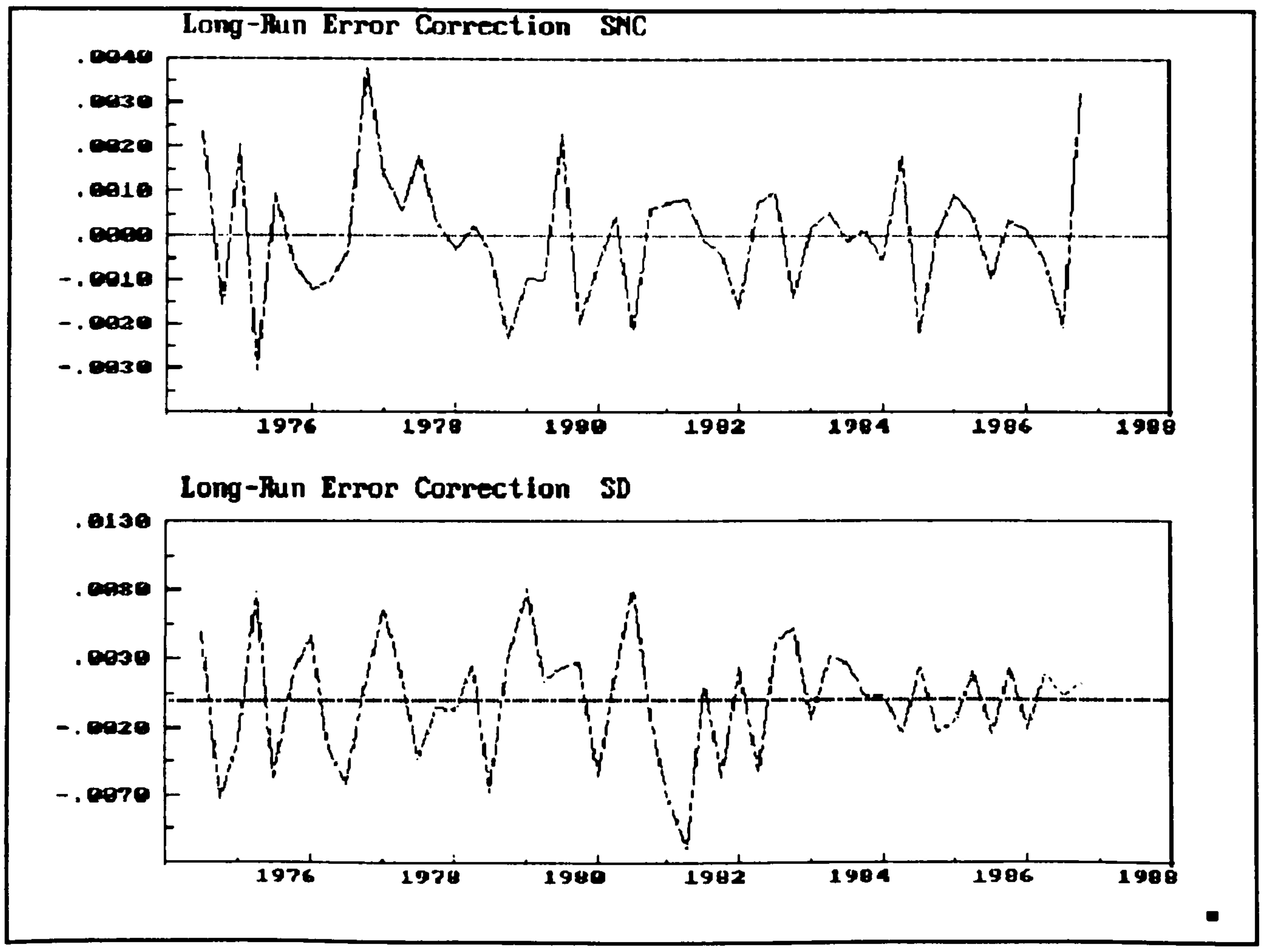


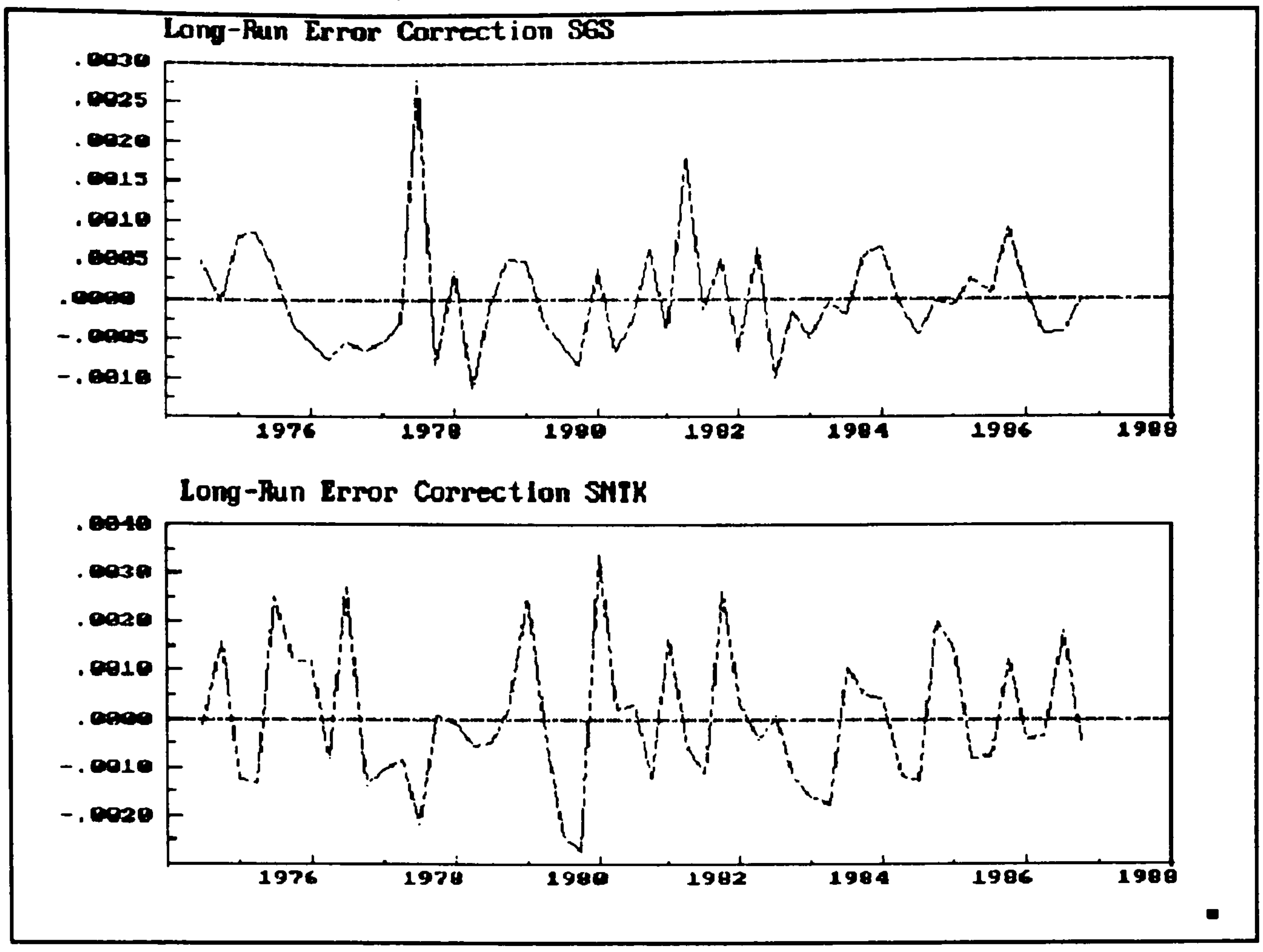
Figure 4.4

Demand Share Equations: Long-Run Error Corrections

(a) and (b) ECsNC and EcSD



(c) and (d) EcSGS and EcSNTK



(e) and (f) EcSTK and EcSTI

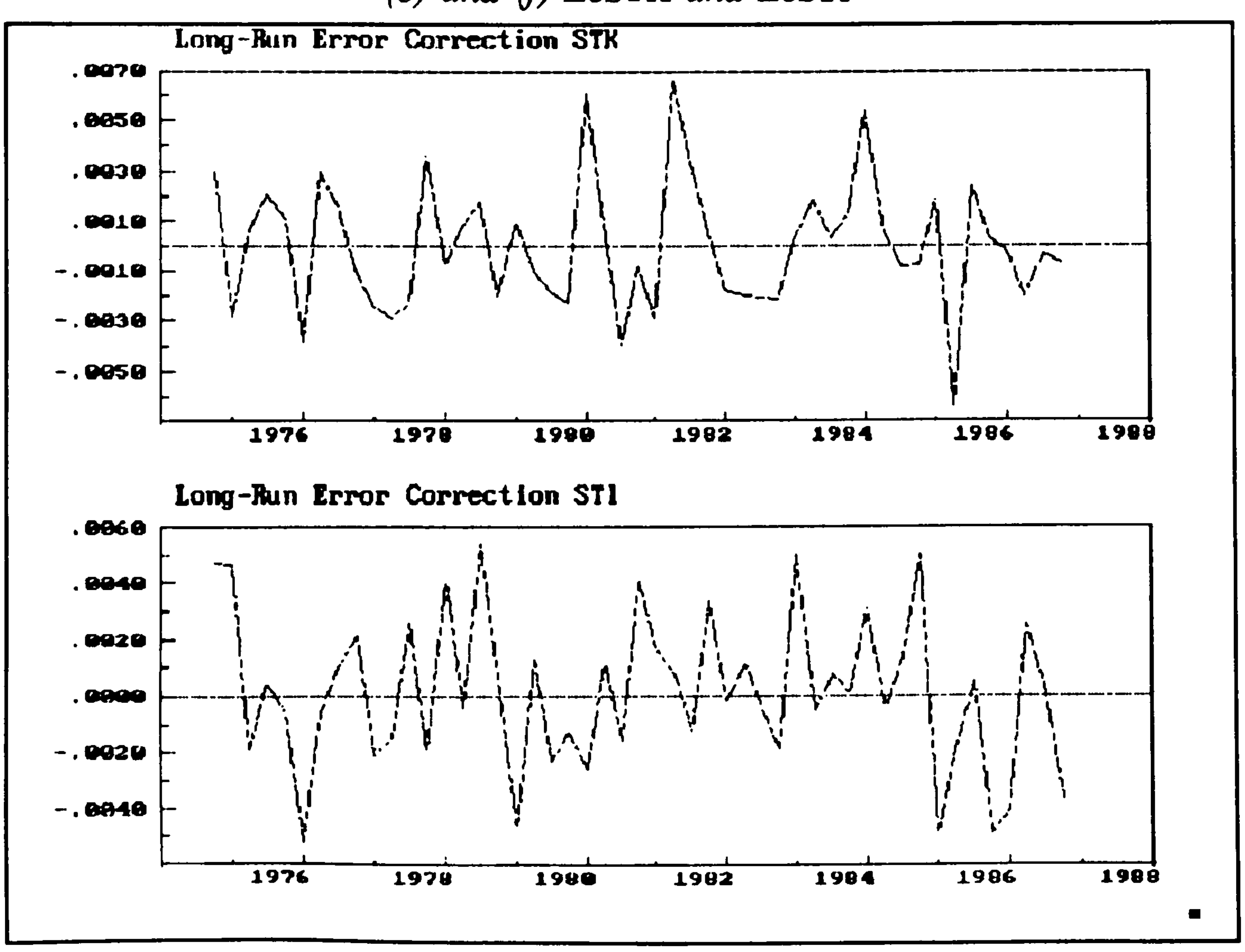


Table 4.6
Time Series Characteristics of Error-Correction Terms

Series	SBDW	DF 't'	ADF(4) 't'	Lag
EcNC	2.276	-8.74	-3.14	-
EcD	2.151	-7.59	-3.16	1
EcGS	2.217	-7.74	-4.38	2
EcNTK	2.084	-7.32	-3.41	3
EcTK	2.099	-7.32	-4.46	-
EcI	2.073	-8.32	-3.36	-

As before, since no detailed critical values have been computed for the residuals of cointegrating equations of this form and size of sample, we use the Banerjee *et al* (1992) 5% critical values for the residuals of a five-variable cointegrating regression with 50 observations. In this instance the results are relatively conclusive: both the Durbin Watson tests and the Dickey-Fuller tests (which are most-powerful for EcD, EcTK and EcI given that there is no significant lag in the ADF test) strongly indicate stationarity in the residuals from the equations. This is clearly borne out by the plotted error corrections terms for the demand shares.

The time series characteristics of the revised equations are dramatically improved and now strongly suggest that the residuals of the long-run equations are stationary, and therefore tentatively support the inclusion of the long-run levels demand share equations within a dynamic error-correction model. First however we shall discuss the economic interpretation of the long-run demand system.

Interpretation of the Equations and Definition of Error Correction Terms

In the light of our initial caveats concerning problems with this class of model when applied to the analysis of durable commodities such as assets, the revised long-run share equations are, reasonably well specified. The long-run share equations perform relatively well in terms of the standard criteria of goodness-of-fit and the reduction in standard error, relative to the quarterly standard-deviation quoted in Table 4.2.

Examination of the plots of actual and fitted values indicates a number of interesting features of the model. The first is that while the fit is generally close, the long-run model in the level of the demand shares does not fully pick up the short run, transitory shift from accumulation of real assets into financial assets at the beginning of the coffee boom. These "excess" holdings of cash and deposits were however gradually converted into fixed capital formation, although lags in capital formation resulted in over-accumulation of fixed capital relative to the long-run equilibrium in the period from 1980-82. These movements are clearly likely to be more consistent with a dynamic model in which cash and non-interest bearing money performs the role of a buffer stock in the asset portfolio. In other words, in response to a positive shock to income, agents temporarily hold higher cash balances than desired, but these cash holdings are gradually reallocated to other assets. But perhaps more importantly, the results lend support to the fact that the dynamic model of asset accumulation around these levels equations will capture the pattern of relative asset accumulation consistent with the "construction boom" theory of Bevan *et al.* (1990) noted earlier through differential speed of adjustment to disequilibria.

The long-run model of inventory accumulation however fails to pick up what may be termed expectations effects in relation to inventory accumulation. The graph for sTI suggests quite clearly that the actual levels of accumulation of inventories during the period of "incredible" trade liberalization in the early 1980s are not captured by the demand share model, but rather suggests that modelling holdings of inventories in terms of relative prices fails to adequately capture perceptions of the credibility of trade liberalizations which, as suggested by Calvo and others, would explain periodic accumulation.

Turning to the long-run coefficients themselves some interesting patterns emerge. First, demand theory would suggest that all the own-price coefficients γ_{ii} should be negative. This is the case for sNC, sD and the two fixed capital shares. The price effect is positive for the other two assets, although, as in

Chapter 3, the own price effect for sGS is not significantly different from zero. Given the movement in this asset's share, and the concerns about identification of this relationship, this is not surprising. In general, however, with the exception of the inflation and domestic interest rate effects (see below), the magnitude of the price effects is quite low, possibly reflecting our earlier comments concerning the dampening effect of durability of assets on measured price elasticities. With the exception of the role of non-traded capital prices in the demand for assets other than fixed capital, the price matrix $\mathbf{\Gamma}$ is quite well defined, with all but four of the cross-price effects being sign-symmetric (the exception being γ_{15} and γ_{51}, γ_{23} and γ_{32}, γ_{26} and γ_{62}, and γ_{53} and γ_{35}), and a reasonably high proportion (25 out of the 36) of the own- and cross-price effects being individually significant in terms of the 't' statistic.[121] We can conclude that, at least in the long-run, relative prices do matter for the determination of asset holdings. Similarly, in contrast to the Engle-Granger static regressions, both the wealth and income effects are now statistically significant and interpretable (see below).

Using the Hicksian classification of complements and substitutes, where a positive cross-price elasticity $\gamma_{ij} > 0$ means that goods are substitutes, and $\gamma_{ij} < 0$ implies complementarity, we note that, leaving aside the interpretation of the inflation effects for the moment, there is evidence of substitution *between* financial and real assets (taking the combined effect of the LpNC and LpD coefficients), but complementarity *within* different forms of fixed capital formation. There is thus some evidence of substitution between government stock and real capital, suggesting weak evidence of crowding out, although because of the relatively poorly defined long-run solution for the government stock equation it would be inadvisable to place any stronger weight on this conclusion. The other important result from these price-effects concerns the different price responses between tradable and non-tradable capital formation. Though their cross-price effects indicate complementarity between the assets, tradable capital is substitutable for deposits, while non-tradable capital is not. One possible explanation for this result, which we shall discuss in more detail below, is that tradable capital, which

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[121] Because of the eclectic nature of the dynamics of the individual long-run equations, it is difficult to formally test for symmetry of these revised long-run solutions.

is predominantly imported, is subject to a more binding "cash-in-advance" constraint. Accumulation of predominantly imported capital in the long-run requires prior accumulation of financial assets (in order, for example to secure foreign exchange or finance trade credit). Domestic accumulation of non-tradable capital, on the other hand, where, at least in the domestic residential sector, may be expected to be less dependent on access to the formal financial sector, and more dependent on own-labour, and other non-financial inputs.

The interpretation of the monetary effects in the model raises issues of interpretation on the coefficients for LpNC and LpD, which, because of the very high correlation between the two quarterly rates of return,[122] produces the high joint coefficient estimates (a feature identified in other such portfolio model studies), and thus renders interpretation difficult. However it is clear that inflation leads to a reduction in relative share of long-run holdings of cash, bonds and tradable capital in the portfolio, while leading to an increase in deposits, inventories and, particularly, non-tradable capital. Fixed, non-tradable capital formation thus offers the safest (*ex ante*) hedge against inflation, followed by inventories and bonds. However, the presence of interest bearing deposits dampens the effects of inflation on composition of assets. Thus, for example, the shift into non-traded capital in response to and increase in inflation as measured by LpNC is partially offset by the opposite effect from LpD. The net effect of this switch, for a constant nominal interest rate is reported in column under the heading "Net Monetary Impact", which indicates the extent to which, for a given nominal interest rate on deposits, inflation induces a shift from financial assets and tradable capital into government bonds, non-tradable capital, and inventories.

Fourth, the reported long-run rationed wealth elasticities (measured by the sign of the coefficient β_i), suggest that cash and fixed capital are "necessities" (ie $E_w < 1$), while deposits, bonds and inventories are increasing in wealth (referred

[122] ie the nominal interest rate effect in LpD is dominated by the price deflator, which is simply LpNC.

to in the consumer demand literature as "luxuries").[123] In general these forms of Engel curve are very much as expected, although a number of features may be noted. First, it may have been expected that both forms of real capital formation would exhibit the same characteristics, and would have been classed as "luxury" assets. As it is, while the wealth elasticity for tradable capital is approximately unity, that for non-tradable capital is only half this amount. One explanation for this result is found from the original share plots which indicate that the relative inferiority of non-traded capital is caused by the rapid fall in relative accumulation from 1973 to 1975, while the slower supply response in non-traded capital formation may mean that the rise in income in 1986 is only matched by a rise in the share of non-tradable capital formation beyond the end of the sample period. Second, as before, it is difficult to evaluate results for government stock which suggest that it is a "luxury" asset. While this is plausible, the fact that the coefficient is non-significant suggests that no firm inference can be drawn. Finally, it needs to be noted that these Engel curve effects are based on an aggregate rather than a per capita basis. Given the rapid growth in population, per capita estimates for the Engel curves may differ substantially.[124]

Fifth, using the interpretation of Barr and Cuthbertson (1991) in which a positive value for the income coefficient indicates that the asset has a positive liquidity, and can be interpreted as a "transactions" asset, we note that as expected only cash and inventories are classed as transactions, or liquid, assets in this model. The other assets are all interpretable as "speculative" assets, the interpretation of the relative size of the other coefficients is consistent with prior expectations, where non-tradable capital is clearly the least liquid asset. Thus we would expect that in periods where transactions levels were high, for a given stock of wealth, cash and inventory accumulation may be expected to rise. Although the coefficient on the income term is not significant, it is negative.

[123] Combined with the slightly "inferior" Engel curve for cash this accords with all other evidence of financial deepening in Kenya (see Killick and Mwega (1990)).

[124] There is only one true observation of population for the period, and the official population series is thus log-linear interpolation of this series. We could therefore proxy the population growth effect by including a log linear trend in the model. Doing so does not, however, radically alter the results of the model.

While this is interpretable in terms of the liquidity interpretation offered here, it is somewhat counterintuitive in terms of the results from Chapter 2. Although we shall attempt to address this issue in Section 4.6, it is instructive to note that the sum of the mean-share wealth and transactions elasticities for both the sNC equation of 1.097, and the weighted sum of the sNC and sD equation of 1.284 (= 13% x 1.097 + 87% x 1.313), are broadly comparable to the equivalent long-run *income* elasticities for the equivalent monetary aggregates M0 (1.001) and M3 (1.13). Note, however, that the models in Chapter 2 are conditioned on gross national income, while we use total final expenditure in the demand share model.

Finally, we turn to the issue of the interpretation of the ration. In the long-run estimates we have imposed coefficients of zero on the effect of the ration on the share of cash, since it was found to be insignificant. Otherwise, the other estimates from Table 4.4(b) indicate that as the ration is relaxed (ie z falls),[125] the relative share of tradable capital rises while those of bonds, non-tradable capital, deposits and inventories fall. This suggests that the rationed good (ie credit) is complementary with tradable capital, and indicates an economy where the private sector operates against its credit limit and at the limit, given no access to other assets is forced to accumulate excess deposit assets (which have constituted the persistent excess liquidity of the banking system in Kenya over the period) and, to a lesser extent, non-tradable capital. Again this is consistent with our earlier comments concerning the relative importance of "cash-in-advance" constraints. Credit rationing therefore acts as a break on the accumulation of real tradable capital assets in the economy, and as a consequence of a marginal increase (ie relaxation) in the ration the private sector increases its borrowing which allows it to substitute deposit assets (whose real rate of return is low or negative) with a portfolio of borrowing and real tradable capital assets (whose combined expected rate of return, given the low real borrowing costs is significantly higher than that payable on deposits). Across the other assets which serve as non-financial alternatives for accumulation when credit is rationed, we note that the pattern of the coefficients is consistent with the characteristics of the

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[125] Since z is credit in this model it is modelled as a negative asset.

assets in the portfolio: a relaxation in the ration results principally in a shift out of deposits (the coefficient is 0.545), non-tradable capital (0.235) and into tradable capital.

4.4 Dynamic Demand Share Equations

The inconclusive results obtained in terms of the theoretical restrictions on the data mean that it is inappropriate simply to impose the theoretical restrictions of homogeneity and symmetry on the long-run solutions to the model. However we re-define the levels equation to ensure that they are not grossly inconsistent with theory, in particular by imposing the restrictions that the own price effects on sGS sTI are set equal to zero ($\gamma_{33} = \gamma_{66} = 0$). We do not restrict violations of cross-equation symmetry, but elsewhere we delete regressors from the levels equations when their values are low and insignificantly different from zero.[126] We test the validity of these exclusion restrictions by evaluating the loss of likelihood resulting from their imposition. The restrictions are accepted by the data, with the value of the LR test being 16.54 against a 1 per cent critical value of 20.09. Subject to these restriction the long-run solutions presented in Table 4.4(b) are incorporated directly into the dynamic equations.

The dynamic demand share equations around these error-correction terms are reported in detail in Appendix 4(B). Following the pattern established in Chapter 2 (Table 2.11), we summarise the results in Table 4.6, where the details of the dynamics are suppressed for the sake of clarity. A similar specification search was adopted as in Chapter 2 through which we employ a 4 period lag on all variables in the over-parameterized dynamic error-correction model. One important caveat needs mentioning concerning the specification of the monetary prices, LpNC and LpD. While the levels equation maintained the strict functional form of the Deaton and Muellbauer model by expressing all prices in real terms, it was clear that the high colinearity between the two prices rendered interpretation difficult. In the dynamic model we therefore estimated the model

[126] Specifically we set $\gamma_{14} = \gamma_{24} = \gamma_{34} = 0$.

in terms of LpNC and Lrd, where the latter, defined as L(pD/pNC), is the *nominal* quarterly deposit rate. This circumvents the multicollinearity problems caused by the correlation, which, given the infrequency with which nominal interest rates have been changed over the period, becomes severe in terms of ΔLpNC and ΔLpD. This transformation is executed for purely statistical reasons since without it the covariance matrix would be rendered virtually singular in the dynamic model.

Table 4.6

Summary Demand Share Models: OLS Estimates (1973(1)-1986(4))

Asset Shares

Explanatory Variables	ΔsNC	ΔsD	ΔsGS	ΔsNTK	ΔsTK	ΔsTI
EcS_i	-.429	-.148	-.295	-.154	-.187	-.491
	(3.56)	(1.76)	(2.69)	(3.09)	(2.11)	(3.90)
ΔLpNC	-.107	.742	.026	-.101	-.196	-.139
	(1.84)	(5.00)	(3.69)	(3.99)	(5.39)	(2.89)
ΔLrd	-.418	3.146	-.328	-2.091	-	-1.293
	(1.86)	(3.88)	(3.30)	(7.72)		(2.90)
ΔLpGS	-.016	-.065	-.008	.019	-.043	-.031
	(2.20)	(4.51)	(3.28)	(2.37)	(2.95)	(2.05)
ΔLpNTK	-	.006	-.001	-.002	-.002	.008
		(1.84)	(2.16)	(2.60)	(1.74)	(3.76)
ΔLpTK	-	-	.012	-.024	-.054	-
			(2.38)	(2.35)	(2.09)	
ΔLpTI	-	-	-	-	-	-.017
						(1.82)
ΔLy	.011	-.074	.003	.016	.023	-
	(2.19)	(2.39)	(2.65)	(5.07)	(2.52)	
ΔLwz	-	.121	.013	-.039	-.134	-.053
		(7.14)	(5.49)	(4.87)	(8.01)	(3.44)
Δz	-	.076	.006	.025	-.040	.040
		(4.91)	(2.02)	(1.11)	(2.75)	(2.47)
Δs_{it-i}	-	.621	-	.415	.421	.391
		(3.00)		(5.20)	(5.20)	(3.06)
R_2	0.814	0.850	0.604	0.818	0.722	0.575
s.d	0.43%	0.92%	0.17%	0.33%	0.6%	0.41%
σ	0.18%	0.42%	0.06%	0.17%	0.34%	0.33%
DW	1.78	1.80	1.49	1.65	2.06	1.92
ζ_1 (4)	0.89	0.85	1.65	1.91	0.84	0.37
ζ_2 (4)	0.40	0.64	0.89	0.79	0.34	0.42
ζ_3	0.41	1.11	0.52	0.62	0.42	
ζ_4	4.47*	0.32	1.12	1.19	1.20	0.04

* indicates rejection of null.

Notes: (1) t statistics are reported in parenthesis; s.d is the standard error of the dependent variable; σ the corresponding equation standard error; DW is the first-order error autocorrelation Durbin-Watson statistic.

(2)) ζ_1 (6) is the fourth order Lagrange Multiplier test for autocorrelation; ζ_2 (6) the fourth order Lagrange Multiplier test for autoregressive conditional heteroscedasticity; ζ_3 is White's (1980) test for unconditional heteroscedasticity; ζ_4 the Jarque-Bera (1983) test for the normality of the error distribution. Tests ζ_1, ζ_2, and ζ_3 are reported as sample-adjusted F-Tests (see Kiviet (1985)): ζ_4 is are distributed as χ_2 with two degrees of freedom.

As indicated in the table, the dynamic equations fit relatively well, both statistically and in terms of economic interpretation. Starting with the diagnostic statistics, we note that in general there is no evidence of statistically significant error autocorrelation or heteroscedasticity. The exception is with the sGS equation which exhibits very high first-order autocorrelation. Re-examination of the dynamic structure of the lagged variables in the equation (principally LpNC and Lwz) suggested that a first order common-factor restriction could be accepted (Hendry and Mizon (1978)), and thus the equation for sGS was re-estimated a first-order autoregressive least squares procedure.[127] This model is reported in Appendix 4(C), and it is immediately apparent that for the parameters of the principal regressors, it is statistically indistinguishable from the OLS model. This amendment notwithstanding, the dynamic models seem relatively well specified. In all cases the equations significantly reduces the standard error of the dependent variable, while the dynamic equation residuals are distributed independently and homoscedastically normal. Additionally, the dynamic models track the actual movements in the shares well, both across the sample as a whole, and also in relation to the large changes in asset shares during the coffee-boom, where the errors in the long-run equations were most marked.

Due to computational limitations on the scale of the model, and the relatively short data sample, a detailed examination of the recursive properties of the model was not possible. However Table 4.7 reports the results of estimating the model over the period to 1982(4) and forecasting from 1983(1) to 1986(4). The table reports the standard split-sample Chow Test and a "t" test against the null that there is a systematic component in the errors. Figures 4.5(a) to (f) plot the actual versus forecast outcomes.

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[127] The χ^2 (1) statistic against a null of a first-order common-factor restriction on the model was 0.433, against a critical value of 6.65. Higher order restrictions were, however, not accepted.

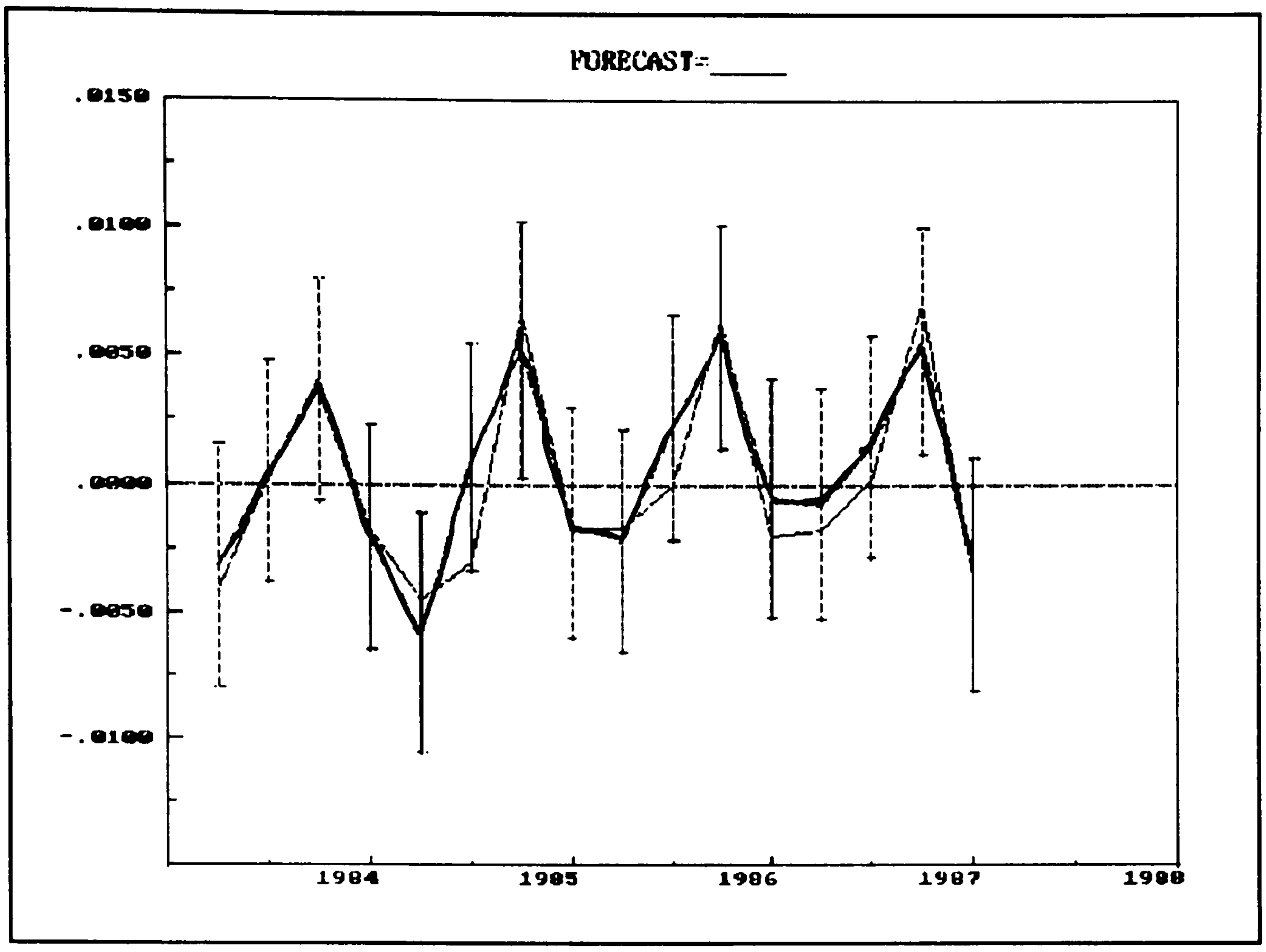
Table 4.7
Within-Sample Stability Analysis: 16 Period Forecast 1983(1) to 1987(1)

Demand Share	ζ_5	ζ_6	ζ_7
sNC	0.52	0.37	-0.85
sD	1.24	0.66	-0.97
sGS	1.18	0.61	1.18
sNTK	1.07	0.86	1.20
sTK	1.19	0.72	0.15
sTI	1.98	1.31	-1.35

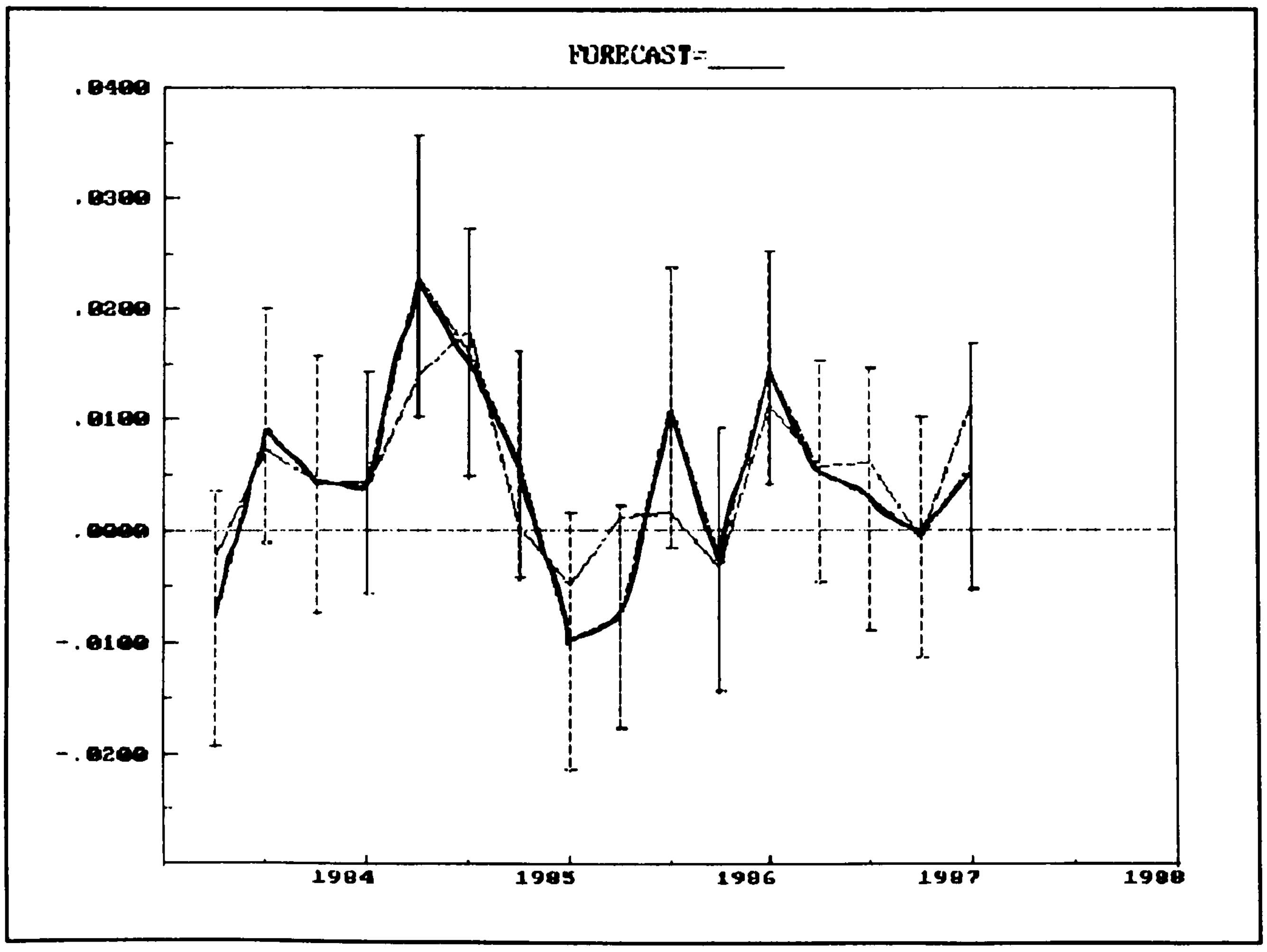
Notes: ζ_5 is test of forecast stability, and is distributed χ^2 (1); ζ_6 is a standard Split-Sample Chow test, distributed F(16,34) the critical value for which is approximately 2.15; and ζ_7 is a "t" test for systematic bias in the forecast errors against the null that the mean forecast errors over the forecast period are zero mean. See Hendry (1989) Chapter 3.

For all the share equations, with the possible exception of that for inventories, the null of stable, unbiased forecasts derived from a parameter-constant model cannot be rejected. The relatively poor tracking of the sI model, though not significantly poor, confirms the view that the demand-share view does not provide particularly valuable insight into the process of inventory accumulation. In general, however, the actual vs forecast plots (Figure 4.5) reveal that for all equations, the model forecasts the turning points accurately (and especially so for ΔsNC and ΔsNTK), although the plots indicate that, if anything, the model over-smooths the demand shares relative to their actual volatility.

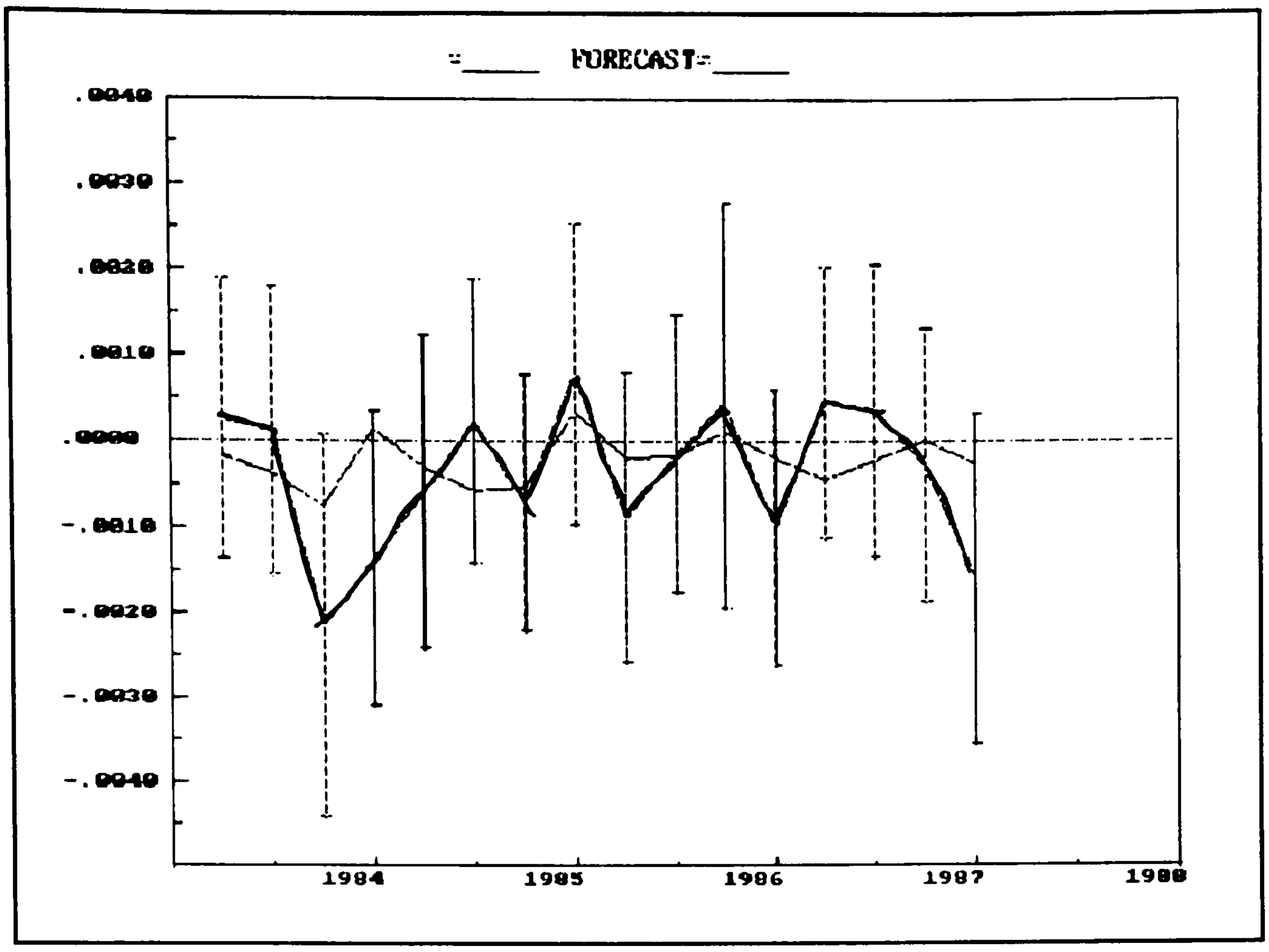
Figure 4.5
Forecast Accuracy 1983-1987
(a) Notes and Coin



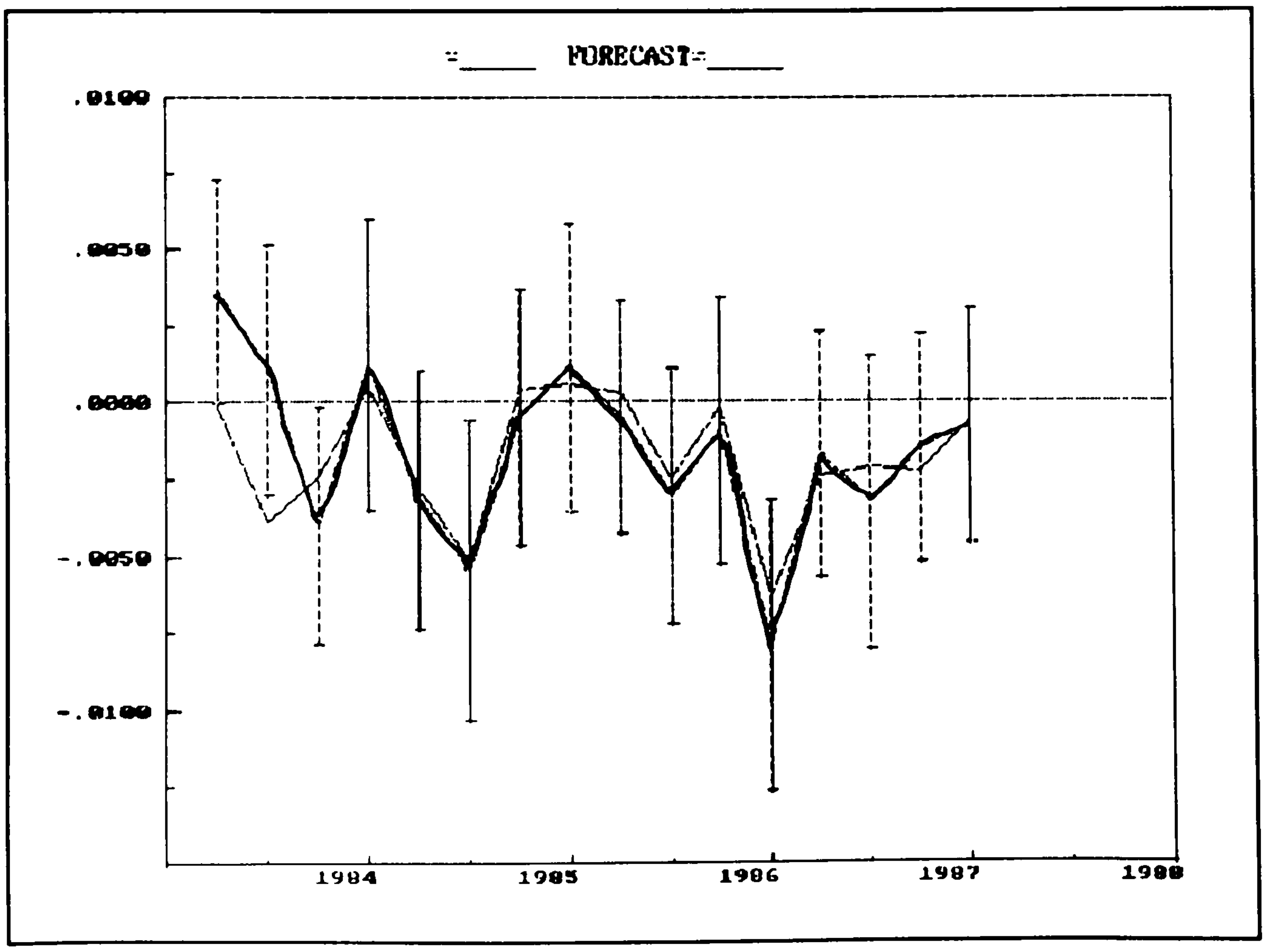
(b) Deposits



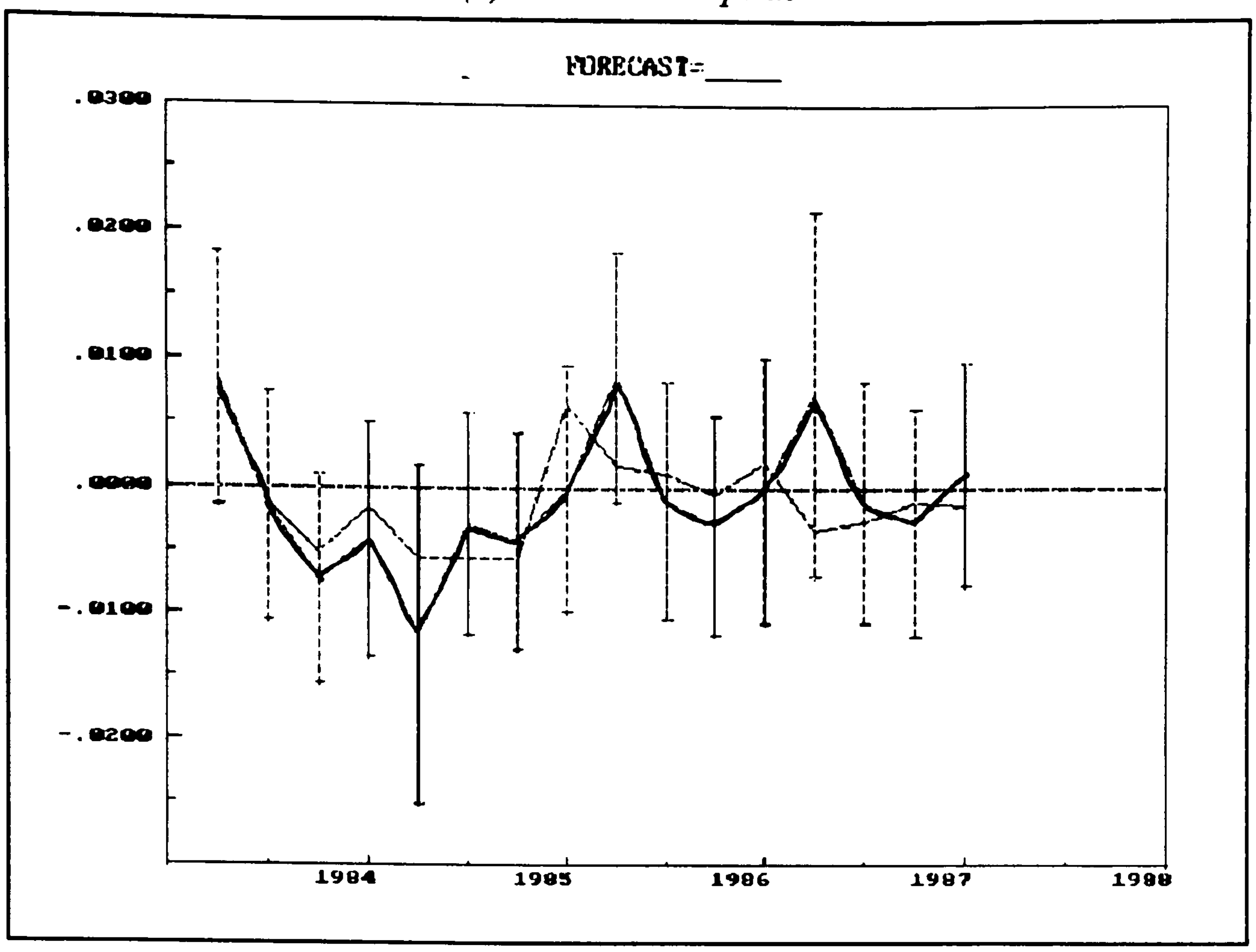
(c) Government Stock



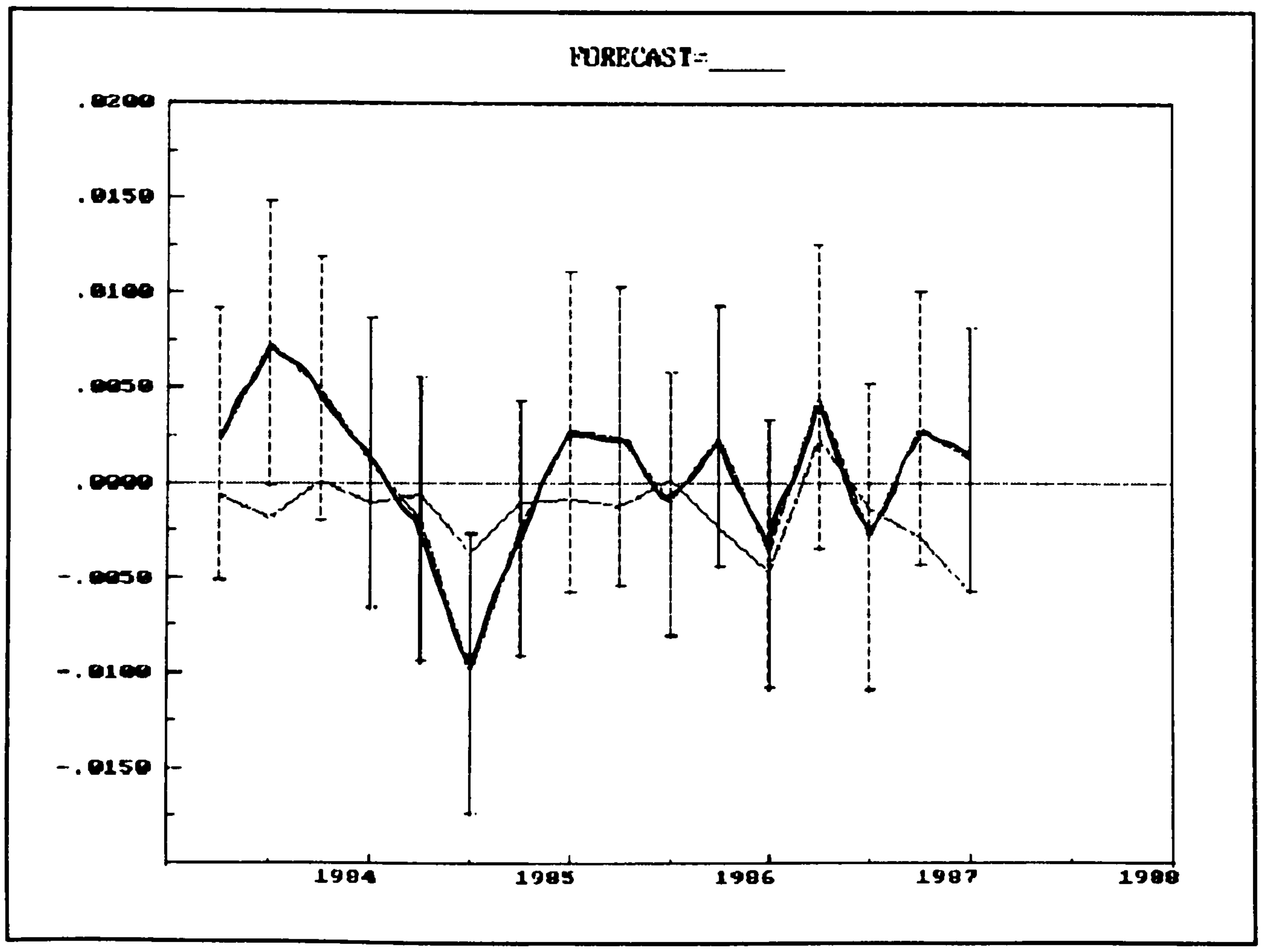
(d) Non-Tradable Capital



(e) Tradable Capital



(f) Inventories



4.5 Interpretation of Dynamic Equations

In general the interpretation of the dynamic equations is straightforward. In terms of their coefficients, the most striking results from the models are the significant feedback effects towards the long-run equilibrium model. In all cases the coefficient on the error correction term is correctly signed (ie short-run disequilibrium is corrected by a negative feedback) and the speed of adjustment is consistent with the relative liquidity of the assets, ranging from approximately two quarters in the case of cash and inventories, three quarters for government bonds, to around five quarters for traded and non-traded capital. The combination of the well defined error-correction terms, and the presence of significant lagged dynamic effects in all the equations except those for sNC and sGS, underlines the strong inter-temporal linkages in asset demands which Deaton and Muellbauer (1980b) have argued strongly mitigates against efficient modelling of durable goods and asset demands. It may also be noted that in contrast to the long-run levels equation the short-run transactions elasticity is quite well defined across all the equations while the relative magnitude of the coefficients bears out the implicit hypothesis suggested by Barr and Cuthbertson (1991) that while asset stocks are determined as a function of wealth in the long-run, their relative liquidity with respect to the production process is an important short-run determinant of demand.

Examination of the individual coefficients of the dynamic models reveals a number of features. First, the effect of the ration is the same as in the levels model, with relaxations in the ration leading to asset switching into tradable capital formation. Second while accumulation of tradable and non-tradable capital have roughly the same short-run dynamics, adjustments in tradable capital are consistently more elastic to changes in relative prices and to changes in income, wealth and credit rationing, reflecting the closer dependence of the of the tradable capital sector on the financial sector. Moreover, in the short-run the inflation process is also more complex: whereas in the long run inflation was accompanied by a shift into non-tradable capital, the acceleration in current prices has the opposite effect on capital accumulation in the short run. One possible explanation for this sign-switch is the absence in the model of any independent measure of investment uncertainty. The construction of the rates of return generally used the *ex post* actual capital gain as a measure of *ex ante* expected capital gains. Consequently this provides only a point estimate of investment expectations, and does not capture any measure of the variance of the expected capital gain. Since it is plausible that the variance in the expected capital gain is correlated with the short-run acceleration in prices, then the latter may be expected to have a dampening effect on investment in real capital.[128]

The dynamic equations also confirm quite clearly the relative inappropriateness of this structure for explaining movements in inventories. The links between inventory and other real asset accumulation are not strongly identified, while the overall fit of the equation is relatively poor. Clearly alternative models may explain these dynamics more effectively, but there is some evidence at least that the cost of working capital (the ΔLrd effect) is an important determinant of the decision to hold inventories in the asset portfolio.

Finally, on the issue of the accumulation of government stock, it is not surprising that the overall explanatory power of the sGS equation is relatively weak (again the cross-price effects are low), given our single-equation evidence from Chapter 3. However, given that the private bond market is so thin, and turnover so low, it is surprising to note the importance of the bond-price in the other demand share equations. One possible explanation of this again concerns the issue of uncertainty and expectations, caused by the fact that the capital gain to holding bonds has been proxied by the Nairobi Stock Exchange Index. In the short-run increases in the price of bonds may be dominated by the decline in the growth of the NSE index rather than by changes in the yield on bonds.

[128] A number of studies of the demand for money (see the survey by Laidler (1985) have attempted to capture this effect by using measures of the variance of equity prices to proxy investment uncertainty. In general however, they have not proved to have high explanatory power.

4.6 Reconciliation of the Demand Share Model with Single-Equation Demand Models.

The final issue which flows from this chapter concerns the consistency of this modelling approach with that employed in Chapter 2. In this chapter we have found a dominant role for wealth in determining the long run demand for broad money (ie Lwz is *the* significant scale variable in the sNC and especially the sD equations), while in Chapter 2 we found that income itself was significant. In this section we therefore consider the implications for the demand for broad money of including a wealth variable in the single-equation model. The modelling of wealth effects in the demand for money is a relatively recent development, and in general has focussed on narrower measures of wealth than considered in this chapter (see for example, Grice and Bennett (1985), Hall *et al* (1989), and Adam (1991) all of whom model the demand for money in the UK conditional on gross financial wealth). The reason for exclusion of wealth from the models estimated in Chapter 2 is straightforward: there are, at present, no officially constructed data series for financial and non-financial wealth in Kenya. Although derived from official data, the series used in this chapter is constructed solely on the basis of the definitions of the assets presented in section 4.2, and is specific to the modelling exercise in hand. As a consequence it omits certain assets (such as equities) which would reasonably be included in official measures of wealth, and includes measures of inventories and fixed capital which may not. Moreover, the exclusion of foreign currency balances on which the private sector may be expected to condition their asset demands, are not included in the measure of wealth used here, and are unlikely to be included in official estimates. The wealth series used here is clearly only an approximation. In the light of these problems we shall examine only the case of our preferred broad-money aggregate from Chapter 2, namely the Divisia M3 aggregate, which is comparable with the weighted sum of sNC and sD in the demand share model.[129]

[129] We have also examined the M3 aggregate, and although the implications are the same as for the Divisia index, the concerns about the extremely high interest elasticity noted in Chapter 2 are also present when the model is conditioned on wealth.

We commence by examining the long-run cointegrating relationship between the variables of the model with the inclusion of the rationed wealth term from the demand-share model in the VAR. The relevant β' eigenvectors for the demand for money relationship are presented in Table 4.8, where (4.33) is the cointegrating vector with the inclusion of the wealth term, and (4.34) is the Divisia M3 money-demand cointegrating vector presented in Table 2.6 of Chapter 2. Note that we report only the cointegrating demand for money relationship. The addition of wealth to the original VAR results in two other significant cointegrating vectors. The first is, as before, the relationship between the domestic interest rate and the rate of inflation, while the second a relationship between wealth, inflation and the interest rate.

Table 4.8
Cointegrating Money Demand Vectors

Johansen β'Eigenvector

	(m3-p)	(gny-p)	Lwz	π	exb	α
(4.33)	1.00	-0.58	-1.04	4.33	-0.07	-.107
(4.34)	1.00	-0.84		5.51	0.07	-.077

Notes: Lwz is real rationed wealth as defined in Section 4.2.; α is the feedback coefficient from the cointegrating relationship onto the demand for money.

The two cointegrating vectors have broadly the same structure except for the term in wealth. The significance of this term can be assessed by using the Likelihood Ratio class of tests of restrictions on the Π cointegrating vector. Doing so we find that, as expected, there is a loss of likelihood associated with imposing the restriction that Lwz = 0.[130] The addition of the wealth terms in the long-run vector will thus clearly enhance the power of the money-demand model. Equation

[130] The significance of wealth can be tested by evaluating the loss of likelihood ocurring as a result of the imposition of the restriction that the coefficient on Lwz is zero (see Johansen and Juselius (1990)). This is a variant of the standard LR test and the test, Q, is distributed χ^2 v(p-s) where Q = -2T$\Sigma\{(1-\lambda^*_i)/(1-\lambda_i)\}$, λ^*_i the restricted eigenvalues, p the number of variables in the VAR, v the rank of the Π matrix, and s the number of restrictions. In this case imposing the restrictions produces a test statistic of 83.14 against a critical value for $\chi^2(12)$ of 26.22, indicating the significance of the wealth term in the cointegrating vector.

(4.33) does however exhibit two notable features. The first is that though the wealth and income elasticities are individually plausible, their combined effect is somewhat high, since the long-run relationship indicates that equal increases in income and wealth of 1% increases real money balances by over 1.6%. This lack of homogeneity may however be a reflection of the process of financial deepening which has occurred over the period: in the very-long-run, this inhomogeneity may be expected to disappear. The second difference between the two vectors is the sign-switch on the exb variable, although the magnitude of the currency-substitution effect is relatively small and its exclusion does not result in a significant loss of likelihood in either model.[131]

The long-run money demand relationship can then be used to define the error correction relationship in a dynamic model and direct non-nested tests can be applied between the preferred dynamic model conditioned on wealth and income and that conditioned only on income.[132] The specification search does not differ greatly from that followed in Chapter 2 and so we merely present the preferred wealth-based model in Table 4.9. The model is estimated using an Instrumental Variable estimator to allow for any simultaneity as a result of conditioning on current period wealth, although it was found that the results did not differ substantially from the corresponding OLS estimate.

[131] It is important to note that there is a slight inconsistency in the structure of the model presented here since, as was noted earlier, wealth held in terms of foreign currency is not included in Lwz.

[132] Although the wealth model nests the income models in levels specification, the models can be treated as non-nested in their dynamic form since the error correction terms are different.

Table 4.9

Revised Demand for Money Equation, M3d using Net Wealth

Modelling Δ(m3-p) by IVE Sample:1975(2) to 1986(4)
IV Estimation: (m3d-p) and Lwz endogeneous.

Variable	Coefficient	Standard Error	t-value
Δ(m3-p)3	-.12667	.07095	-1.7853
ΔLwz	.93299	.16885	5.5257
ΔLwz 1	-.33798	.13579	-2.4889
$\Sigma\Delta y_{12}$	-.12209	.05807	-2.1026
$\Delta\pi$ 1	-.18932	.12392	-1.5277
Δrtb	-5.73707	1.28951	-4.4490
Δrtb 3	-1.53170	1.23203	-1.2432
Δexb 3	-.07534	.04886	-1.5419
Ecm3 1	-.11536	.03696	-3.1209
Constant	.03983	.00724	5.5023
Q 1	-.01540	.00814	-1.8920
Q 2	-.03692	.01042	-3.5432
Q 3	-.03681	.01160	-3.1725

RSS = .0100852532 σ = .0172228 DW = 1.771
$\xi(1) = \chi^2(9)/9 = .96$
$\xi(2) = \chi^2(13)/13 = 13.49$
$\xi(3) = \chi^2(4)/4 = 1.22$
$\xi(4) = F(4, 26) = .05$
$\xi(5) = \chi^2(2) = 5.49$
$\xi(6) = \chi^2(15)/15 = .91$

Notes: $\xi(1)$ is a test of the validity of the identifying restrictions on the implicit reduced form of the model; $\xi(2)$ is equivalent to the F test on the significance of the regressors; $\xi(3)$ and $\xi(4)$ are the analog of the AR and ARCH tests in the OLS models presented in Chapter 2, $\xi(5)$ is the Jarque-Bera test for error-normality, and $\xi(6)$ a forecast stability test.

The demand function is well specified and broadly consistent with the demand function estimated in Chapter 2. The statistical performance of the model, its goodness of fit, and its forecast stability all match that of the model presented in Chapter 2, although there is evidence of higher non-normality in the error distribution than in the income-based M3d model presented in Chapter 2. The feedback on the error-correction term in the wealth-based model is slightly higher than the equivalent income based model (11% per quarter as opposed to 9%), while in addition short-run changes in income and wealth are also found to be significant. The other main difference between the two models, however, lies in the magnitude of the short run inflation effect: in the income based model (estimated either by OLS or in the FIML estimate), the short-run inflation elasticity was approximately 0.75. In the wealth based model the coefficient has an elasticity of less than 0.2 in absolute terms. This latter result would seem consistent with the interpretation of the short-run inflation elasticity in the previous models as a proxy for uncertainty in the real rate of return on fixed capital, which in the current specification may, in part, be captured in the definition of the current wealth stock.

Finally, we perform non-nested encompassing tests between the two preferred specifications of the model, where both models are estimated using an instrumental variable estimator. The results, presented in Table 4.10, provide evidence that inclusion of the wealth term in the demand for broad money model does enhance the performance of the model.[133]

Table 4.10
Encompassing Tests for Significance of Wealth in the Demand for Money

Model 1 is Wealth-based Δ(m3-p) (Table 4.9)

Model 2 is Income-based Δ(m3-p) (Chapter 2 Annex 2(C))

$\sigma 1$ = .019493 $\sigma 2$ = .036502 σ[Joint] = .018067

Model 1 v Model 2	Form	Test	Form	Model 2 v Model 1
-2.174	N(0,1)	Cox	N(0,1)	-19.396
1.892	N(0,1)	IV	N(0,1)	9.234
10.074	χ^2(5)	Sargn	χ^2(5)	32.180
2.345	F(5,36)	Joint	F(5,36)	26.270
[.0609]		Prob.		[.0000]

[133] Due to restrictions on the dimensions of the encompassing test procedure it was not possible to fully specify the dynamics of both models.

The individual tests are described in Chapter 2. Because of the limited capacity of the software used to execute these tests, the dynamics on both models were slightly truncated, but while neither model can formally encompass the other (ie the null for the Cox, Sargan, and Joint tests is rejected for both Model 1 encompassing Model 2 and *vice versa*), the evidence strongly supports Model 1 as the preferred specification. The implications from this re-estimation of the demand for money conditional on a measure of net wealth is that the demand for broad money is a function of wealth as well as of income, and that omission of the former reduces the explanatory power of the model. While this result is consistent with the evidence of the role of wealth in the demand for money in industrialized economies, we have seen that the strong collinearity of this measure of wealth with gross national income in Kenya since 1973 has ensured that the extent of the long-run omitted variable bias in the single equation models is slight. Nonetheless, the increased explanatory power of the model conditioned on wealth, combined with the significant role for wealth in the demand share model clearly emphasise the importance to the research programme on asset substitution and the demand for money of developing consistent time-series data on financial and real wealth

4.7 Conclusions

The results presented in this chapter lead us to a number of conclusions. The first is that although the long-run solutions to the model exhibited some statistical weaknesses, the demand shares model provides as reasonably robust, and economically coherent description of the nature of and changes in financial and real asset holdings in Kenya since 1973. In particular it describes an environment where the private sector has a long-run equilibrium or target asset portfolio which is reasonably consistent with basic assumptions of demand theory, and that short-run deviations from this target are corrected relatively rapidly. Moreover, the interaction of the dynamic and long run features of the model accurately captures the salient features of the coffee-boom of 1976-79, and is consistent with existing research on the impact of temporary trade shocks on aggregate savings behaviour. Inflation plays an important role in the model and, in accordance with theoretical expectations the model, provides strong evidence of a "flight-from-money" in response to rising inflation, which corresponds to the negative cointegrating relationship between real money balances and inflation identified in Chapter 2. As expected interest-bearing deposits are partially sheltered from the effects of inflation, while it seems that non-traded capital has provided the best hedge against inflation.

Second, it is apparent that despite the presence of thin financial and asset markets, there is evidence that relative price effects do impact on the determination of aggregate asset demands. Moreover there is quite clear evidence of a differential response pattern between tradable and non-tradable fixed capital formation, with the former exhibiting higher short-run price responsiveness and a concomitantly more rapid adjustment to disequilibrium. However because of the absence of markets and presence of a high degree of inter-temporal linkages in asset demands, the magnitude of relative price effects is low.

Third, the model indicates that the composition of the asset portfolio is determined by changes in the financial policy environment. In particular changes in the level of credit rationing and alterations in the structure of relative prices, including inflation are important factors, with the accumulation of tradable capital being much more sensitive to the nature of the financial policy environment than is non-tradable capital. In the final chapter this phenomenon is explored as we use the structure of the model to examine in some more detail the implications of this structure for the likely effects of programmes of inflation reduction and financial liberalization.

Finally, we have suggested that the inclusion of wealth in the single-equation models will lead to a better performing demand for money functions, although in the special case experienced in Kenya where income and wealth are strongly cointegrated, the exclusion of wealth from the demand for broad money will not lead to systemic failure of the model.

APPENDIX 4(A)
COMPARISON OF LOG-LINEAR AND DEMAND SHARE EQUATIONS

Comparison of the results from a log-linear and a demand-share model of asset demands is not straightforward since neither functional form nests the other. Moreover, because of the violation of the adding-up restrictions within the log-linear model, it is not possible to readily define a more general functional form which nests the two rivals. Formal encompassing tests are therefore not possible.

The solution adopted here is to proceed on an *ad hoc* basis, by estimating the individual demand equations using an unrestricted log-linear system of the form

(A4.1) $ln\ q_i = \alpha_i + \beta_i\ ln\ (x/P) + \delta_i ln\ (y/P) + \Sigma\gamma_{ij} ln\ (p_j/P)$,

which uses the same set of explanatory variables as the demand systems model, and then compare the derived price and income elasticities between the two approaches. In general we would expect the log-linear specification has the advantage of being a much less restrictive functional form on an equation-by-equation basis, and therefore may be expected to be more data coherent and less prone to mis-specification error. Against this, however, is the problem that this form of log-linear demand system violates the adding-up restriction on demands, except under restrictive conditions concerning the Engel curves.[134]

Because the rival systems are non-nested, it is unlikely that we could expect to derive any firm conclusions about the preferred specification of the short-run dynamic relationships in the data, and we therefore restrict our test to an examination of the long run equations only. This we do

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[134] See Deaton and Muellbauer (1980)). Under a log-linear transformation the demand system is of the form

$$\ln q_i = \alpha_i + \beta_i \ln x + \Sigma\gamma_{ik} \ln p_k + u_i.$$

Under homogeneity we require that $\beta_i + \Sigma\gamma_{ik} = 0$, which is clearly testable on an equation-by-equation basis. However the adding up condition requires that the demand functions totally exhaust the budget constraint. Expressing the budget share identity ($s_i = p_i q_i/x$) as

$$\ln s_i = \ln p_i + \ln q_i - \ln x$$

we can substitute from the log-linear equation to give

$$\ln s_i = \alpha_i + (\beta_i - 1)\ln x + (\gamma_{ii} + 1) \ln p_i + \Sigma\gamma_{ik}\ln p_k$$

Adding up thus requires $\Sigma s_k\beta_k = 1$. This is achieved only if the demand system has unit Engel curves for all the commodities or there is at least one luxury good. In general we would not expect these conditions to hold.

by examining the overall statistical characteristics of the individual equations in the two systems and by comparing the long-run elasticities derived from the models. In view of the violation of the adding-up restriction our comparison is carried out on a strict equation-by-equation basis, rather than between the systems when taken together.

The results from the long-run solution to the log-linear model are reported in Table A4.1. The reported values can be compared directly with the mean value elasticities of the demand share model reported in the bottom half of Table 4.4(b) above. Though not reported, the time series characteristics of the real asset values are, because of the constancy of real wealth, virtually identical to those of the wealth-deflated asset shares. Starting with the structure of the equation residuals, we note that the time series characteristics of the equations are broadly similar. There is no discernable difference in the goodness of fit between the two systems, and as figures A4.1(a) to (f) show, there is no systematic differences between the two errors.

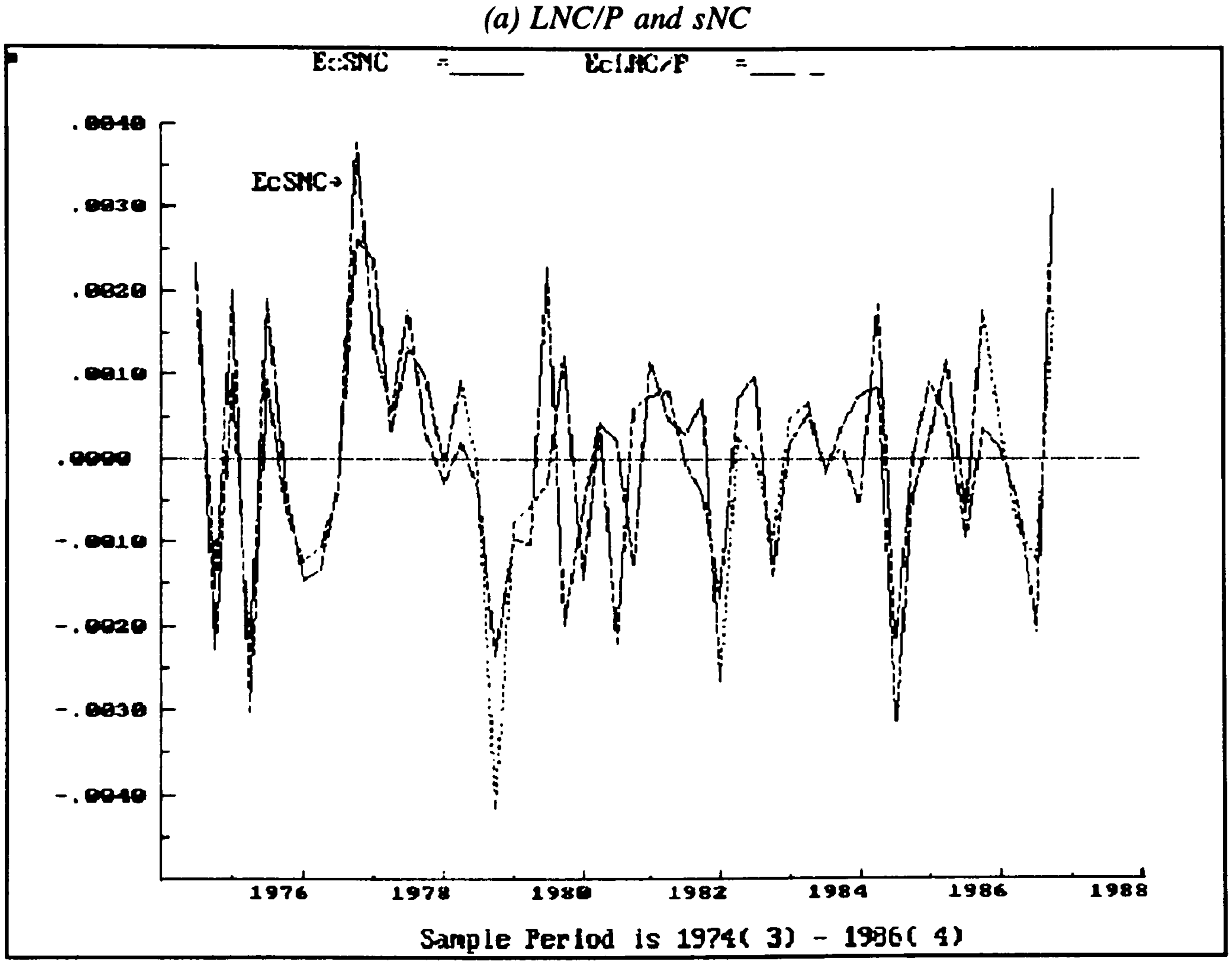
Table A4.1 Long-Run Solution to Log-Linear Demand Equations

Sample 1974:1 to 1986:4

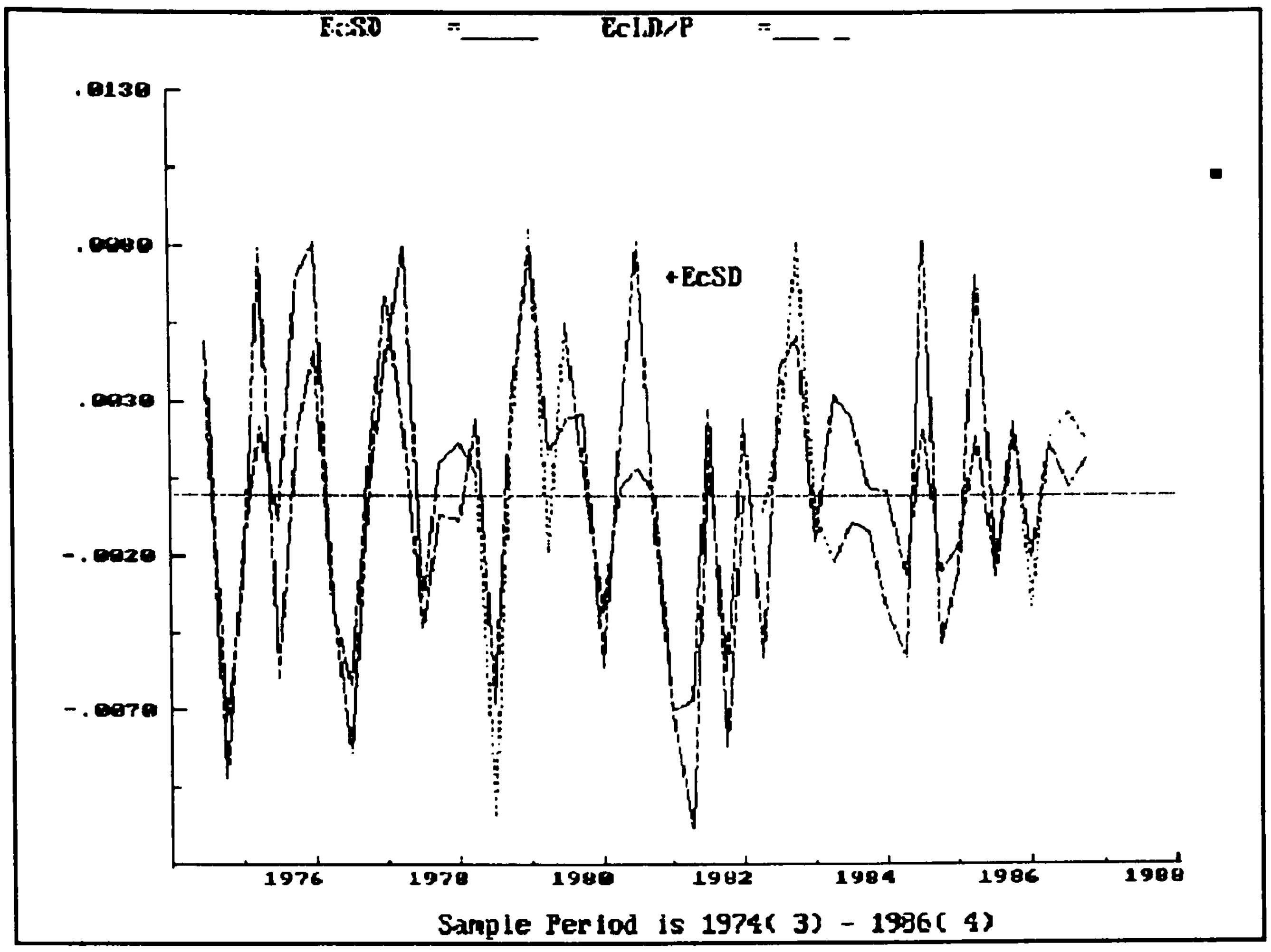
Share	(CNST)	(z)	(LPNC)	(LPND)	(LPGS)	(LPNTK)	(LPTK)	(LPTI)	(Lw)	(Ly)	DW	R2	s.e	s.d
LNC/P	-3.689	0.000	-4.898	7.224	-0.755	0.152	-0.004	0.450	0.873	0.209	2.114	0.939	0.036	0.116
	(0.04)		(1.63)	(1.50)	(2.33)	(1.35)	(1.50)	(1.71)	(3.83)	(1.12)				
LD/P	-1.489	0.578	12.540	-0.696	-1.180	-0.389	1.671	-1.730	1.169	-0.124	2.111	0.992	0.015	0.134
	(0.39)	(0.98)	(5.30)	(1.89)	(1.90)	(3.14)	(1.85)	(2.78)	(15.00)	(0.28)				
LGS/P	2.600	1.492	-15.278	17.222	1.597	0.119	-1.680	0.978	2.778	-1.011	2.089	0.985	0.059	0.407
	(0.31)	(1.61)	(2.13)	(2.15)	(1.85)	(0.79)	(1.62)	(1.34)	(2.46)	(1.72)				
LNTK/P	18.630	0.815	2.600	-33.248	8.980	-1.176	-1.965	-2.617	-0.519	-0.826	2.213	0.991	0.013	0.107
	(0.99)	(1.01)	(3.36)	(3.72)	(3.02)	(2.41)	(1.62)	(2.35)	(3.10)	(2.44)				
LTK/P	5.936	-0.534	-21.178	19.652	-1.898	-0.072	-0.682	-0.125	0.705	-0.159	2.204	0.984	0.012	0.078
	(2.59)	(1.95)	(4.55)	(4.37)	(0.76)	(1.63)	(2.70)	(0.64)	(5.11)	(0.96)				
LI/P	-5.257	0.551	11.026	-12.874	0.706	-0.023	-0.444	0.923	2.190	-0.388	2.144	0.849	0.037	0.078
	(1.06)	(1.58)	(1.14)	(1.23)	(1.65)	(1.92)	(1.95)	(2.72)	(3.72)	(1.25)				

Neither approach provides an unambiguously better description of the data, and in both cases the DW and ADF tests for the stationarity of the residuals indicate the same stationary structure. With the exception of the constant term in each equation, and the inflation and deposit-rate terms in the NTK equation, the two models recover broadly the same elasticities: the derived coefficients of the demand share model all lie well within the two standard errors of the estimates from the log-linear demand shares. Given the constancy or real wealth over the long run, these results are not surprising. Constancy of real wealth simply means that the time-series of nominal wealth and the general price level are virtually identical (when normalized), and thus in this special case the demand functions are invariant to scaling of nominal demands by either nominal wealth (the demand share model) or by prices. In general, when real wealth is not so constant over time, this equivalence will not hold.

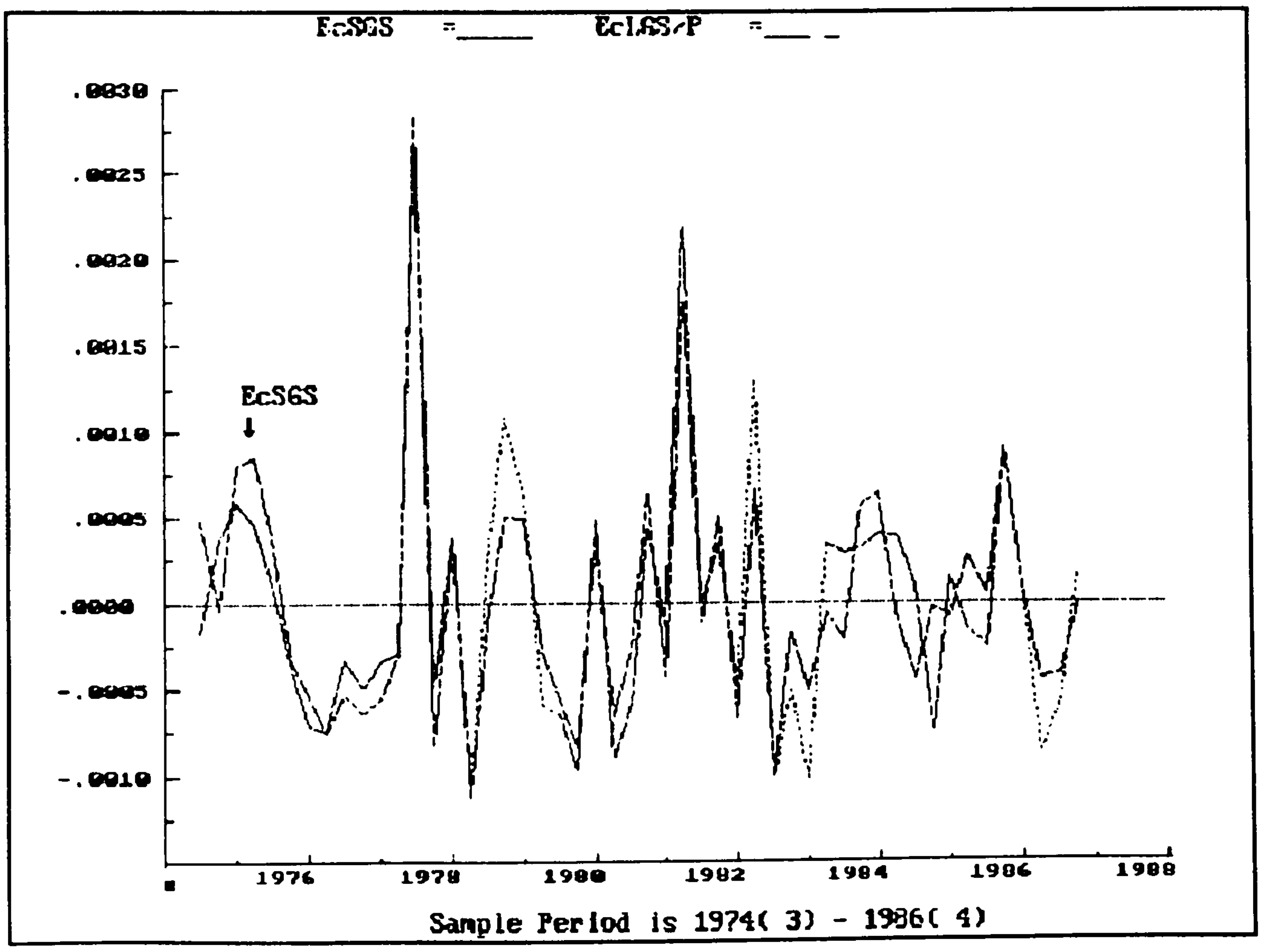
Figure A1
Scaled Residuals from Demand Share and Log-Linear Models
(a) LNC/P and sNC



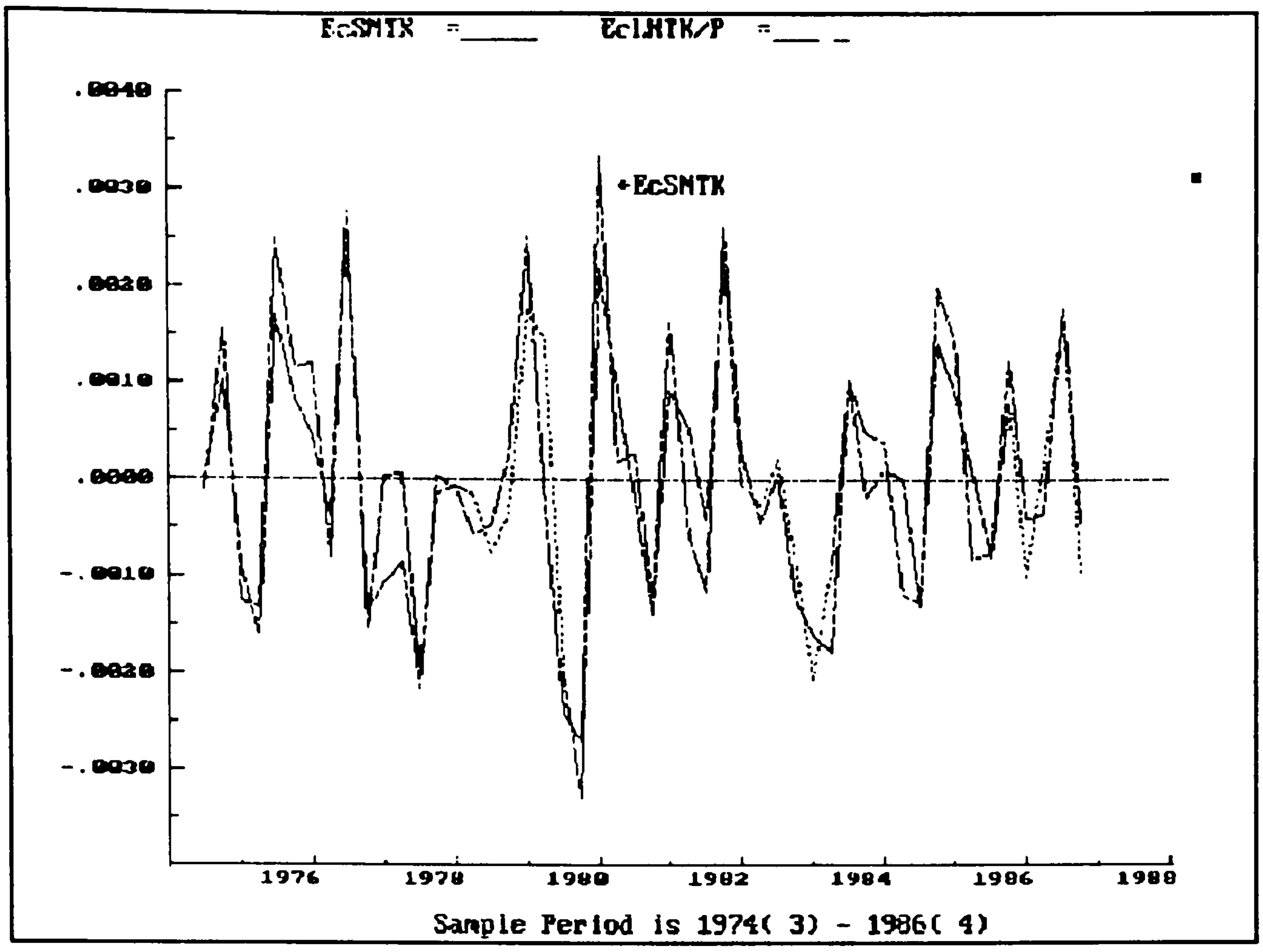
(b) LD/P AND sD



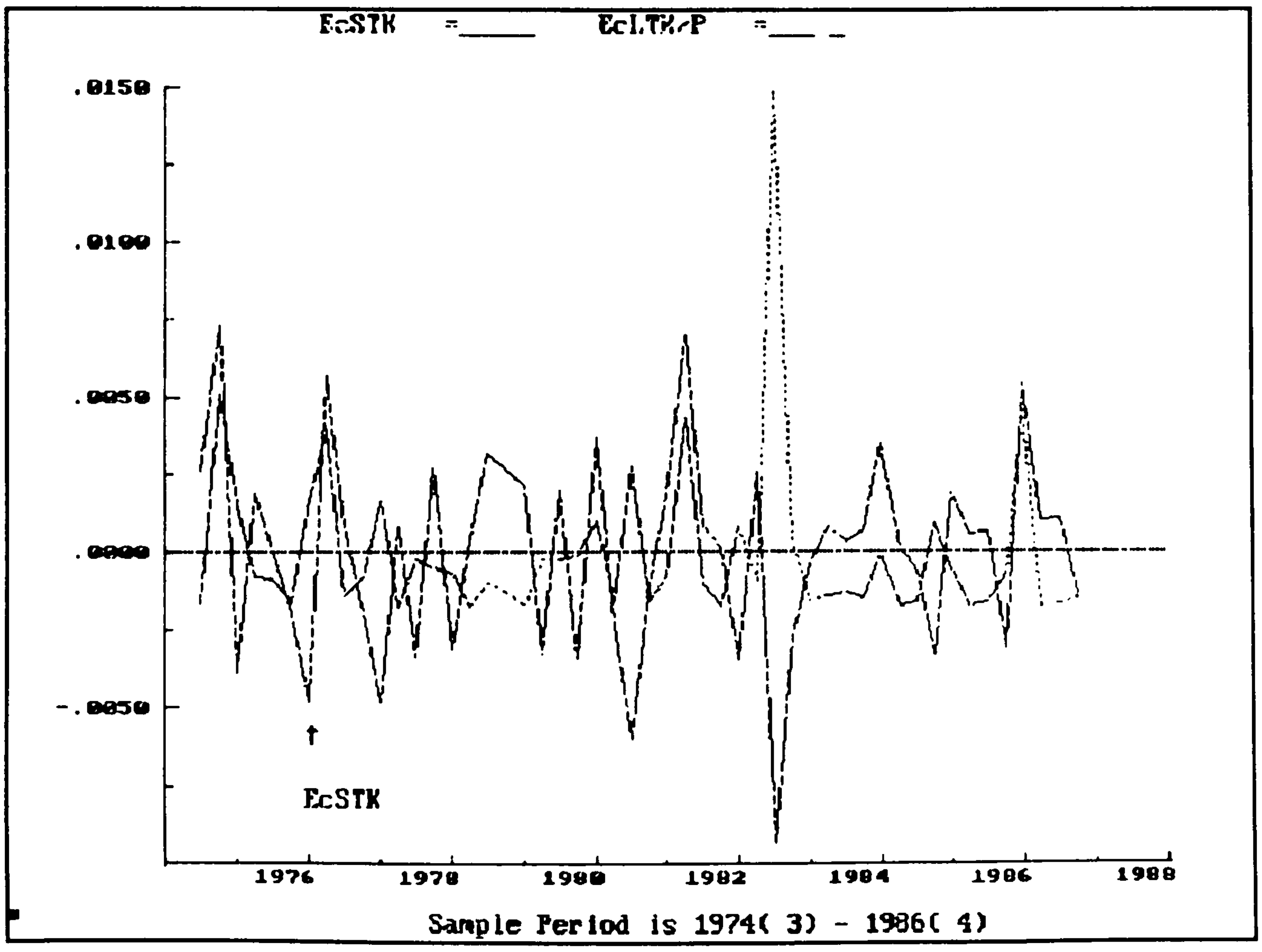
(c) LGS/P and sGS



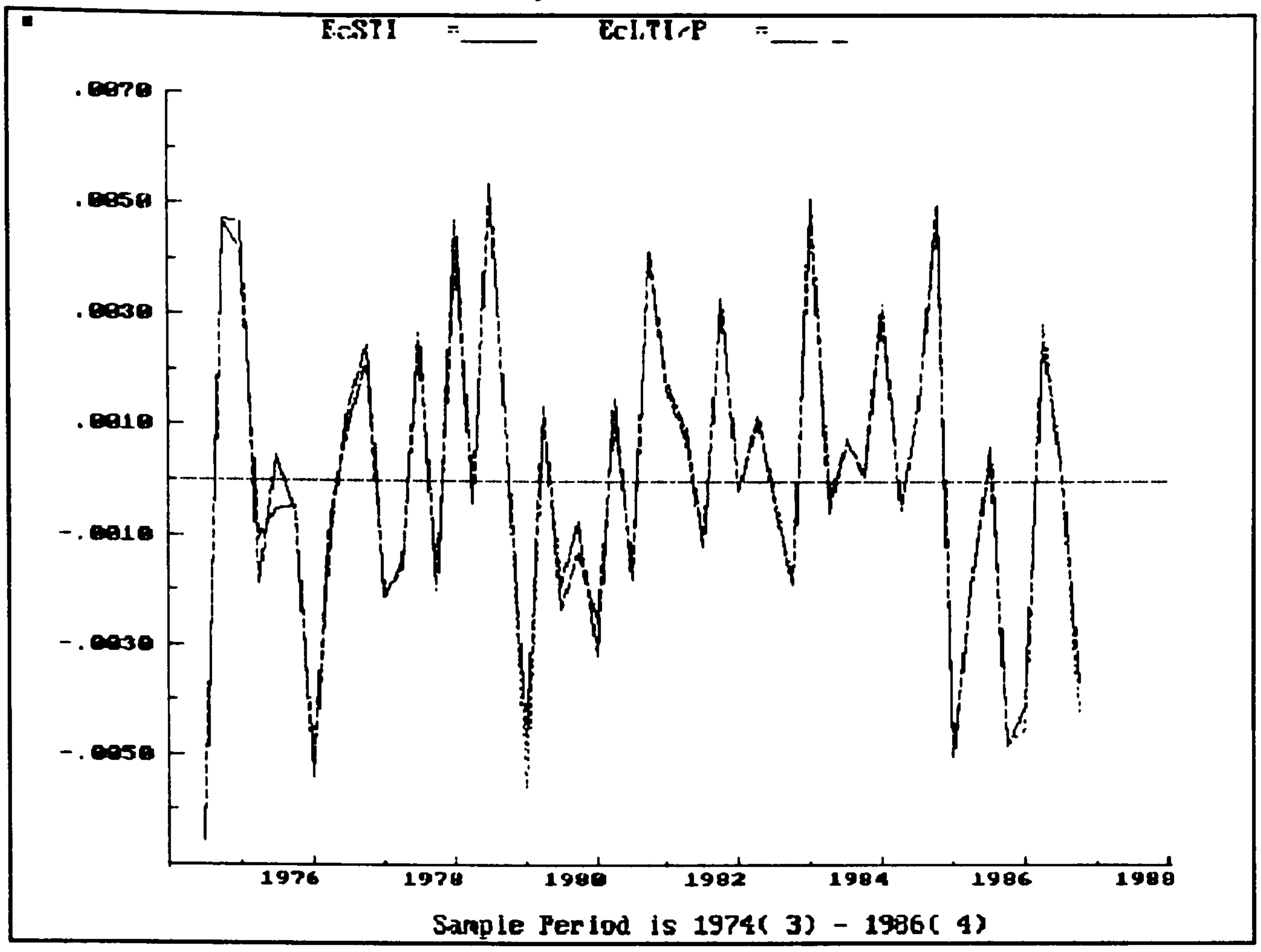
(d) LNTK/P and sNTK



(e) LTK/P and sTK



(f) LI/P and sI


EcSTI =
EcLTI/P =
.0070
.0050
.0030
.0010
-.0010
-.0030
-.0050
1976
1978
1980
1982
1984
1986
1988
Sample Period is 1974(3) - 1986(4)

APPENDIX 4(B)
DYNAMIC RATIONED ASSET SHARE EQUATIONS

EQ(A4.1) Modelling ΔsNC by OLS: Sample is 1974(2) to 1987(1)

Variable	Coefficient	Std Error	H.C.S.E	t-Value	Partial r^2
EcSNC 1	-.4297059	.12060	.12112	-3.56320	.2280
ΔLPGS 2	-.0163784	.00742	.00502	-2.20846	.1019
ΔLY 3	.0107118	.00488	.00370	2.19363	.1006
Δ2ΔLrd	-.4188901	.22456	.20759	-1.86540	.0749
Σ03ΔLPNC	-.1066112	.05770	.05445	-1.84776	.0736
CONSTANT	.0048397	.00052	.00067	9.36750	.6711
Q 1	-.0076779	.00073	.00077	-10.48061	.7187
Q 2	-.0078206	.00077	.00076	-10.20785	.7079
Q 3	-.0036630	.00071	.00086	-5.15492	.3819

R^2 = .8145 σ = .0017926 F(8, 43) = 23.56 [.0000] DW = 1.779

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(4, 39) = .89 [.4782]	F(4, 43) = .40 [.8090]
F(3, 40) = .85 [.4728]	F(3, 45) = .92 [.3655]
F(2, 41) = 1.26 [.2941]	F(2, 47) = 1.21 [.3079]
F(1, 42) = 1.01 [.3208]	F(1, 49) = .93 [.3394]

Jarque - Bera Test for Error Normality χ^2 (2) = 4.469
White's Heteroscedastic Error Test F(18, 28) = .4143 [.9521]

One-Step Forecast Analysis 1983 Q2 to 1987 Q1

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-value
1983 2	-.004109	-.003199	-.000910	.002390	-.380558
1983 3	.000231	.000501	-.000270	.002159	-.124961
1983 4	.004026	.003651	.000375	.002153	.174210
1984 1	-.001793	-.002097	.000304	.002195	.138457
1984 2	-.004528	-.005820	.001291	.002367	.545568
1984 3	-.003030	.001052	-.004081	.002202	-1.853153
1984 4	.006611	.005277	.001333	.002497	.533926
1985 1	-.001680	-.001529	-.000151	.002253	-.066977
1985 2	-.001674	-.002172	.000498	.002181	.228430
1985 3	-.000023	.002215	-.002239	.002181	-1.026370
1985 4	.006365	.005768	.000597	.002175	.274476
1986 1	-.002030	-.000514	-.001516	.002320	-.653449
1986 2	-.001789	-.000761	-.001028	.002246	-.457665
1986 3	.000175	.001485	-.001311	.002163	-.605845
1986 4	.007027	.005601	.001426	.002203	.647374
1987 1	-.003264	-.003553	.000289	.002270	.127399

Tests of Parameter Constancy over:		1983(2) - 1987(1)
Forecast $\chi^2(16)/16$	=	.52
Chow Test F(16, 34)	=	.37
Zero Forecast Innovation t(15)	=	.85

EQ(A4.2) Modelling ΔsD by OLS: Sample is 1974(2) to 1987(1)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
ECsD 1	-.1484138	.08397	.08123	-1.76749	.0842
ΔLrd	3.1461836	.81052	.87650	3.88169	.3071
ΔΔLPGS	-.0651723	.01445	.01850	-4.51105	.3744
ΔLPNTK 2	.0055258	.00299	.00312	1.84550	.0911
ΔLWZ	.1758920	.02461	.02876	7.14820	.6005
ΔLWZ 2	-.0545186	.02532	.02223	-2.15285	.1200
$\Delta^2\Delta z$	.0763142	.01556	.02156	4.90299	.4142
Σ02ΔLY 1	-.0744909	.03113	.03212	-2.39292	.1441
ΔsD 1	.4496876	.09132	.09875	4.92457	.4163
ΔsD 3	.1852708	.08310	.08321	2.22961	.1276
ΔLPNC	.3748368	.07189	.07764	5.21379	.4443
ΔLPNC 3	.2759475	.05572	.05432	4.95236	.4191
CONSTANT	-.0059587	.00157	.00202	-3.79947	.2980
Q 1	.0113405	.00209	.00210	5.41394	.4630
Q 2	.0113694	.00228	.00221	4.99302	.4230
Q 3	.0083123	.00201	.00198	4.13834	.3350

R^2 = .8509091 σ = .0042029 F(15, 34) = 12.94 [.0000] DW = 1.804

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(4, 36) = .85 [.5025]	F(4, 36) = .64 [.6362]
F(3, 35) = .22 [.8820]	F(3, 34) = .32 [.8550]
F(2, 34) = .33 [.7228]	F(2, 32) = .75 [.4654]
F(1, 33) = .51 [.4822]	F(1, 30) = .48 [.7394]

Jarque - Bera Test for Error Normality χ^2 (2) = 0.318

One-Step Forecast Analysis 1983 Q2 to 1987 Q1

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-Value
1983 2	-.002494	-.007868	.005374	.005698	.943141
1983 3	.007295	.009458	-.002163	.005324	-.406357
1983 4	.004299	.004184	.000115	.005778	.019888
1984 1	.003732	.004321	-.000589	.004979	-.118262
1984 2	.013884	.022861	-.008977	.006348	-1.414081
1984 3	.018160	.015999	.002161	.005574	.387658
1984 4	.000242	.006024	-.005782	.005129	-1.127137
1985 1	-.004951	-.009929	.004978	.005707	.872217
1985 2	.001158	-.007757	.008915	.005017	1.776937
1985 3	.001510	.011040	-.009530	.006384	-1.492799
1985 4	-.003388	-.002568	-.000820	.005918	-.138587
1986 1	.011306	.014690	-.003384	.005300	-.638583
1986 2	.005677	.005391	.000286	.004990	.057388
1986 3	.006111	.002813	.003298	.005883	.560584
1986 4	-.000813	-.000528	-.000285	.005423	-.052598
1987 1	.011422	.005820	.005603	.005557	1.008144

Tests of Parameter Constancy over: 1983(2) - 1987(1)

Forecast $\chi^2(16)/16$	=	1.24
Chow Test F(16, 34)	=	.66
Zero Forecast Innovation t(15)	=	-.97

EQ(A4.3) Modelling ΔsGS by OLS: Sample is 1974(2) to 1987(1)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
Σ12ΔLPNC	.0262875	.00712	.00718	3.69362	.2452
ΔLrd	-.3277480	.09931	.08905	-3.30035	.2059
Σ01ΔLPNTK	-.0010132	.00047	.00044	-2.16706	.1006
ΔLPTK	.0124915	.00525	.00507	2.38055	.1189
ΔΔLWZ 2	.0130208	.00239	.00311	5.45930	.4151
Δz 1	.0060465	.00299	.00357	2.02017	.0886
ECsGS 1	-.2947274	.10934	.12925	-2.69542	.1475
Δ^2ΔLY	.0033018	.00124	.00149	2.65455	.1437
Δ^3ΔLPGS	-.0082992	.00252	.00221	-3.28764	.2047
CONSTANT	-.0002596	.00016	.00016	-1.58125	.0562
Q 3	.0004490	.00025	.00024	1.79816	.0715

R^2 = .6038612 σ = .0006713 F(10, 42) = 6.40 [.0000] DW = 1.495

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(4, 38) = 1.65 [.1808]	F(4, 38) = .89 [.4804]
F(3, 37) = 2.26 [.0970]	F(3, 36) = 1.16 [.3390]
F(2, 36) = 3.47 [.0407]	F(2, 34) = 1.08 [.3550]
F(1, 35) = 5.97 [.0189]	F(1, 32) = 2.98 [.0919]

Jarque - Bera Test for Error Normality χ^2 (2) = 1.122
White's Heteroscedastic Error Test F(19, 22) = 1.1134 [.4010]

One-Step Forecast Analysis 1983 Q2 to 1987 Q1

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-Value
1983 2	-.000170	.000263	-.000433	.000820	-.527980
1983 3	-.000364	.000124	-.000488	.000841	-.580997
1983 4	-.000761	-.002171	.001411	.001125	1.254480
1984 1	.000149	-.001374	.001523	.000865	1.760496
1984 2	-.000300	-.000591	.000291	.000911	.319591
1984 3	-.000578	.000244	-.000822	.000827	-.993756
1984 4	-.000535	-.000716	.000181	.000752	.240916
1985 1	.000352	.000793	-.000441	.000880	-.500825
1985 2	-.000195	-.000888	.000694	.000843	.822393
1985 3	-.000167	-.000140	-.000026	.000813	-.032438
1985 4	.000122	.000434	-.000312	.001182	-.263895
1986 1	-.000188	-.001013	.000825	.000801	1.030262
1986 2	-.000451	.000461	-.000912	.000797	-1.144742
1986 3	-.000220	.000365	-.000585	.000858	-.681901
1986 4	.000017	-.000273	.000290	.000799	.363393
1987 1	-.000272	-.001606	.001334	.000968	1.378358

Tests of Parameter Constancy over: 1983(2) - 1987(1)

Forecast $\chi^2(16)/16$	=	1.18
Chow Test F(16, 34)	=	.61
Zero Forecast Innovation t(15)	=	1.18

EQ(A4.4) Modelling ΔsNTK by OLS: Sample is 1974(2) to 1987(1)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
ΔSNTK 1	.4151399	.07981	.08764	5.20181	.4096
ΔLPNC 3	-.1013186	.02536	.03022	-3.99458	.2903
ΔLrd	-2.0976815	.27021	.25430	-7.76324	.6071
ΔLPGS 3	.0193863	.00815	.00812	2.37919	.1267
$\Delta^2\Delta$LPNTK	.0023440	.00097	.00100	2.41360	.1300
ΔLPNTK 3	-.0052089	.00134	.00222	3.88185	.2787
$\Delta^2\Delta$LPTK1	-.0242460	.01031	.01543	-2.35206	.1242
$\Delta^3\Delta$LY	.0160910	.00317	.00360	5.07744	.3980
ΔLWZ	-.0395010	.00811	.00853	-4.87065	.3782
ECsNTK 1	-.1539552	.04970	.06674	-3.09784	.1975
Δz	.0254732	.00856	.00932	2.97702	.1852
CONSTANT	.0005275	.00047	.00005	1.11517	.0309
Q 3	-.0025203	.00065	.00061	-3.89368	.2799

R^2 = .8188326 σ = .0016614 F(12, 39) = 14.69 [.0000] DW = 1.652

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(4, 35) = 1.91 [.1308]	F(4, 31) = .79 [.5437]
F(3, 34) = 2.34 [.0890]	F(3, 29) = 1.11 [.3601]
F(2, 33) = 1.03 [.3681]	F(2, 27) = 1.71 [.1950]
F(1, 32) = 1.71 [.1983]	F(1, 25) = 3.37 [.0746]

Jarque - Bera Test for Error Normality χ^2 (2) = 1.195
White's Heteroscedastic Error Test F(23, 15) = .4610 [.5215]

One-Step Forecast Analysis 1983 Q2 to 1987 Q1

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-Value
1983 2	-.000155	.003609	-.003764	.001830	-2.057083
1983 3	-.003903	.001073	-.004976	.002048	-2.429858
1983 4	-.002463	-.004039	.001575	.001928	.817114
1984 1	.000499	.001248	-.000749	.002364	-.316821
1984 2	-.002800	-.003162	.000362	.002107	.171559
1984 3	-.005131	-.005444	.000312	.002427	.128718
1984 4	.000415	-.000492	.000907	.002074	.437502
1985 1	.000566	.001136	-.000570	.002351	-.242573
1985 2	.000267	-.000483	.000751	.001899	.395174
1985 3	-.002501	-.003054	.000553	.002085	.265122
1985 4	-.000189	-.000938	.000750	.002171	.345410
1986 1	-.006328	-.007911	.001583	.002371	.667687
1986 2	-.002407	-.001705	-.000702	.002004	-.350119
1986 3	-.002105	-.003271	.001166	.002388	.488305
1986 4	-.002217	-.001492	-.000726	.001848	-.392590
1987 1	-.000626	-.000748	.000123	.001909	.064181

Tests of Parameter Constancy over: 1983(2) - 1987(1)
Forecast $\chi^2(16)/16$ = 1.07
Chow Test F(16, 34) = .86

EQ(A4.5) Modelling ΔsTK by OLS: Sample is 1974(2) to 1987(1)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
ΣΔSTK12	.4210253	.08018	.07972	5.25122	.3963
ECsTK 1	-.1875392	.08860	.08646	-2.11668	.0964
ΣΔLPNC23	-.1961340	.03633	.02841	-5.39834	.4096
ΔΔLPNTK	-.0023306	.00133	.00156	-1.74776	.0678
ΔLPTK 2	-.0546907	.02612	.03032	-2.09394	.0945
ΔLY	.0228107	.00903	.00824	2.52700	.1320
ΔLWZ	-.1345424	.01679	.01368	-8.01492	.6047
Δz 2	-.0403577	.01463	.01379	-2.75774	.1533
ΔLPGS 1	-.0431414	.01461	.01418	-2.95303	.1719
CONSTANT	-.0021006	.00085	.00074	-2.48364	.1281

R^2 = .7223372 σ = .0034957 F(9, 42) = 12.14 [.0000] DW = 2.069

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(4, 38) = .84 [.5085]	F(4, 34) = .34 [.8484]
F(3, 39) = 1.11 [.3571]	F(3, 36) = .41 [.7483]
F(2, 40) = 1.71 [.1946]	F(2, 38) = .63 [.5402]
F(1, 41) = .17 [.6816]	F(1, 40) = 1.46 [.2343]

Jarque - Bera Test for Error Normality	χ^2 (2) = 1.290
White's Heteroscedastic Error Test	F(18, 23) = .8217 [.5215]

One-Step Forecast Analysis 1983 Q2 to 1987 Q1

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-Value
1983 2	.007548	.008487	-.000939	.004927	-.190515
1983 3	-.001356	-.001537	.000180	.004532	.039778
1983 4	-.005151	-.007306	.002155	.004173	.516510
1984 1	-.001546	-.004217	.002671	.004617	.578603
1984 2	-.005598	-.011741	.006143	.006737	.911803
1984 3	-.005656	-.002906	-.002750	.004394	-.625881
1984 4	-.005703	-.004261	-.001441	.004309	-.334490
1985 1	.006602	-.000180	.006782	.004869	1.392860
1985 2	.001715	.008734	-.007019	.004920	-1.426585
1985 3	.001068	-.001096	.002163	.004710	.459354
1985 4	-.000505	-.003020	.002515	.004330	.580811
1986 1	.001968	-.000270	.002238	.005264	.425154
1986 2	-.003346	.007332	-.010678	.007175	-1.488204
1986 3	-.002622	-.001212	-.001410	.004787	-.294574
1986 4	-.001146	-.002743	.001598	.004528	.352826
1987 1	-.001441	.001076	-.002517	.004423	-.569104

Tests of Parameter Constancy over:		1983(2) - 1987(1)
Forecast $\chi^2(16)/16$	=	1.19
Chow Test F(16, 34)	=	.72
Zero Forecast Innovation t(15)	=	.15

EQ(A4.6) Modelling ΔsTI by OLS: Sample is 1974(2) to 1987(1)

Variable	Coefficient	Std Error	H.C.S.E.	t-Value	Partial r^2
ΔSTI 1	.3919738	.12779	.14159	3.06741	.1944
ECsTI 1	-.4911411	.12568	.12781	-3.90781	.2814
ΔLPNC 3	-.1394694	.04669	.03248	-2.98721	.1862
ΣΔLrd03	-1.2935800	.44535	.48655	-2.90466	.1779
ΔLPNTK	.0085630	.00227	.00235	3.76739	.2668
ΣΔLPTI12	-.0174998	.00962	.00875	-1.82002	.0783
ΔLWZ 1	-.0534211	.01550	.01316	-3.44683	.2335
Δz	.0400141	.01619	.01810	2.47104	.1354
ΔLPGS 2	-.0315134	.01537	.01595	-2.05014	.0973
CONSTANT	.0031015	.00129	.00149	2.39671	.1284
Q 1	-.0031886	.00145	.00176	-2.19329	.1098
Q 2	-.0029449	.00149	.00131	-1.97891	.0913
Q 3	-.0043793	.00153	.00140	-2.86239	.1736

R^2 = .5751015 σ = .0033040 F(12, 39) = 4.40 [.0002] DW = 1.918

LM Autocorrelation	LM Autoregressive Conditional Heteroscedasticity
F(4, 35) = .37 [.8318]	F(4, 31) = .42 [.7952]
F(3, 36) = .09 [.9627]	F(3, 33) = .51 [.6754]
F(2, 37) = .01 [.9897]	F(2, 35) = .17 [.8406]
F(1, 38) = .00 [.9932]	F(1, 37) = .15 [.6966]

Jarque - Bera Test for Error Normality χ^2 (2) = .004
White's Heteroscedastic Error Test F(21, 17) = .4212 [.9689]

One-Step Forecast Analysis 1983 Q2 to 1987 Q1

Date	Actual	Forecast	Y - Yhat	Forecast SE	t-Value
1983 2	-.000620	.002047	-.002667	.003580	-.744947
1983 3	-.001903	.007343	-.009246	.003736	-2.475003
1983 4	.000050	.004910	-.004860	.003465	-1.402448
1984 1	-.001041	.001043	-.002084	.003823	-.544975
1984 2	-.000658	-.001943	.001285	.003741	.343410
1984 3	-.003765	-.010016	.006251	.003673	1.701971
1984 4	-.001030	-.002408	.001377	.003354	.410686
1985 1	-.000889	.002729	-.003618	.004228	-.855709
1985 2	-.001272	.002427	-.003699	.003946	-.937472
1985 3	.000114	-.001119	.001234	.003462	.356306
1985 4	-.002405	.002413	-.004818	.003439	-1.400887
1986 1	-.004728	-.003751	-.000977	.003524	-.277120
1986 2	.002316	.004504	-.002188	.004010	-.545639
1986 3	-.001339	-.002896	.001557	.004045	.384984
1986 4	-.002867	.002888	-.005755	.003603	-1.597468
1987 1	-.005820	.001214	-.007034	.003504	-2.007392

Tests of Parameter Constancy over: 1983(2) - 1987(1)
Forecast $\chi^2(16)/16$ = 1.98
Chow Test F(16, 34) = 1.31

APPENDIX 4(C)
RECURSIVE AUTOREGRESSIVE LEAST SQUARES ESTIMATE FOR ΔsGS

Variable	Coefficient	Std Error	t-Value
Σ12ΔLPNC	.02821	.00690	4.0897
ΔLrd	-.35396	.09187	3.8529
Σ01ΔLPNTK	-.00097	.00042	2.3185
ΔLPTK	.01336	.00503	2.6563
ΔΔLWZ 2	.01381	.00236	5.8514
Δz 1	.00971	.00349	2.7821
ECsGS 1	-.53588	.18600	2.8811
Δ^2ΔLY	.00313	.00103	3.0353
Δ^3ΔLPGS	.00984	.00208	4.7275
CONSTANT	-.00023	.00021	1.1213
Q 3	.00057	.00020	2.8528
Alpha 1	.47254	.20755	2.2767

σ = .00063282

APPENDIX 4(D)
DATA SOURCES AND DEFINITIONS

Name	Definition	Source
Raw Data		
NC	- Notes and Coin in Circulation with private sector	CBKQR
DD	- stock of non-interest bearing M1	CBKQR
CBD	- private sector deposits with the commercial banks	CBKQR
OFID	- private sector deposits with non-banks	CBKQR
TD	- total interest bearing deposits = CBD + OFID	
CBL	- private sector lending from commercial banks	CBKQR
OFIL	- private sector lending from non-banks	CBKQR
TL	- total lending to the private sector = CBL + OFIL	
RCD	- commercial bank savings deposit rate	CBKQR
ROFI	- OFI deposit rate	CBKQR
EX	- Kenya Shilling / US dollar exchange rate	CBKQR
TFE	- Nominal Gross Total Final Expenditure	(Chapter 2)
NSE	- Nairobi Stock Exchange Index	CBKQR
CPI	- IFS Consumer Price Index	IFS
BCI	- Building Cost Index	KSD
RENT	- Rental Price Index	KSD
BUILD	- New Building Completions	KSD
PVI	- Index of Sale price per square foot (Quarterly MA)	KSA
PTK	-Traded Capital Deflator	Bevan et al.(1990)/Text
TC	- Total Traded Capital Formation	KSD/Text
TK	- Traded Capital Stock	World Bank/Text
NTK	- Stock of Buildings	World Bank/Text
TI	- Stock of Inventories	BEE/Text
MEI	- Estimated marginal efficiency of investment for Traded Capital Stock	Text
MUV($)	- Industrial Country Manufacturing Unit Value (US$)	IFS

Notes: BEE = Business Expectations Enquiry; CBKQR = Central Bank of Kenya Quarterly Review; KSA = Kenya Statistical Abstract (Annual); KSD = Kenya Statistical Digest (Quarterly); IFS = International Financial Statistics.

Table A4.2
Demand Share Data

		sNC	sD	sGS	sNTK	sTK	sI
1974	I	0.058	0.311	0.020	0.155	0.349	0.107
	II	0.057	0.312	0.022	0.158	0.350	0.100
	III	0.061	0.306	0.023	0.163	0.352	0.095
	IV	0.059	0.293	0.022	0.165	0.352	0.109
1975	I	0.057	0.295	0.021	0.162	0.344	0.120
	II	0.052	0.304	0.020	0.163	0.346	0.115
	III	0.055	0.304	0.021	0.164	0.341	0.114
	IV	0.058	0.316	0.019	0.163	0.336	0.108
1976	I	0.056	0.329	0.019	0.163	0.334	0.100
	II	0.053	0.329	0.018	0.162	0.342	0.097
	III	0.056	0.332	0.017	0.159	0.338	0.098
	IV	0.066	0.332	0.016	0.155	0.332	0.098
1977	I	0.065	0.363	0.015	0.143	0.316	0.097
	II	0.062	0.379	0.015	0.137	0.315	0.092
	III	0.064	0.386	0.019	0.131	0.308	0.093
	IV	0.069	0.384	0.016	0.128	0.312	0.092
1978	I	0.064	0.387	0.015	0.122	0.313	0.098
	II	0.062	0.380	0.013	0.121	0.325	0.099
	III	0.060	0.374	0.013	0.118	0.335	0.099
	IV	0.060	0.377	0.013	0.116	0.334	0.099
1979	I	0.056	0.382	0.013	0.124	0.336	0.089
	II	0.054	0.388	0.012	0.126	0.330	0.089
	III	0.056	0.386	0.012	0.128	0.329	0.089
	IV	0.060	0.392	0.010	0.125	0.319	0.093
1980	I	0.058	0.390	0.011	0.127	0.327	0.088
	II	0.057	0.380	0.011	0.129	0.331	0.093
	III	0.056	0.385	0.010	0.129	0.328	0.092
	IV	0.063	0.368	0.011	0.129	0.333	0.096
1981	I	0.058	0.370	0.010	0.130	0.329	0.103
	II	0.056	0.357	0.012	0.133	0.337	0.104
	III	0.058	0.368	0.012	0.131	0.329	0.102
	IV	0.063	0.361	0.011	0.139	0.325	0.102
1982	I	0.054	0.364	0.011	0.139	0.331	0.100
	II	0.053	0.360	0.010	0.140	0.332	0.104
	III	0.052	0.377	0.010	0.137	0.320	0.105
	IV	0.057	0.393	0.009	0.134	0.306	0.100
1983	I	0.057	0.382	0.009	0.136	0.312	0.103
	II	0.053	0.380	0.009	0.136	0.320	0.102
	III	0.053	0.387	0.008	0.132	0.319	0.100
	IV	0.057	0.391	0.008	0.130	0.313	0.100
1984	I	0.055	0.395	0.008	0.130	0.312	0.099
	II	0.051	0.409	0.008	0.128	0.306	0.099
	III	0.048	0.427	0.007	0.122	0.301	0.095
	IV	0.054	0.427	0.006	0.123	0.295	0.094
1985	I	0.053	0.422	0.007	0.123	0.302	0.093
	II	0.051	0.424	0.007	0.124	0.303	0.092
	III	0.051	0.425	0.006	0.121	0.304	0.092
	IV	0.057	0.422	0.007	0.121	0.304	0.090
1986	I	0.055	0.433	0.006	0.115	0.306	0.085
	II	0.054	0.439	0.006	0.112	0.302	0.087
	III	0.054	0.445	0.006	0.110	0.300	0.086
	IV	0.061	0.444	0.006	0.108	0.299	0.083

Demand Share Data [contd]

		LpNC	LpD	LpGS	LpNTK	LpTK	LpI	Lcpi	Ly	Lwz
1974	I	0.008	0.002	0.003	0.102	-0.066	0.084	3.015	11.397	11.138
	II	0.009	0.002	0.025	0.268	-0.056	0.007	3.060	11.454	11.066
	III	0.010	0.002	0.026	0.487	-0.046	0.021	3.103	11.411	11.013
	IV	0.005	-0.002	0.027	0.148	-0.060	0.035	3.125	11.438	11.010
1975	I	0.015	0.008	0.032	0.041	-0.063	-0.031	3.190	11.375	11.008
	II	0.013	0.006	0.008	-0.089	-0.066	-0.073	3.243	11.400	10.981
	III	0.008	0.000	-0.029	-0.194	-0.070	0.119	3.272	11.348	10.992
	IV	0.007	0.000	-0.028	0.012	-0.086	-0.021	3.300	11.345	10.993
1976	I	0.014	0.006	-0.013	0.092	-0.079	-0.015	3.349	11.325	10.982
	II	0.008	0.000	-0.019	0.093	-0.071	-0.009	3.376	11.397	10.967
	III	0.005	-0.003	-0.026	0.089	-0.064	-0.007	3.391	11.431	11.005
	IV	0.005	-0.003	-0.020	0.120	-0.040	-0.004	3.408	11.468	11.015
1977	I	0.016	0.009	-0.059	0.057	-0.053	-0.012	3.459	11.379	11.070
	II	0.025	0.017	-0.073	0.241	-0.065	-0.011	3.533	11.388	11.054
	III	0.014	0.007	-0.100	0.010	-0.078	-0.049	3.573	11.534	11.068
	IV	0.015	0.006	-0.119	0.055	-0.095	0.006	3.613	11.596	11.069
1978	I	0.017	0.008	-0.088	0.086	-0.086	-0.005	3.656	11.542	11.072
	II	0.016	0.007	-0.068	-0.269	-0.077	-0.015	3.696	11.489	11.025
	III	0.009	0.001	-0.032	0.143	-0.068	-0.006	3.718	11.578	11.056
	IV	0.008	-0.001	0.038	-0.109	-0.056	0.024	3.737	11.498	11.092
1979	I	0.005	-0.004	0.031	-0.029	-0.053	-0.009	3.749	11.584	11.098
	II	0.008	-0.002	0.031	-0.093	-0.049	0.014	3.766	11.590	11.126
	III	0.008	-0.002	0.104	-0.052	-0.045	-0.002	3.784	11.555	11.141
	IV	0.015	0.005	-0.014	0.085	-0.040	0.067	3.816	11.500	11.168
1980	I	0.021	0.012	0.004	0.274	-0.039	-0.063	3.862	11.533	11.135
	II	0.019	0.009	-0.001	0.158	-0.037	0.018	3.901	11.458	11.085
	III	0.005	-0.007	-0.088	0.070	-0.036	-0.012	3.911	11.573	11.097
	IV	0.023	0.010	0.035	0.083	-0.055	0.042	3.956	11.487	11.057
1981	I	0.009	-0.004	-0.007	0.025	-0.067	-0.012	3.972	11.519	11.105
	II	0.015	-0.001	-0.004	0.083	-0.078	0.115	4.000	11.528	11.091
	III	0.015	-0.001	0.001	-0.126	-0.090	-0.001	4.027	11.524	11.126
	IV	0.031	0.011	-0.023	-0.063	-0.115	-0.006	4.079	11.466	11.110
1982	I	0.080	0.061	0.054	-0.071	-0.104	-0.034	4.202	11.417	11.005
	II	0.028	0.009	0.005	0.016	-0.093	-0.050	4.243	11.355	10.965
	III	0.022	0.002	-0.007	0.137	-0.083	0.092	4.273	11.438	10.988
	IV	0.016	-0.007	-0.029	0.141	-0.125	0.003	4.295	11.367	11.023
1983	I	0.024	0.001	-0.023	0.080	-0.111	-0.047	4.326	11.306	10.980
	II	0.019	-0.005	-0.034	0.252	-0.098	-0.028	4.350	11.388	10.962
	III	0.021	-0.003	-0.035	-0.028	-0.086	-0.026	4.377	11.368	10.972
	IV	0.015	-0.009	-0.033	-0.323	-0.040	-0.044	4.396	11.355	11.011
1984	I	0.022	-0.004	-0.026	0.012	-0.030	0.025	4.422	11.247	10.999
	II	0.023	0.000	-0.013	-0.184	-0.025	-0.045	4.448	11.319	10.995
	III	0.019	-0.004	-0.014	0.157	-0.025	-0.004	4.469	11.396	11.018
	IV	0.025	0.002	-0.008	0.319	-0.030	-0.047	4.497	11.418	11.008
1985	I	0.045	0.022	0.007	-0.297	-0.030	0.008	4.545	11.380	10.964
	II	0.035	0.012	-0.011	0.072	-0.060	0.040	4.581	11.404	10.936
	III	0.014	-0.010	-0.037	-0.032	-0.085	-0.019	4.595	11.442	10.938
	IV	0.010	-0.014	-0.054	0.011	-0.109	0.017	4.605	11.390	10.959
1986	I	0.004	-0.019	-0.067	0.289	-0.114	-0.031	4.609	11.426	11.036
	II	0.004	-0.019	-0.068	-0.072	-0.119	-0.021	4.614	11.432	11.067
	III	0.006	-0.016	-0.075	0.264	-0.125	-0.041	4.619	11.492	11.126
	IV	0.023	0.000	-0.057	-0.073	-0.122	-0.051	4.641	11.540	11.131

5

INFLATION REDUCTION, FINANCIAL LIBERALIZATION, AND THE PRIVATE SECTOR DEMAND FOR ASSETS.

To conclude the thesis we briefly consider the implications of the demand share model for the monetary and financial policies espoused by the Government of Kenya in the Sessional Paper No.1 of 1986 on *Economic Management for Renewed Growth* and implemented more recently through the 1989 World Bank Financial Sector Credit and the concurrent establishment of the Capital Markets Development Authority (CMDA).[135] As was noted in Chapter 1, the financial sector reform programme accelerated the deregulation of domestic interest rates - which were eventually fully liberalized in July 1991 - although administered rates had been rapidly revised upwards since the mid-1980s, and interest rate movements upon deregulation were consequently relatively modest. Accompanying this process of deregulation, the CMDA undertook measures to promote secondary trading in government bond and equity markets, principally through the creation of a regulatory environment for the financial sector.

The main steps taken towards the liberalization of the financial sector, such as the increase in administered interest rates and the development of the bond and inter-bank money markets, all occurred beyond the end of the sample period of the demand share model estimated in Chapter 4. To investigate the likely effects of these changes we therefore examine a series of out-of-sample forecast scenarios over the period from 1986 to 1991 to examine how the non-bank private sector would have responded had such policies of financial liberalization and inflation reduction (which may be expected to occur under the forms of monetary reform discussed in Chapter 3) occurred.

We address these questions by using the model from Chapter 4, which was estimated on data from the period from 1973 to 1986, to forecast changes in the

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See Mosley *et al* (1991), Chapter 10.

demand shares in the face of alternative policy scenarios. The initial values for the forecast model are calibrated using the actual data and demand shares as at the end of 1986. The structural demand equations used to generate the forecasts are the long-run cointegrating relationships presented in Table 4.4(b) of Chapter 4. Four alternative counterfactual scenarios are then presented. Each scenario differs only in terms of the four policy-influenced variables: the rate of inflation, the nominal rate of interest on government securities, the administered deposit rate of interest on domestic deposits with the banking sector, and the level of credit rationing. Otherwise we assume that the same underlying real economic conditions pertain. Specifically, we assume that the real rate of growth, the marginal efficiency of tradable capital, and the implicit real user cost of capital in the non-tradable sector are invariant to the changes in the policy variables. It is clear that these assumptions impose a strict and unrealistic partitioning between the independent variables of the model, particularly with respect to the relationship between inflation and the real rate of growth of income. As was established in the cointegration analysis from Chapter 2, this restriction is not wholly valid, since although the inflation rate and real income were not cointegrated (except through the demand for money function), there was a strong feedback from the inflation/interest rate equation onto income.[136] For reasons of tractability however, these additional cross-equation links could not be easily integrated into the demand systems model of Chapter 4.[137] As a consequence the scenarios provide an examination only of the first order effects of policy change on the composition of the asset portfolio.

The scenarios extend over a period of five years (from end 1986 to end 1991), and represent the evolution of the long-run cointegrating demand share models. It is also possible to generate short-term dynamic simulations for the model around these long-run relationships. However, since we have no strong *a*

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[136] This is identified from the second column of the α matrix of adjustment coefficients presented in Appendix 2(B).

[137] The integration of this form of asset structure into a general-equilibrium framework is beyond the scope of this thesis, and the integration of asset and financial markets into general-equilibrium models has not been widespread. See Brock (1989) and Romer (1985).

priori basis on which to determine the likely evolution of the short-run dynamic behaviour of the exogenous variables, we restrict ourselves to the analysis only of the former conditional demand share equations. Two facts suggest that this approach is acceptable. The first is that, ultimately, the policy measures are concerned with the evolution of the long-run demand structure. Secondly however, we have already established in Chapter 4 that the private sector's adjustment of its actual to its equilibrium portfolio composition is relatively rapid, with the error-correction coefficients from the dynamic demand share models indicating adjustment lags of between three and five quarters. Over the five year projection period, especially where the policy changes being modelled are monotonic, the loss of information as a result of examining only the evolution of the long-run solution may be expected to be relatively low. Indeed, as shall be noted below when we discuss the outturn of Scenario I, the relatively close tracking of the actual evolution of asset quantities suggests that this simplification is valid.

The four scenarios are presented in Table 5.1, and the detailed parameter values for the independent variables are presented in Table 5.2. In addition to each main scenario, where the nominal growth of credit to the private sector is maintained in line with the nominal growth of the economy (the A scenario) we also consider the outturn when credit growth is restricted (the B Scenario). Throughout we report only the change in the share of each asset in the total portfolio over the full forecast period.

Table 5.1
Alternative Scenarios on Demand Share Movements

Scenario	Description
I	Actual data from 1986 to 1989. Used to evaluate the accuracy of the forecast model.
II	Gradual Financial Liberalization with Actual Inflation. Based on financial sector policy statements by Capital Market Development Authority.
III	High Inflation Scenario with severe Financial Repression Policies.
IV	Low Inflation with Financial Liberalization Policies.

Table 5.2

Scenario Assumptions for Demand Share Model

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
SCENARIO I Actual Central Bank of Kenya Data 1986-91					
Inflation	8%	5%	9%	12%	15%
Nominal Stock Rate	12%	12%	14%	15%	15%
Nominal Deposit Rate	12%	10%	13%	13%	13%
Real Income Growth	3%	4%	4%	5%	5%
Real MEI	11%	6%	5%	5%	5%
Nominal Growth of Credit	17%	13%	19%	16%	15%
SCENARIO II Financial Liberalization (with Actual Inflation 1986-91)					
Inflation	8%	5%	9%	12%	15%
Nominal Stock Rate	12%	20%	25%	22%	22%
Nominal Deposit Rate	12%	14%	15%	17%	18%
Real Income Growth	3%	4%	4%	5%	5%
Real MEI	11%	6%	5%	5%	5%
Nominal Growth of Credit	17%	13%	19%	16%	15%
SCENARIO III High Inflation with Financial Repression					
Inflation	30%	30%	30%	30%	30%
Nominal Stock Rate	12%	14%	16%	18%	18%
Nominal Deposit Rate	8%	10%	12%	14%	16%
Real Income Growth	3%	4%	4%	5%	5%
Real MEI	11%	6%	5%	5%	5%
Nominal Growth of Credit	35%	35%	35%	35%	35%
SCENARIO IV Zero Inflation with Financial Liberalization					
Inflation	0%	0%	0%	0%	0%
Nominal Stock Rate	5%	5%	5.5%	6%	6%
Nominal Deposit Rate	4%	4%	4%	4%	4%
Real Income Growth	3%	4%	4%	5%	5%
Real MEI	11%	6%	5%	5%	5%
Nominal Growth of Credit	3%	4%	4%	5%	5%

This first scenario uses actual annual data[138] to provide a benchmark evaluation. Insufficient data exist with which to evaluate the accuracy of the model over the full period to 1991, particularly for the real capital assets, but as is demonstrated in Table 5.3 below, the results indicate that the model tracks the actual data up to the end of 1990 well. Scenario II, which is the principal scenario of interest, assumes that the process of financial liberalization which began in the early 1990s had, in fact, commenced in 1986. It thus assumes that from that point the real rate of return on financial assets is determined by market forces. Since however the policy statements issued by the government and the CMDA are qualitative rather than quantitative, we therefore make specific assumptions about the values for the rate of return on government stock and on domestic deposits over the scenario. In particular we assume that the counterfactual developed in Chapter 3 to estimate the implicit taxation on government securities prevails, so that government stock carries a rate of return which is determined by the uncovered interest rate parity condition between the SDR and the Kenyan Shilling.[139] Domestic deposit interest rates are assumed to move broadly in line with the rate on government stock, but to be lower in absolute terms, reflecting the nominal capital certainty and greater liquidity of the asset.

In contrast to the first two, Scenarios III and IV provide illustrations of how demand shares would have moved under other extreme conditions. Scenario III considers the case where domestic inflation is maintained at a high level (more than twice the revenue maximizing level) but where policies of financial repression are continued. In other words, domestic financial assets earn negative real rates of return. Scenario IV considers the opposite extreme where inflation is reduced to zero over the forecast period, and where domestic assets enjoy positive nominal (and thus positive real) rates of return. These latter two

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[138] All data are derived from the Central Bank of Kenya Quarterly Economic Review and the Economic Survey of the Central Bureau of Statistics. Data for 1990 on real variables are based on estimates contained in the Economic Survey (1991).

[139] It is important to stress that this form of interest rate determination is not contained in policy statements in either the Sessional Paper No.1 of 1986 or in statements from the CMDA.

scenarios are somewhat radical, and they implicitly assume not only that the relationships between the explanatory variables of the model are constant over the period, but that they are also super-exogenous for the parameters of the demand share model (see Engle and Hendry (1983)). In other words it is assumed that the parameters of the estimated model would be invariant to changes in the process determining the exogenous variables. This is clearly a very strong assumption and one that is not directly testable given the data. Therefore, although the estimated model was seen to exhibit a fair degree of parameter constancy over the period from 1973 to 1986, the results of the final two scenarios must nonetheless be interpreted with caution.

Results

We start by evaluating the accuracy of Scenario IA in tracking the actual evolution of the demand shares over the period from 1986 to 1991. As noted before, data on all the assets do not exist for the full period, and thus Table 5.3 reports the predicted nominal value of the demand shares with the actual outturn as at the end of 1990 (the final date for which data are available). Nonetheless the results suggest that the out-of-sample demand share model predictions track the actual evolution of asset demands with a reasonable degree of accuracy.[140]

[140] The difference in the total actual rationed asset stock and that predicted by the model reflects the deviation of the actual ratio of the total rationed wealth stock to income from that estimated by the model for the 1973 to 1986 period. It is this ratio, along with the volume of credit, which is used to forecast the total stock of rationed wealth .

Table 5.3

Actual vs Predicted Demands (Current Shillings)

Asset	Predicted	Actual	Prediction Error (%)
NC	8,971	9,654	-7.6%
D	69,809	64,204	8.1%
GS	4,861	2,612	46.2%
NTK	22,772	109,309(est)	-13.9%
TK	73,169		
TI	13,419	15,525	-15.6%
Total	193,001	201,304	- 4.3%

Notes: Data from CBK Economic Review, except for the estimated total capital stock which is derived from CBS Economic Survey 1991 estimate. Predicted values based on long-run cointegrating relationships in Table 4.4(b)

Despite the fact that the model forecasts only the values of the cointegrating relationships rather than their dynamic representation, the overall prediction errors are quite small. This reflects in part the relatively rapid speed of adjustment in the dynamic model, but is also to be expected in a model where the forecast series have historically low variances around their mean values (see Table 4.1 in Chapter 4). The largest forecast error occurs in the equation for government stocks which over-predicts the actual stock level by almost 50%. This result would seem to support the findings from Chapter 3 where concern was expressed that because of significant crowding-out by public sector financial institutions, the actual data was not in fact identifying the demand function, but rather the supply function for government securities. This is clearly consistent with the evidence presented in Chapter 1 that the 1986 "liquidity absorption" bond issue was taken up almost entirely by public sector institutions. While this result raises concerns about the interpretation of the underlying demand function for government securities, their relatively small share in the total portfolio means that it presents no fundamental problems for the interpretation of the other demand shares.

The prediction error for total fixed capital formation is also quite large, but this may be explained by the fact that not only is the actual total fixed capital stock based on an estimate of gross fixed capital formation, but the rate of return on fixed capital (principally the marginal efficiency of investment) is also based on official estimates for 1989 and 1990.

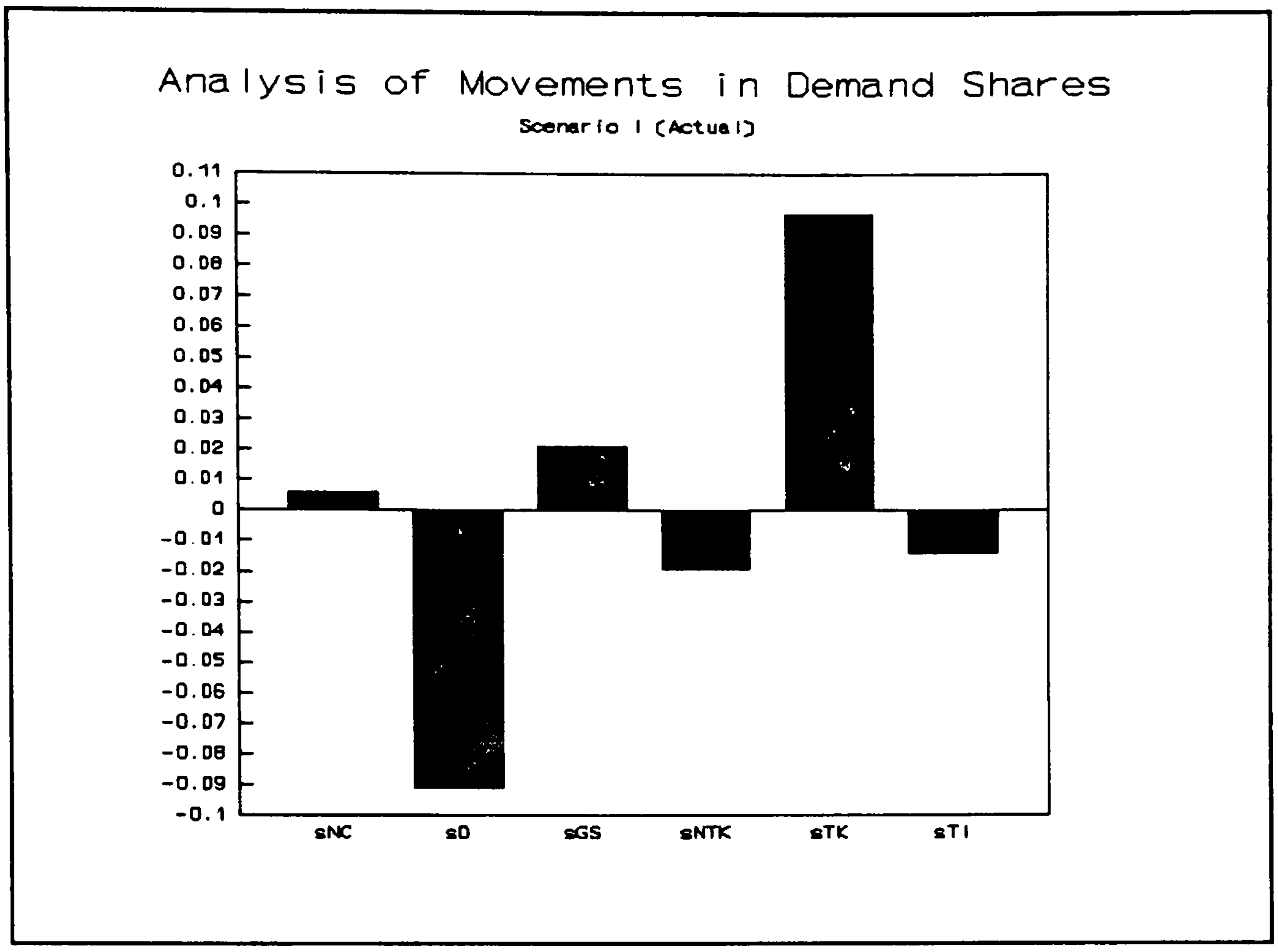
Table 5.4
Demand Share Five Year Forecasts

Asset	Scenario	IA	IB	IIA	IIB	IIIA	IIIB	IVA	IVB
sNC	1986	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%
	1991	5.5%	6.3%	5.4%	5.9%	4.4%	5.4%	6.4%	6.6%
	% Increase	12.2%	28.5%	10.2%	21.4%	-10.2%	10.8%	30.6%	34.6%
sD	1986	46.5%	46.5%	46.5%	46.5%	46.5%	46.5%	46.5%	46.5%
	1991	37.4%	43.2%	40.7%	45.3%	28.0%	36.2%	44.1%	45.1%
	% Increase	-19.5%	-7.1%	-12.4%	-2.5%	-39.7%	-22.0%	-5.0%	-3.0%
sGS	1986	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
	1991	3.0%	2.6%	3.3%	3.1%	4.2%	4.1%	2.1%	1.9%
	% Increase	212.1%	167.7%	242.4%	218.2%	333.3%	319.2%	121.2%	94.9%
sNTK	1986	14.1%	14.1%	14.1%	14.1%	14.1%	14.1%	14.1%	14.1%
	1991	12.2%	10.8%	11.9%	9.3%	18.1%	16.5%	7.2%	5.3%
	% Increase	-13.4%	-23.4%	-15.6%	-34.0%	28.3%	17.1%	-48.9%	-62.4%
sTK	1986	29.5%	29.5%	29.5%	29.5%	29.5%	29.5%	29.5%	29.5%
	1991	39.2%	35.3%	38.1%	36.4%	41.7%	40.5%	39.3%	37.5%
	% Increase	32.8%	19.6%	29.1%	23.3%	41.3%	37.2%	33.2%	27.1%
sTI	1986	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
	1991	2.6%	1.7%	0.5%	-0.1%	3.5%	-2.8%	0.7%	3.5%
	% Increase	-34.9%	-85.4%	-87.2%	-126.3%	-12.4%	-262.4%	-81.0%	8.6%
sK	1986	47.6%	47.6%	47.6%	47.6%	47.6%	47.6%	47.6%	47.6%
	1991	54.0%	47.8%	50.5%	45.6%	63.3%	54.1%	47.2%	46.3%
	% Increase	13.4%	-89.1%	6.0%	-137.0%	32.9%	-207.9%	-0.7%	-26.6%

Table 5.4 illustrates the asset share movements over the forecast period under the four scenarios. Figure 5.1 illustrates the predicted change in composition of the asset portfolio over the period from 1986 to 1991, as determined by Scenario IA. Although the macroeconomic environment has been relatively stable over the forecast period, the movements in the asset portfolio have been quite substantial. Although the demand shares for base money, non-traded capital and inventories have not altered greatly over the five year period, the data indicate a large switch, equivalent to almost 10 per cent of the portfolio, from financial assets with the banking sector into real capital accumulation. Part of this swing is, however, due to the disequilibrium levels of financial asset accumulation at the start of the period following the 1986 coffee boom. As with the coffee boom of the previous decade, and despite the attempts of the Central Bank of Kenya to absorb excess liquidity, the temporary windfall accruing to the private sector is held initially in the form of deposits with the banking sector before being substituted for real capital accumulation (see Table 3.7 in Chapter 3). Because of this specific event, Figure 5.1 overstates the long-run variation in the asset portfolio. It would be possible to avoid this phenomenon in the data by calibrating the forecast model using the demand shares as at the end of 1985, before the coffee boom. However to do so we would also have had to develop a series of counterfactual assumptions for the movement of the exogenous variables of the model to eliminate the effect of the coffee boom, and since we measure the effects of each scenario relative to the same baseline, the disequilibrium effect of the boom cancels out.

Figure 5.1

Percentage Change in Asset Composition



Despite the presence of this disequilibrium effect in the early stages of the forecast, a number of features emerge. The first is that in contrast to the coffee boom of 1976/77, the share of non-tradable capital in the total portfolio has not increased. It seems that in this case the moderate inflation rates (at levels at or below the revenue maximizing level determined in Chapter 3) resulted in the maintenance of a relatively stable share of cash and a slight reduction in the share of non-traded capital in total rationed wealth, which we noted in Chapter 4 seemed to provide the most attractive hedge against inflation. Secondly, combined with the reduction in inflation, the continued increase in the deposit rate of interest (which is closely correlated to the lending rate) is reflected in a reduction in the share of inventories whose rate of return is a negative function of the cost of working capital. Third, while the switch in composition between financial assets and real capital formation may be explicable in terms of the initial disequilibrium in the portfolio, the model also suggests that the principal determinant in this case is not the relative price effect, but the effect of the relaxation in the level of rationed credit. Improved credit availability to the private sector, especially in years 1 to 3 of the forecast period, has led to a reduction in the levels of excess liquidity in the banking sector and the growth in tradable capital accumulation. That it is this effect which explains much of the portfolio switch can be confirmed by examining the results from Scenario IB. Here it is assumed that the growth in real credit to the private sector is kept at 5% below the rate of inflation over the forecast period, and while other portfolio adjustments are similar, the switch from deposits to tradable capital formation is only 3 per cent (of the portfolio) rather than 9 per cent in the original scenario. As credit rationing therefore increases, excess liquidity increases *ceteris paribus*, and the share of bank deposits to real capital in the portfolio increases. As can be seen from Table 5.4, credit rationing operates in the same way across all the other scenarios.[141]

Table 5.4 and Figures 5.2 to 5.4 illustrate the change in the asset portfolio composition relative to the baseline (i.e. Scenario IA) under the other scenarios.

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[141] Note that under the credit rationing scenarios IIB and IIIB, the stock of inventories fall to virtually zero. This is clearly somewhat unrealistic, and reflects the fact that these scenarios can model only the first order effects of the policy changes.

Figure 5.2

Change in Portfolio Composition Relative to Baseline - Scenario II

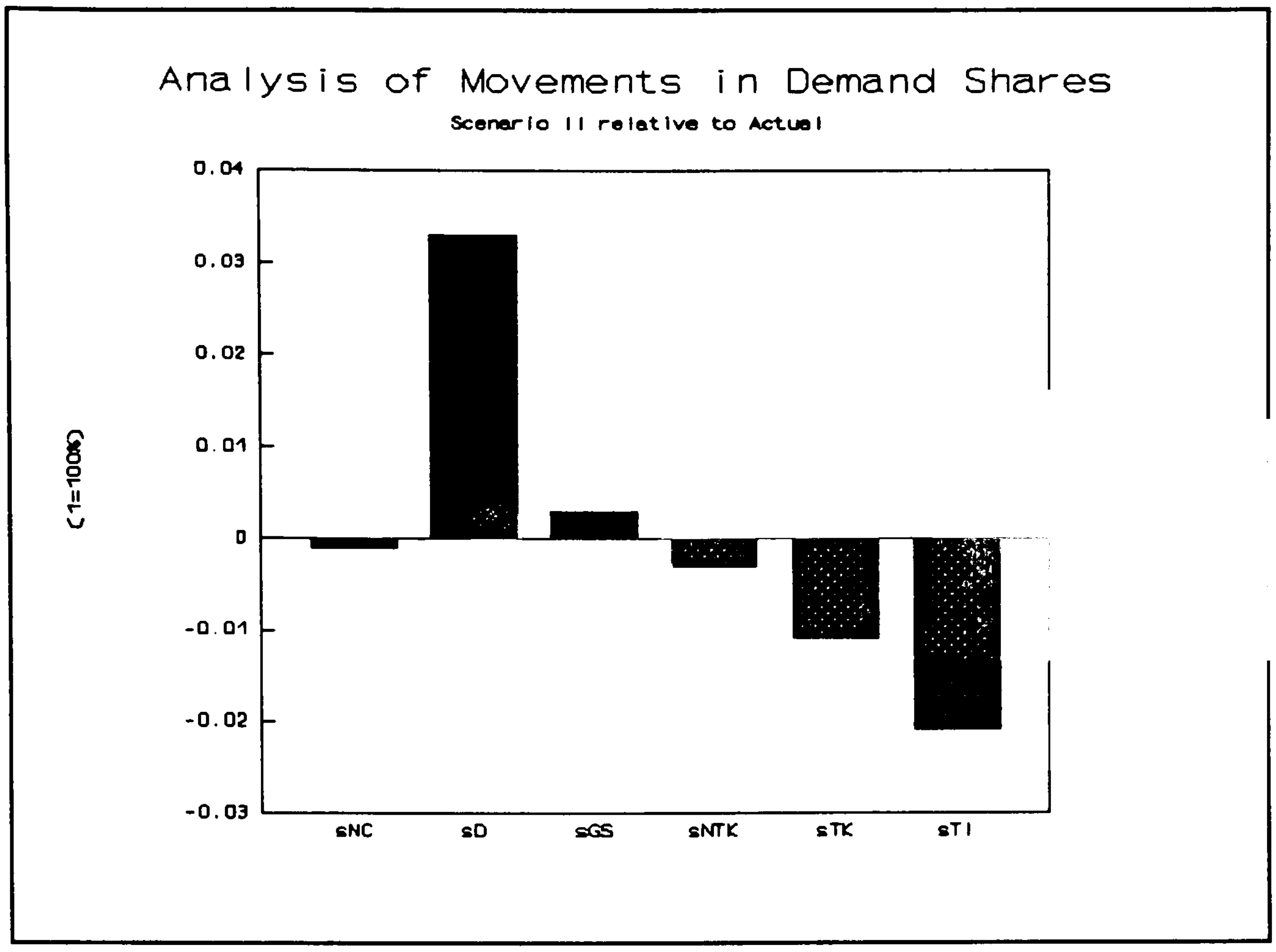


Figure 5.3

Change in Portfolio Composition Relative to Baseline - Scenario III

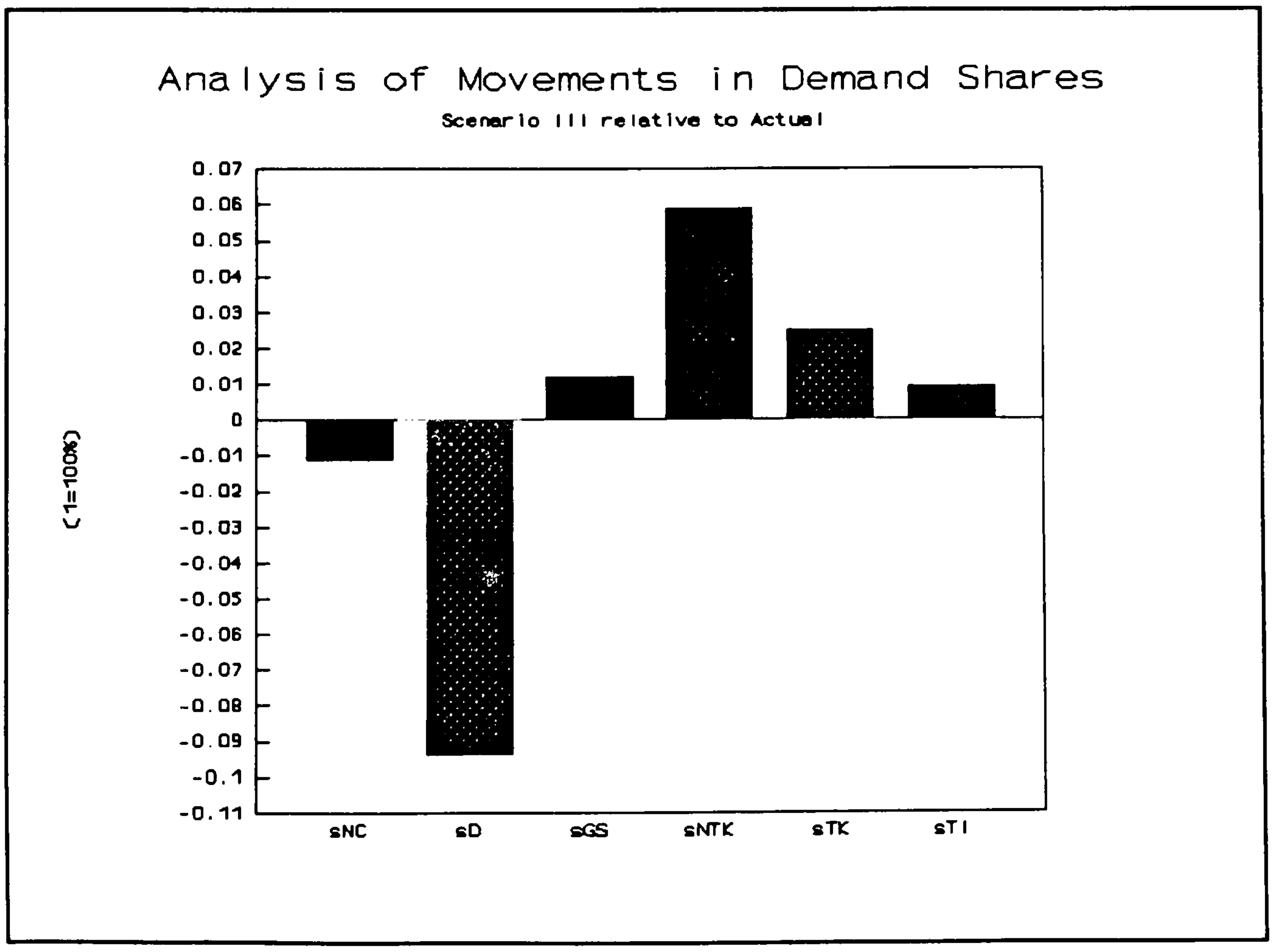
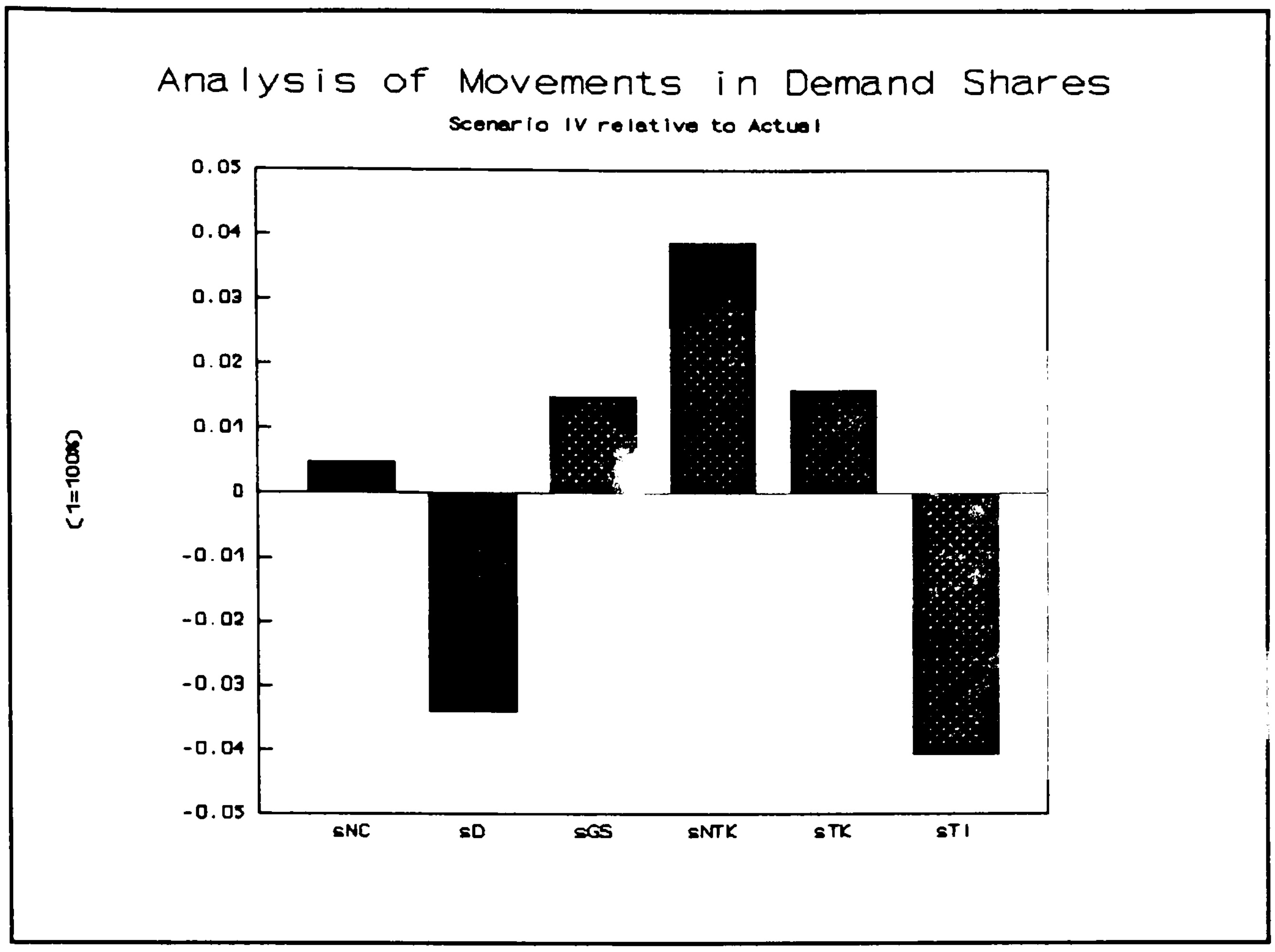


Figure 5.4
Change in Asset Portfolio Relative to Baseline - Scenario IV



In its outturn, Scenario IIA reveals that the implementation of policies of financial liberalization would have reduced the sharp switch in the asset portfolio away from interest-bearing financial assets. In view of the overhang of excess liquidity, the share of deposits with the banking sector in the total portfolio would also have fallen under the financial liberalization scenario, but by over 3% less than in Scenario IA. Significantly in this scenario, the share of inventories in the total portfolio is seen to fall sharply as a result of the increase in the cost of working capital. As expected, the rise in the "cost" of holding cash balances is reflected in a marginal reduction in the share of that asset in the total portfolio. Finally, though we have already raised concerns about the interpretation of the share of government stocks in the portfolio, it is notable nonetheless that under this scenario the share has increased marginally.

Scenario III, on the other hand, illustrates clearly the effects of high inflation on asset composition when policies of financial repression pertain. The sharp fall in the relative return on financial assets results in a 9 per cent switch away from interest-bearing financial assets (including cash)[142] relative to the baseline and into real accumulation, with tradable capital increasing by an additional 3 per cent and, notably, the non-tradable sector increasing by over 6 per cent relative to the baseline.

Finally, Scenario IV illustrates how reductions in the rate of inflation increases the relative utility to holding money, and once again confirms the hedging role played by non-tradable capital and inventories. Although the average real rate of return under this scenario is in fact *lower* than under the financial liberalization scenario, the switch from non-tradable capital into financial deposits is in fact greater than under financial liberalization, suggesting quite strongly that the reduction of inflation rather than the raising of the nominal rate of interest on financial assets has the stronger smoothing effect on the composition of the asset portfolio. In fact if we focus on the shift from financial to real assets as a whole over the period, indicated in the final line of Table 5.4, we note that though the liberalization of financial market rates of return almost halves the shift into total real capital accumulation (sK) relative to the baseline, the reduction of inflation to zero maintains the total portfolio virtually unchanged.

Implications and Conclusions

These scenarios highlight a number of important features which confirm the conclusions drawn from the full sample estimates of the model in Chapter 4. The first is the predominant role played by inflation in determining the composition of the private sector asset portfolio. In the face of rising prices, agents switch from holding claims against the government and the banking sector into the accumulation of fixed capital, principally in the form of non-tradable assets such as buildings. Inflation also serves to increase the level of inventories held by the private sector. These quite sharp asset reallocations are indicative of the limited opportunities for diversification of the portfolio into other financial assets through which the domestic inflationary consequences of macroeconomic policy and other

[142] This is consistent with the results from Chapter 3, since under Scenario III not only does the relative share of cash in the portfolio reduce, but the absolute volume of cash held reduces in real terms as well.

shocks can be offset. Bevan *et al* (1990) discuss how such constraints on asset choice, combined with the limited supply-response in the construction sector, resulted in a sharp increase in the relative price of non-tradable capital following the 1976/77 coffee price boom. Although agents were acting rationally *ex ante* given the restrictions on their portfolio composition, the rapid and large switch into non-tradable real capital accumulation in response to the low rates of return on available financial assets drove up prices in the sector and reduced the *ex post* rate of return on such investment. As a consequence, *ex post,* non-tradable capital accumulation in such an economy with limited supply-side responsiveness offers a relatively imperfect hedge against inflation. Programmes of financial liberalization which allow agents to hold foreign denominated financial assets, and which increase the availability of (market-related) interest-bearing assets into which the private sector can move in response to inflationary shocks will therefore be expected to mitigate this aspect of the construction-boom effect of trade shocks, as well as reduce the options for inflation tax revenue collection by government.

The second dominant conclusion from these scenarios concerns the relative importance of credit in the process of fixed capital formation. This was noted in Chapter 4, but the scenarios have served to isolate the specific impact of credit rationing. Increases in the level of credit to the private sector reduce the excess liquidity of the asset portfolio, and is reflected principally in accumulation of tradable capital. One clear conclusion from these scenarios is the differential response of tradable and non-tradable capital accumulation to credit rationing. As we noted in Chapter 4, a possible explanation is that the higher import content of tradable capital goods and inventories creates a "cash-in-advance" constraint to tradable capital accumulation and creates a higher degree of complementarity with credit availability. By contrast non-tradable capital is, by definition, domestically supplied and in addition, particularly in the domestic residential sector, is a more divisible form of capital accumulation. As such, non-tradable capital accumulation consequently is less dependent on "cash-in-advance" requirements which is manifest in a lower elasticity with respect to credit.

Pulling these strands together, the evidence from these simple projections on the likely effects of policies of financial liberalization is two-fold. First, in a static sense, the development of domestic interest rates which maintain the real value of financial assets clearly dampens inflation-induced rapid substitution into capital and inventory accumulation which may, *ex post* have a relatively low rate of return. By improving the timing of investment, such policies are thus likely to be welfare enhancing. This result is thus entirely consistent with the financial repression literature. The scenarios also suggest though that the direct effects of financial liberalization are relatively weak in comparison with the impact of the relaxation of credit rationing and the reduction in inflation. Together these effects have a much more profound effect on the composition of the asset portfolio. However, as we noted in Chapter 3, programmes of financial liberalization which facilitate greater substitution of government liabilities for other assets, principally foreign currency, will also reduce the revenue maximizing rate of inflation, and increase the cost of domestic borrowing from the private sector. If these two effects then feedback onto the determinant of the actual rate of inflation, the dynamic effects of financial liberalization on the structure of the asset portfolio will be enhanced.

6

Conclusions

This thesis has attempted to model aspects of the private sector's demand for financial and real assets. The natural starting point for such an exercise is the determination of the aggregate demand for money, which although widely studied in a number of sub-Saharan African economies, including Kenya, has not yet been re-examined in the light of recent developments in the theory of dynamic specification and time series econometrics. Employing recent techniques for analyzing cointegrating relationships between non-stationary time series data, we have drawn together a number of disparate issues concerning the demand for money within a series of single-equation models.

First we suggested that the use of a Divisia or similar index-based aggregation for money stock aggregates may result in a more data coherent specification of broad money demand than would occur in the case of the more commonly used simple-sum aggregate. Second, it was possible to identify a small but significant currency-substitution price-effect in which agents held illegal foreign currency balances for speculative or portfolio considerations. Though of limited scale in the Kenyan context, the form of the currency substitution indicates that the approach could also be profitably applied to economies in which a greater proportion of transactions are denominated in foreign currency. Third, the equations embody long-run solutions which are consistent with theoretical priors from the literature on the demand for money and currency substitution, while the dynamic specifications successfully track actual movements in the holdings of real money balances. Finally, it was possible to establish that the demand functions were broadly consistent with a small simultaneous model in which the demand for real money balances is determined simultaneously with income, inflation and interest rates.

Despite the success of the single equation models of money demand they provide only limited insight into the detailed processes of asset substitution, both within financial assets, and between financial assets and real assets. We therefore proceeded to take a broader perspective on the issue of asset substitution by modelling the demand for money aggregates within a more general model of asset demands. A variant of the Deaton and Muellbauer Almost Ideal demand system model was employed. This structure rests on a number of quite restrictive assumptions concerning the functional form of the model, and also faces a range of conceptual issues which emerge when this structure is applied to the modelling of assets rather than consumption demands. While a number of these issues could not be fully resolved, the model served to adequately characterize the salient long-run and dynamic features of asset accumulation in Kenya. The results from the model were broadly comparable with those of the single-equation model, but also augmented them by providing a richer description of the relative substitution between different classes of assets, although, due to a paucity of data it was impossible to extend the analysis of currency substitution to the demand system. The model describes an economy in which a credit-constrained private sector is faced with a limited range of assets, and where export earnings are compulsorily surrendered to the central bank in exchange for domestic claims against the banking system. In this economy, inflation plays an important role, and the model provides strong evidence of a "flight-from-money" in response to inflationary shocks which erode the real value of financial assets. In the face of inflation, and an absence of diversification into foreign financial assets, the private sector shifts its asset holdings into inventories and real capital accumulation, particularly in the non-tradable construction sector.

Despite the presence of thin financial and asset markets, the model also provides evidence that relative price effects do impact on the determination of aggregate asset demands. Because of the absence of markets and the presence of a high degree of inter-temporal linkages in asset demands, the magnitude of relative price effects is small. However, there is quite clear evidence of a differential response pattern between tradable and non-tradable fixed capital formation, with the former exhibiting higher short-run price responsiveness and a concomitantly more rapid adjustment to disequilibrium.

Finally, the model also casts light on the impact of credit rationing on the nature of asset accumulation. In accordance with traditional theoretical results, credit is very strongly complementary with private sector real capital accumulation. Relaxation of credit limits to the private sector reduces the relative liquidity of the private sector portfolio, and increases the share of real capital accumulation. One interesting feature of this result is that tradable capital is more sensitive to credit rationing, a fact that may be explained by the higher import content of tradable capital, which is likely to be more sensitive to "cash-in-advance" constraints than non-tradable investment in the construction sector.

Combining the results of the two models provides an analysis of the implications of policies of financial liberalization currently being implemented by the Government of Kenya on both the structure of private sector asset demands, and on public finances. With respect to the latter we have attempted to quantify the static fiscal gains from inflation tax and from the imposition, through controls on the capital account, of policies of domestic financial repression. The structure of the demand for money given the limitations on the asset portfolio suggests that the revenue-maximizing rate of inflation is approximately 14% per annum. The economy has operated at or below this rate of inflation throughout most of the period, and the two occasions in which inflation exceeded this level were accompanied by a reduction in the real value of the monetary base. Although the total revenue from the inflation-tax has, historically, represented a relatively small proportion of total tax revenue - equivalent to less than 1 per cent of GDP per annum - the relative ease with which it can be levied compared with other forms of taxation suggests that there may exist an important short-run role for inflation tax. The presence of significant costs in the adjustment of the non-bank private sector to their equilibrium levels of monetary holdings provides the government with a important source of short-run revenue, even though it also generates potential time-inconsistency problems in the conduct of monetary policy. Thus while the steady-state revenue loss associated with moving to a regime of international relative price stability is relatively low, the consequent loss of short-run flexibility in revenue may be significant. Of greater long-run magnitude however is the fiscal impact of full liberalization of the capital account. By permitting the domestic private sector to hold foreign assets, not only is the elasticity of substitution between domestic and foreign assets increased (thereby reducing the sustainable level of taxation of domestic non-interest bearing liabilities), but the government also commits itself to offering competitive rates on its domestic loan stock, which would greatly increase the cost of servicing domestic debt. Financial liberalization may therefore be expected to induce significant domestic costs.

Offsetting these expected fiscal costs of financial liberalization are the likely effects of such policies on the structure of the private sector's asset accumulation behaviour. In particular, the research in this thesis would suggest that broadening the range of assets in the portfolio of the non-bank private sector by permitting accumulation of foreign denominated (or possibly foreign-indexed) financial assets would have a dampening effect on asset substitution. Financial assets would then provide a hedge against domestic inflation, and would allow the private sector to smooth its process of fixed capital formation so as to avoid the price-raising effects which accompanied the short-term excess demand for non-tradable capital in the immediate aftermath of the 1976/7 coffee boom.

In the introduction to this thesis we suggested that Kenya enjoyed certain characteristics which disposed itself towards the use of data-demanding econometric techniques. The successful use of these techniques in generating statistically robust and economically valid conclusions from a relatively short data sample indicates that the techniques may be usefully employed more widely in research on other sub-Saharan countries. In addition, however, since Kenya also shares a wide range of characteristics with other Sub-Saharan African economies, particularly in terms of the limitations inherent in the asset market, the results concerning the impact of programmes of financial liberalization on the structure of the demand for financial and real assets in Kenya are likely to be applicable to a number of other economies undergoing similar programmes of financial liberalization.

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