DETERMINATION OF THE KENYA SHILLING REAL EXCHANGE RATE VOLATILITY

BY

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DECLARATION

This research paper is my original work and has not been presented for a degree in any other university.

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This research paper has been submitted for examination with our approval as University supervisors.

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ABSTRACT

This study focuses on the Kenya Shilling (KSH) real exchange rate volatility over the period 1980:1/1991:3. The prime objective is to formulate and estimate an econometric model that could capture the underlying data generation process of the KSH real exchange rate. An integrated Towe-Onis and Ozmucur model is formulated and econometrically estimated using Two Stage Least Squires (2SLS) in the PC-GIVE computer package. The empirical results thereof lead us to conclude that the KSH real exchange rate volatility cannot be ascribed entirely to exchange rate market fundamentals but also to foreign exchange market psychology. Consequently, we suggest that any attempt to defend the KSH real exchange rate from undue misalignment entails a policy mix that should include both indirect and direct remedial policy measures. The empirical results are also suggestive of the existence of a negative median in the excess rate of return on three month forward contracts denominated in domestic currency. That could partly explain observed asset portfolio adjustments effected by some international trade agents; presumably, in their effort to realize sound currency exposure management.

CHAPTER ONE: INTRODUCTION

1.1: Nature of the Kenyan Economy

Foreign exchange rate concepts, exchange rate movements for that matter, find relevance in discussion(s) to the extent that the reporting economy is largely monetary and economically open. The Kenyan economy qualifies in both respects.

As at independence, in 1963, Kenya's monetary sector dwarfed the non-monetary by 48.6 percentage points. The former sector's contribution to the country's Gross Domestic Product (GDP) stood at 74.3% compared to the latter sector's 25.7%. Due to structural economic changes, the monetary sector increasingly eclipsed the non-monetary sector over the years. For instance during the 1980s, the two sectors' contributions equilibrated at about 95% and 5%, respectively; making the Kenyan economy largely monetary in nature.

Kenya's economic openness is equally appreciable. Taking the proportion of volume of her external visible trade in Real GDP as a proxy of the size of her external sector, one gets the picture depicted in table 1; below.

Table 1: Size of Kenya's External Sector in the 1980s and 1990s; Selected Years

Year	1982	1984	1986	1988-89
Proportion of Total Exports in Real GDP	18.48%	24.64%	28.32%	24.80%*
Proportion of Total Imports in Real GDP	29.25%	34.85%	38.40%	45.99%*
Proportion of Total External Trade in Real GDP	47.73%	59.53%	66.72%	70.78%*

Source: Compiled by author using data from the Central Bureau of Statistics, Kenya Statistical Abstract and Economic Survey, various issues of each.
Note: * = geometric means over the four years

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From the above table, it can be observed that the openness of the Kenyan economy is not only appreciably wide but also that the degree of openness of the economy increased during the 1980s and the early 1990s. The degree of openness of the economy estimated at about 48% in 1982, peaked about 71% in 1988, implying increased participation in international trade. Over the period 1982/88, the country's degree of openness averaged about 61%. The volume of visible trade expanded by about 7% between 1990 and 1992.

1.2: Trends in Kenya's Macroeconomic Performance

Trends in the country's macroeconomic performance is assessed with respect to both her domestic and external sectors. Her domestic macroeconomic performance is outlined with respect to the rate of economic growth, level of resource employment rate of inflation, and central government finances. Her external macroeconomic performance, on the other hand, focuses on the country's balance of payments position and scope of equilibrium in the currency markets.

During the late 1960s, Kenya experienced periods of economic growth averaging 5.0% plus per annum. That commendable rate of economic growth later hovered very close to just 5.0% per annum before decelerating to almost 4.0%. For instance, over the period 1973/79, the Kenyan economy grew at 5.1% per annum. Over the period 1983/89, the rate of economic growth decelerated by one percentage point to be recorded at 4.2% per annum. Although, for some specific years in the 1980s the Kenyan economy rejuvenated (i.e in 1987 and 1988 when respective economic growth rates of 4.9% and 5.2% per annum were recorded), the economy backslid soon afterwards to register growth rates of 5.0% and 4.5% per annum during the respective years of 1989 and 1990, respectively. The downward trend in economic growth seems to have persisted with the

rate of growth having recorded a low level of 0.4% per annum in 1992.

Domestic inflation (proxied by the average Nairobi Consumer Price Index) has been on the increase since independence. The relatively low single-digit inflation rate experienced during the 1960s and the early 1970s, economists talk of one-digit inflationary rates for the period worsened during the early 1980s and 1990s to record double-digit inflationary rates. It topped an historical high of 22% in 1982. Currently, it is believed to be far in excess of 40% per annum (within donor circles).

The country's inflationary trends have been attributed to a variety of factors including the existence of excessive domestic liquidity; the implementation of domestic and international trade liberalization policies such as domestic commodity price decontrols, the relaxation of foreign exchange controls and the fully-fledged floatation of the Kenya Shilling exchange rate[1] leading to increasing imported inflation and the inflationary budget deficit financing activities of central government.

Trends in domestic liquidity are presented in Table 2; below.

Table 2: Monetary Expansion in Kenya; Annual Rates of Change; 1980's

YEAR	1981	1982	1983	1984	1985	1986	1987	1988
M2	+8%	+9%	+10%	+11%	+12%	+23%	+19%	+6%
GDP[a]	+6%	+3%	+3%	+1%	+5%	+6%	+5%	+5%
CPI[b]	+13%	+22%	+15%	+9%	+11%	+6%	+7%	+13%
M*[c]	+6%	+3%	+3%	0%	+5%	+6%	+4%	+5%
M**	+17%	+19%	+11%	-1%	+9%	+5%	+3%	-17%

Source: Organized by author from OVP&MP&ND; Historical Economic Data of Kenya, 1972-90.

Note: [a] = annual rate of growth of Real GDP; [b] = annual rate of domestic inflation; [c] = annual rate of monetization of the Kenyan economy; M** = estimated annual rate of growth of excess domestic credit calculated as $M^{**}=[M^{*}-(^{a}+^{b}+^{c})]$

The early 1980s are characterized with relatively higher rates of excess domestic

liquidity as compared to the late 1980s. For instance, the highest rate of domestic monetary expansion, estimated at 19%, obtained in 1982. Incidentally, this was the same year in which Kenya reported the highest rate of domestic inflation. Presumably, in its efforts to mop up excess domestic liquidity, the Government may have led to the observed tight monetary stance in 1984. During that year, the rate of domestic monetary expansion was short of the rate of monetary expansion that could offset the rate of expansion in real domestic income and the rate of monetization of the economy. It was short by about 1%. Possibly in an effort to loosen the tight monetary stance, the Government seems to have triggered excessive monetary expansion. The rate of monetary expansion stood at about 9%, 5% and 3% for the following respective years: 1985, 1986, and 1987. Eventually, this downward sub-trend in monetary expansion touched the lowest rate of about 17% per annum in 1988. Overall, Kenya's monetary policy during the 1980s and early 1990s appears to display an on and off scenario: with the rate of monetary expansion at times getting out of hand and at other times being too constrained. That could demonstrate Kenya's lack of monetary discipline during the observed period. Unfortunately, so is the position in her fiscal policy.

Central government finances that reflected surpluses throughout the 1972/73-1980/81 Financial Years (FYRs) reverted into current deficits, to start with, before assuming overall budget deficits. The current surplus that topped K£35.5 million and K£72.2 million during the respective FYRs 1976/77 and 1977/78 deteriorated to a low of K£8 million in 1980/81 before recording an enormous deficit amounting to K£238.4 million in the FYR 1990/91. All the 1980s' FYRs save 1983/84, 1985/86 and 1987/88 recorded overall budget deficits. Most distressing, however, is the manner in which the budget deficits were financed. The following table 3 stipulates domestic debt by method

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of central government financing.

Table 3: Domestic Debt by Method of Financing; 1986/91

YEAR	1986	1987	1988	1989	1990	1991	1986-91
BANKS (1)	37%	35%	29%	26%	31%	27%	31%
NON-BANKS (2)	63%	65%	71%	74%	69%	73%	69%
BANKS (3)	46%	47%	43%	37%	49%	43%	44%
NON-BANKS (4)	54%	53%	57%	63%	51%	57%	56%
OVERDRAFTS [(3)-(1)]	9%	12%	14%	11%	18%	16%	13%

Source: Adapted by author from Ng'ok (January,1992;pg.10); "Domestic and External Public Indebtedness: The Case of Kenya." (OVP&MP&ND, Long-Range Planning Dept.; Technical Paper 92-01).

Notes: (1) = proportion of deficit financing from banks excluding central government Pay Master General (PMG) overdrafts; (2) = proportion of such financing inclusive of central government Pay Master General overdrafts; [(3)-(1)] = PMG Overdrafts

From the above table, it is notable that whereas domestic non-bank public-debt-holding, and hence non-inflationary budget deficit financing averaged 56-69% of the total domestic financing; inflationary budget deficit financing averaged about 31-44%. Such inflationary budget deficit financing that is attributable to high powered money rose from a low of 9% to 18 per annum or a simple average of 13% per annum.

Upon the realization that financing the budget deficit through domestic sourcing especially banking system could crowd out the private sector, the country's policy makers diverted their attention to external concessionary and non-inflationary domestic sources of finances. Suspension of inflow of quick-disbursement donor funds, may partially explain why the policy makers may have receded their earlier resolve to rely on non-inflationary domestic sources of finances, implying that the country's running budget deficits were an unfortunate eventuality. Under the circumstances of limited inflow of donor funds, implemented policies such as the Budget Rationalization, and Cost-Sharing,

in the provision of social-economic amenities, cannot succeed in slashing down the budget deficit to the projected figure of about 2.5% of GDP by the turn of the century. By the end of November, 1991 the overall budget deficit was substantially down at 3.5 of Real GDP from 6% during the 1990/1991 FYR. But going by the experience of the last two years, 1991 and 1992, and the current fiscal situation, the expected budget deficit during the next FYR, 1993/94, is estimated at 5% of GDP while the financing gap is expected to be K£265.2 million[2].

Overall, Kenya's domestic macroeconomic performance during the 1980s appears to have been sluggish.

From table 1, above, we concluded that Kenya's economy is largely an open one. The high degree of the Kenyan economy' openness can be cited as a measure of the size of the country's external sector. Similarly, one can interpret the trends observable from table 1 in country's exports, imports and volume of trade as being indicative of the evolution of Kenya's external sector.

Before examining Kenya's external macroeconomic performance, we should consider the structure of her external sector. Kenya is predominantly a primary goods net exporter. Most of these primary exports are agricultural in nature. The key agricultural products include: coffee, tea and horticultural products. Besides, Kenya exports a lot of services. The most notable in this category of exports are the tourist and the hotel industry services. Conversely, Kenya's imports are chiefly manufactured goods, plant and machinery. Consequently, a big proportion of Kenya's international trade is carried out with the industrialized countries.

Owing to small economy relative to her major trading partners, Kenya is often vulnerable to adverse developments in the international markets. This is most notable

in the country's unfavourable terms of trade. The unfavourable terms of trade are also reflected in the country's persistent current account deficits. For example the terms of trade (in respect of all traded items and 1982=100) that were recorded at about 92, 103 and 85 for the respective years 1985, 1986, and 1987, did deteriorate to 71, 85 and 79 in 1990, 1991 and 1992, respectively. The country's visible balance of trade worsened by about 292% between 1982 and 1990. In spite of that, the volume of visible trade expanded by about 158% over the same period of time.

Overall, the Kenya's external macroeconomic performance was rather good until the earlier 1970s. Owing to her vulnerability to external shocks, she was stroke off balance by the major oil crises of the earlier and the late 1970s and the destabilizing coffee boom of 1977/78[3]. The situation worsened further due to a global economy that found itself in a long drawn economic recession. The country's deteriorating terms of trade made the situation gloomier. Yet, the protracted erosion of the value of the Kenya Shilling both prior to and much more so upon the adoption a fully-fledged float pushed the economy to the verge of a foreign exchange crisis.

1.3: Evolution of the Kenya Shilling Exchange Rate Policy

1.3.1: Definition and Exchange Rate Regimes

The Kenya Shilling (KSH) nominal exchange rate is defined as the price of a unit of US$ in terms of the KSH (i.e KSH/US$) or the price of a unit of the SDR in terms of the KSH (i.e KSH/SDR). The KSH nominal exchange rate can also be defined over any other base currency. But for purposes of this paper, we adopt the KSH/US$ exchange rate. The adoption of the exchange rate is not restrictive as conversion to other definitions of the same exchange rate is possible. The Central Bank of Kenya (CBK), established under the Central Bank of Kenya Act, was officially opened on 14th,

September, 1966. This marks the beginning of the history of the KSH as legal tender. The KSH exchange rate regime , was a fixed peg. The rate of peg was, however, allowed to fluctuate within margins of 1% on either side of exchange rate parities. Under this exchange rate regime, exchange rate par-values could be adjusted by government fiat; with due consultations between the concerned government and the IMF. Upon its introduction, the KSH was pegged to gold at KSH 250 per troy ounce of gold. That translated into fixed bilateral exchange rates between the KSH and the US$ (i.e KSH/US$). For instance, the move yielded a KSH/US$ exchange rate of KSH 7.1429 per US$ 1 in 1966.

Following the demise of the Bretton Woods regime in March, 1973, which ushered in a period of generalized float of the major foreign currencies, the KSH displayed excessive volatility. Between March, 1973 and 27th, October, 1975 the KSH was pegged to the US$ at KSH 7.1429 per US$ 1. The currency of peg was short-lived in view of the prevailing KSH/US$ exchange rate volatility.

Subsequently, the currency of peg was shifted from a single-currency to a currency-composite (i.e the SDR[4]. On October, 27th, 1975 the KSH was pegged to the SDR at KSH .9.660 per unit SDR; with an allowance of a 2.25% fluctuation margin on either side of parity. The shift in the currency of peg could be regarded as an enhancement of the flexibility of the KSH exchange rate.

Apparently operating under the provisions of the Jamaica Accords of 1976[5] it ratified in 1978, the Kenya Government adopted a dirty-float exchange rate regime in December, 1982. That regime prevailed March, 1993; when the Government attempted to float the KSH exchange rate, fully. The short-lived floatation was, however, short-lived in view of its short-run adverse implications on the country's foreign reserves amid

the unforthcoming quick-disbursement funds from multilateral donors. That made the Kenyan Government to reverse to the dirty-float regime. Implementation of the country's past fixed and dirty-float exchange rate regimes were complimented by the imposition of foreign exchange controls. An overview of these is presented in the next section.

1.3.2: Foreign Exchange Controls

The controls over foreign exchange transactions in Kenya are provided for in the Foreign Exchange and Exchange Control Act, Cap. 113. The broad objective of the Act is to realize the optimal utilization of the country's often scarce and unreliable foreign reserves in meeting her basic import needs. Its basic and complementary tools in accomplishing the objective seems to be twofold, namely, the "prompt surrender" to and application for foreign exchange from the CBK.

According to the prompt surrender requirement, those who earn any foreign exchange are required by law to surrender the same, in its entirety, to the appointed foreign exchange and gold dealers; within 48 hours. Those who surrender foreign exchange, in turn, get the domestic currency-equivalent of the surrendered foreign reserves.

The requirement that users of foreign exchange apply for the same from the CBK facilitates rationing of available foreign reserves among the applicants in some predetermined order of priority of foreign exchange uses. Prioritization of foreign exchange uses is normally laid down in published Import Schedules.

Closely related to the foreign exchange controls outlined above are capital account restrictions. One such key restriction is the illegality for Kenyan residents to operate foreign exchange deposit accounts both within and without the country. Prior to 1992, when the interest rate regime of the country's banking system was liberalized,

coupled with noticeable inflationary spiral, the political uncertainties engendered by the emergent multiparty electioneering, economic agents apparently chose to capitalize on regulatory arbitrage, reflected in growing capital flight. For instance, Kenya's non-bank offshore-banking that stood below US$1 billion for the most part of the period 1982:1/1985:3, shot up to US$2.5 billion as at the end of the third quarter of 1992 amid the stringent foreign exchange controls and the illegality of Kenyan residents' running foreign exchange accounts. As recently as the 14th, June, 1993 an individual was nabbed attempting to smuggle assorted foreign currency to the tune of about KSH 183 million. Net capital outflows over during 1992 was estimated at about K£265 million.

The recent introduction of Foreign Exchange Bearer Certificates (FOREX-Cs) and the Foreign Exchange Retention Accounts (FOREX-A/Cs) Scheme have somewhat relaxed government's grip on foreign exchange transactions. The new foreign exchange facilities imply alternative sources for foreign exchange, namely; the FOREX-Cs Markets at Mombasa and Nairobi, and the inter-bank foreign exchange market. The FOREX-Cs were also devised to facilitate the voluntary retrieval of domestic savings in foreign banks outside the country, somewhat curbing capital flight. The temporary suspension of the fully-fledged floatation of the KSH exchange rate together with the suspension of the FOREX-Cs, meant elimination of the alternative sources of foreign exchange.

The effect of capital account controls on the KSH exchange rate movements depend on the tightness of such controls, extent of legal effective demand for foreign exchange, and the strength of the domestic currency, resulting in either overvalued or undervalued domestic currency (misaligned exchange rate). Movements (i.e appreciation and depreciation) of the country's exchange rate are outlined in the next section.

1.3.3: Movements in the KSH Exchange Rate

The rises (appreciations and revaluations) and falls (depreciations and devaluations) of the KSH exchange rate during the 1980s are summarized in figures 1 through 2 and table 5; below. The rise/fall of the KSH exchange rate imply a loss/gain in the value of the KSH. The market induced rise/fall of the KSH exchange rate is referred to as appreciation/depreciation of the exchange rate. Its policy fiat induced rise/fall is denoted as revaluation/devaluation. The dichotomy in respect of the source of exchange rate movements translate into the distinction between the nominal KSH exchange rate (the equivalent of the officially determined exchange rate) and the implicit real exchange rate (the KSH exchange rate as could be determined by the free market forces, under a fully-fledged float of the KSH exchange rate).

Due to the non-observable nature of the market-induced exchange rate movements, data on KSH real exchange rate are not available. But going by economic convention, a mathematical derivation of a proxy for the real exchange rate (RER) can be effected[6].

The movements in the nominal and KSH real exchange rate during the period 1966/91 are as shown in figures 1 and 2. The former plots annual data for the period 1966/1991 whilst the latter relate to quarterly data over the period 1980:1/1992:3.

Figure 1 is helpful in demonstrating the long-term movements in the KSH exchange rate. It is capable of highlighting the time when the same exchange rate started loosing ground. In order that one got a feel of the short-run movements in the KSH exchange rates, figure 2 and table 4 have been provided.

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Figure 1: Exchange Rates, 1966/1991

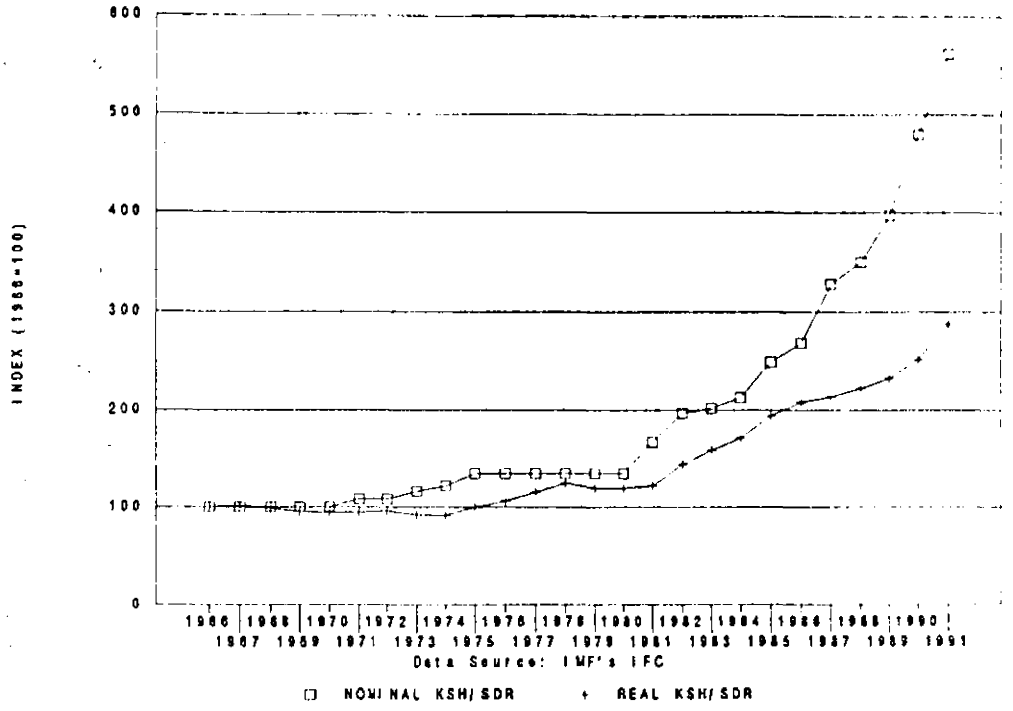


Figure 1 displays trends in the nominal and the real KSH/SDR exchange rates during the period 1966-1991. The exchange rate movements show a structural break. The relatively stable KSH/SDR exchange rate during the 1966-1980 sub-period gave way to its protracted depreciation (devaluation) or loss of value during the 1980-1991 sub-period.

Table 4: Recorded Kenya Shilling Exchange Rate Movements, 1980/1991

DATE (PERIOD)	CHANGE	KSH/US $	KSH/SDR
June,1980/December,1980	Depreciation	12.1%	n/a
January,1981/June,1981	Depreciation	15%	n/a
On 3rd, February,1981	Devaluation	n/a	5%
On 21st, September,1981	Devaluation	n/a	17.7%
During the year 1982	Depreciation	19.3%	n/a
On 10th, December,1982	Devaluation	n/a	15%
On 31st,December,1982	Devaluation	n/a	2.3%
Towards the end of 1983	Devaluation	n/a	1.4%
March,1984/June,1984	Depreciation	2.4%	n/a
April,1984/June,1984	Depreciation	6%	n/a
October,1984/December,1984	Depreciation	6%	n/a
June,1984/June,1985	Devaluation	n/a	7.7%
October,1985/December,1985	Depreciation	1.7%	n/a
February,1986/June,1986	Devaluation	n/a	3.2%
October,1987/December,1987	Appreciation	0.8%	n/a
April,1988/June,1988	Depreciation	6.2%	n/a
July,1988/September,1988	Depreciation	2.3%	n/a
October,1989/December,1989	Appreciation	1.2%	n/a

Source: Compiled by author using data from the Central Bank of Kenya's Quarterly Economic Reviews and Annual Reports
Note: n/a = not applicable.

The above table confirms the structural breaks in the KSH exchange rate

movements reflected in figures 1 and 2 both in terms of the number of depreciations and devaluations and size of the magnitudes of the KSH exchange rate depreciations/devaluations. From the table it can be observed that about 82% of the exchange rate changes in KSH/US$ were depreciations while 100% of the changes in the KSH/SDR were devaluations.

Overall, the KSH/US$ exchange rate was depreciated by about 270% whilst the KSH/SDR nominal exchange rate was devalued by about 320% during the period 1980:1 to 1991:4. Their respective simple average depreciation /devaluation were 27%/32%. In real effective terms, the KSH/SDR nominal exchange rate depreciated by 55% between 1980:1/1991:4. The most dramatic depreciation was however registered in the wake of the full liberalization of the KSH exchange rate regime in March, 1993. In just a matter of twenty-four hours, the KSH shed up up to 50% of its value. As the depreciation of the KSH/SDR escalated threatening to get out of hand (reach the 100% point mark level), as noted above the Kenya Government re-instituted foreign exchange rate and foreign exchange controls, albeit, temporarily to defend the KSH and the economy at large from imminent collapse. Specifically, this action was justified on the irreversible adverse short-term implications of the fully-fledged floatation; including aggravation of domestic inflation, exacerbation of the country's external debt position and draining of the country of her dwindling foreign reserves.

There are number of competing educated guesses regarding the observed KSH exchange rate movements. Some of these explanations ascribe the nature of the movements to the KSH's being highly overvalued. Hence, its protracted depreciation is attributable to search for equilibrium under liberalized conditions. Other explanations attribute the observed depreciation of the exchange rate to market-psychology, that is

destabilizing speculation in the currency markets. Between 1982 and 1987, the KSH exchange rate became increasingly overvalued topping 72% from 27%[7]. During the period 1970/87 the average overvaluation of the exchange rate is estimated at 14%[8]. Offshore banking by non-bank residents, outlined elsewhere herein, can be cited as a manifestation of the presence of destabilizing speculation in Kenya's foreign exchange market.

1.4: Statement of the Research Problem

From the foregoing section, three research issues arise. These are the remarkable KSH real exchange rate depreciation during the period 1980/1991, determination of the scope of the KSH real exchange rate misalignment and determination of the macroeconomic impacts of the observed KSH exchange rate volatility.

In the current fully-fledged floatation of the KSH exchange rate regime, adverse exchange rate movements may entail the institution of appropriate policy remedial measures. The appropriateness of such foreign exchange market intervetionary measures partly derive from a clear understanding of the factors which determine the KSH exchange rate. The relative roles of the KSH exchange rate determinants is another aspect that policy makers need to understand in their quest for an optimum foreign exchange rate policy. Unfortunately, these dual issue entail an empirical investigation since the required answers are not self-revealing.

Kenya's favourable macroeconomic performance is viewed as one of the basic solutions to most of the country's social-economic problems, say, the unemployment and domestic inflation problems. It therefore follows that any occurrence that tends to compromise the country's macroeconomic stability should be taken seriously. It is in view of this that the macroeconomic impacts of the KSH real exchange rate volatility should

be empirically investigated.

Some empirical studies have been carried out to redress the above issues. But as demonstrated in the review of literature, the same studies face limitations in their theoretical and empirical frame works meaning that their associated empirical results would not be dependable.

In view of the recent advancements in both economic theory and econometric analysis[9] it would be interesting to re-examine some of the research issues in order to enrich existing empirical findings. In that sense then, the situation is wanting for an empirical study. The impending study precisely focuses on that knowledge-gap: that no dependable empirical explanation exists for the observed KSH real exchange rate movements.

1.5: Objectives of the Study

The broad objective in this study is to investigate empirically the observed volatility of the KSH real exchange rate. The following are the specific objectives of the study:

1 formulation and estimation of an econometric model of KSH real exchange rate;

2. interpretation and analysis of the empirical results obtained in (1) above using both parametric and non-parametric tests of hypotheses for the presence or otherwise of and non-parametric tests for the presence or otherwise of speculative bubbles in the KSH real exchange rate;

3. based on (2) above, derive policy implications for enhancing the country's exchange rate policy.

1.6: Justification of the Study

The study was rationalized on several grounds. First, by identifying sources of the country's exchange rate volatility (excessive variability in either the exchange rate fundamentals or speculative bubbles or both), the study will influence appropriate remedial policy intervention. Depending on the identified source of the exchange rate volatility, we can recommend foreign exchange market intervention indirectly via the fiscal and monetary policy tools or directly via Government legislations on foreign exchange rates and foreign exchange and exchange control.

Secondly, the findings of the study can influence the country's choice of approach to currency exposure management. The statistical properties of the KSH exchange rate would provide useful information to such economic agents as international banking institutions, in assessing the riskiness of open and short foreign exchange positions. That would undoubtedly be a boost to their foreign exchange rate arbitrage; an undeniably big business, its legality not withstanding, among financial institutions and well-off individuals. Finally, it is hoped that the study may generate further interest in research that appertains to exchange rate theory and policy.

1.7: Organization of the Remainder of the Research Paper

The remainder of the research paper is organized into four chapters, namely; chapters 2, 3, 4, and 5. In chapter two, we review both the theoretical and the empirical literature on exchange rate determination. In chapter three, we formulate theoretical frame-works for the determination of the KSH real exchange rate. The empirical analysis and presentation of the empirical results is done in chapter four. Finally, we present a summary of study, draw conclusions and provide policy implications as derived from the empirical results. Areas of further empirical analysis in the realm of the KSH exchange

rate are provided besides the strengths and weaknesses of the current study.

END-NOTES

1 See Ayako and Manundu (1988); "Devaluation and Inflation in Kenya: A Theoretical and Empirical Framework." The authors discuss on the inflationary impacts of exchange rate devaluation in Kenya. For an outline of some of the key causes of domestic inflation, one can refer to the OVP&MP&ND; Economic Survey (1992 and 1993).

2. See Ministry of Finance (10th, June, 1993); Central Government Budget;1993/94

3. See Ng'eno (1992); Kenya's Export Performance in Jonathan Frimpong-Ansah, S. M. Ravi Kabur and Peter Svedberg (eds.), Trade and Economic Development in Sub-Saharan Africa; 370-398.

4. Initially, the value of the SDR was determined on the basis of weighted values of a "basket" of sixteen currencies. The "basket" was latter, in 1981, eased of many of the currencies. In effect the valuation of the SDR ended up being based on only five currencies: the US Dollar, the German Deutchemark, the Japanese Yen, the French Franc, and the British Pound Sterling. The respective weights of the currencies in the SDR valuation process are recorded as: 35%, 22%, 19%, 12%, and 12%.

5. The Accords, which Kenya ratified, accords the associated countries some autonomy in the determination and pursuit of exchange rate regimes which the affected countries deemed fit. Such shifts in exchange rate regimes should however be communicated to the IMF.

6. $RER_t = E_t*CPIUS_t/CPI(K)_t$; where E = KSH/US$, CPIUS = US Consumer price index, CPI(K) = Nairobi Consumer Price Index, and $_t$ = a time index.

7 See Mwamadzingo (1988).

8 See Dhaneshwar and Grennes (1991).

9. See the sub-section on "Review of Empirical Literature; Kenyan Context"; herein.

CHAPTER TWO: A REVIEW OF LITERATURE

2.1: Introduction

In this chapter, we review both theoretical and empirical literature on exchange rate determination. The remainder of the chapter is organized into three main sections, viz; a review of theoretical literature, a review of empirical literature, and an overview of the reviewed literature. Whereas the first section reviews theoretical literature on the determination of exchange rate variability, the second section deals with a review of existing empirical evidence on the application of the theoretical models that are emergent from the first section. The third section concludes this chapter by providing the notable developments in macroeconomic theory as it appertains to exchange rate determination and such developments as relates to the empirical implementation of the theoretical models. We now turn to the first section.

2.2: Theoretical Literature

The most notable theoretical models of exchange rate determination include: the Purchasing Power Parity (PPP), the Balance of Payments, the Monetary Asset, and the Portfolio Balance models. These form the bases for the formulation of more refined exchange rate determination models.

2.2.1: The Purchasing Power Parity (PPP) Model

The PPP model is basically an algebraic expression of the law of one price. Given a commodity "i" the domestic price of which is "P" (valued in the domestic currency) and international (i.e the Rest of the World) price of which is p^* (valued in foreign currency), then the law of one price is given by:

$$P = S*P^*; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1.1]$$

where "S" denotes the current spot exchange rate; defined in price terms and "*" is the multiplication operator. A reorganization of...[1.1], leads to the following absolute version of the PPP model. This version of the model shows that at any point in time the spot exchange rate must equal the ratio of the domestic and international price levels.

$S = P^*/P$;.....[1.2]

The absolute version of the PPP, as it stands, does not explain exchange rate changes but exchange rate levels. For empirical purposes, therefore, the following relative version of the PPP is often preferable. This is derived by taking logarithms through ...[1.2].

$e_t = p^*_t - p_t$; .....[1.3]

where, "t" is a time period index, "e" is the logarithm of "S", "p" and "p^*" are logarithms of "P" and "P^*" respectively.

The above relative version of the PPP postulates that movements in exchange rates are entirely attributable to changes in national inflation differentials. Though it provides a first step towards grasping the more fundamental determinants of exchange rates[1], this version of the PPP model is based on an unrealistic assumption that free international trade prevails. The assumption implies instantaneous economic adjustments necessary for the law of one price to hold during all time horizons. Moreover, its exclusion of other fundamental determinants of exchange rates, say, "hot money"[2] renders it a partial theory of exchange rate determination.

2.2.2: The Balance of Payments Approach (BOPA)

This approach treats exchange rates as asset prices whose determination depends on the interaction between the aggregate demand for and the aggregate supply of the respective assets (foreign currencies); as derived from the underlying respective supplies

of domestic imports and exports. Thus the model is basically of the position that movements in exchange rates are derived ones; they arise from the corresponding initial movements in either the determinants of the demand for imports or those of the supply of exports (or both). A reduced form of a variant model based on the approach is given by;

$$e = \alpha_1 \delta R + \alpha_2 y - \alpha_3 y^* - \alpha_4 [i - i^* - (e' - e)]$$

$$- i^* SF; \ldots\ldots\ldots\ldots [1.4]$$

where, "δR" = change in official settlements balance; "i^*" = foreign rate of interest; "S" = current spot exchange rate; "F" = domestic residents' real asset-holdings abroad (valued in foreign currency); "i" = domestic country interest rate; "e" = natural logarithm of "S"; "e'" = future expected spot rate; "y" = natural log of "Y" (for "Y" being the real domestic national income); "*" = denotes a foreign variable; α_1, α_2, α_3, α_4 = are parameters in the model.

The above reduced form equation identifies determinants of exchange rates as: changes in the foreign reserves, relative foreign real incomes, interest rate differentials (adjusted for the forward domestic currency premium and the net asset earnings from abroad).

The model has several strengths over the PPP model. First, unlike the simplistic PPP model, the model based on the BOPA incorporates more determinants of exchange rates, thereby minimizing potential econometric problems associated with model mis-specification (i.e heteroscedicity and serial correlation). Second, unlike the PPP, the BOPA based model captures the impact of capital flows on the movement of exchange rates; a factor that is quite crucial. The factor finds entry into the model via the incorporation of the influence of national interest differentials into the same model.

Despite those two advantages, the BOPA, like the PPP, remains a partial model for the determination of exchange rates; in so far as it does not fit observed exchange rate facts well.

2.2.3; The Monetary Approach(es)

The basic argument of the approaches is that exchange rates being asset price relatives ought to be determined by the underlying relative demands for and relative supplies of the affected assets (i.e domestic and foreign money stocks).

Depending on the assumption held about price flexibility, the monetary approach yields three variants of itself: the Flexible-price Monetary Approach (FLMA), the Sticky-Price Monetary Approach (SPMA), and the Real Interest Differential (RID) Model.

2.2.3.1:The Flexible Monetary Approach (FLMA)

The FLMA is attributable to, among others, Frenkel (1976), Bilson (1978), Kouri (1976) and Mussa (1976;1979). It is based on three main assumptions: continuous purchasing power parity, stable relative money demand functions, and uncovered interest parity.

It postulates that exchange rate movements depend on national relative money supplies, $(m-m^*)$, national relative economic growth rates, $(y-y^*)$, and national interest differentials, $(i-i^*)$. In its basic reduced form the FLMA based model is given either by[3];

$$e_t = (m-m^*)_t - \beta_1 y_t + \beta_2 y^*_t + \beta_3 i_t - \beta_4 i^*_t; \quad \text{.....[1.5a]}$$

or, $$e_t = (m-m^*)_t - \beta_1 (y - y^*)_t + \beta_2 (i - i^*)_t; \quad \text{.....[1.5b]}$$

or, $$e_t = (m-m^*)_t - \beta_1 (y - y^*)_t + \beta_2 \delta e^e_{t+1}; \quad \text{.....[1.5c]}$$

The comparative statics in ...[1.5a] are: an increase in the domestic money supply, (m), relative to foreign money supply, (m^*), leads to a depreciation of the domestic currency, an increase in the domestic national product, (y), appreciates the domestic

currency whereas the opposite holds good in respect of increased output in the Rest of the World, (y^*), a rise in the domestic interest rate, (i), appreciates the domestic currency whereas foreign interest increments could lead to an depreciation of the same currency.

The above FLMA based model can be criticized on grounds that it is based on too stringent assumptions. These are continuous purchasing power parity, and the neutrality of risk (i.e that participants in international trade are not risk averse). The more congenial assumption should have been, say, price-fixity and price-flexibility during the short run and the long run periods, respectively. Moreover, by constraining the exchange rate elasticity with respect to relative money supply to unity, the model does impose reality to the effect that exchange rate patterns are devoid of the undershooting and/or overshooting phenomenon.

2.2.3.2: The Sticky Price Monetary Approach (SPMA) Model

Like the FLMA, the SPMA based model is an extremist kind. It assumes absolute price fixity during all time horizons. The beauty of this model, however, derives from the fact that it is amenable to the analysis of exchange rate undershooting and/or overshooting. Its representative reduced form is:

$$e_t = \pi_0 + \pi_1 e_{t-1} + \pi_2 m_t + \pi_3 m_{t-1} + \pi_4 P_{t-1} + \pi_5 y_t + \pi_6 y_{t-1} + \pi_7 u_t + \pi_8 u_{t-1}; \ldots [1.6]$$

for all $\pi_2 > 0$ and $\pi_i < 0$; i = 1, 3, 4, 5, and 6; where "u" is a stochastic disturbance term (assumed to be both an innovation process and white-noise) and all the other variables assume their earlier interpretations. "π_k" for $_k$ = 0, 1, 2,...,8; are parameters in the model.

Besides its too strong an assumption about price behaviour, the above SPMA based model suffers from the following shortfalls. It is based on yet another largely unrealistic assumption of perfect capital mobility and it also underplays the role of

"news", say unanticipated policy innovations, in exchange rate determination.

2.2.3.3: The Real Interest Differential (RID) Model

The RID model, attributable to Hooper and Morton (1982), is a cross-roads kind of a model. It captures elements of both the FLMA and the SPMA based models. Hence, it is not as extremist as either of the two. It is based on the assumption of price-fixity during the short-run and price-flexibility during the long run-period. Algebraically, a variant of its reduced form is given by;

$$e = m' - \alpha_1 y' + \alpha_2 \delta P^{e_1} + \alpha_3 (i - \delta P^{e_1}); \quad \ldots\ldots\ldots\ldots [1.7]$$

for all $\alpha_2 > 0$ and $\alpha_3 < 0$; where, ' = differenced form of the associated variable. For instance, $m' = (m - m^*)$.

Consequently, the RID model is a more realistic monetary model since it never imposes reality. It leaves the question on the scope of price flexibility to empirical determination.

2.2.3.4: The Portfolio Balance Approach (POBA)

This approach is based on the arguments that: one, assets are not perfect substitutes; and, two, that international trade dealers do hold non-monetary assets in their asset portfolios, too; apart from monetary assets.

In view of the first argument, the uncovered interest parity does not hold; meaning that exchange risk is an important consideration in this model. Hence, the assumption of agents' neutrality to exchange risk (that international trade dealers are plungers), as it is held in some of the Monetary approaches, is in this case treated as being too much of a simplification of reality and hence considered accordingly.

Taking the second argument into account, this approach tries to incorporate more explanatory variables, particularly the non-monetary asset ones, into exchange rate

determination. The general form of a model based on this approach is given by;

$$S = S(\overset{+}{M},\overset{-}{M^*},\overset{?}{B},\overset{?}{B^*},\overset{-}{F},\overset{+}{F^*}); \qquad [1.8];$$

where, "S" = spot exchange rate; "M" = domestic money supply; "M^*" = foreign money supply; "B" = domestic non-monetary assets; "B^*" = foreign non-monetary assets; "F" = domestic bonds; "F^*" = foreign bonds (denominated in foreign currency); +,- = hypothesized signs of the partial relationships between the exchange rate and the allied regressors; ? = denotes a ambiguous partial relationships between the exchange rate and the affected regressors.

Though it improves on the specification of the models for the determination of exchange rates, this approach is handicapped by the fact that its kind of dis-aggregated data on the non-monetary assets is hard to come by. Little wonder then that attempts to empirically implement this approach end up dropping regressors for which data is not available.

2.3: Empirical Literature

2.3.1: Global Empirical Literature

Empirical literature on exchange rate determination abounds. Since one cannot do justice to the review of all these literature, only the crucial points are highlighted using some of the literature. In any case detailed and up to date empirical surveys abound. The most recent of such surveys include that of Mcdonald and Taylor (March,1992), Isard (1988), and Levich (1985).

The dominant conclusion from these surveys is that whereas the reduced form monetary approaches seemed to perform well for short sample periods, they became completely handicapped once the sample period is elongated. Empirical results in that respect were, however, contradictory and, hence, inconclusive.

Following the conflicting results concerning the performance of the monetary approaches to exchange rate determination, a number of attempts were made to reconcile the divergent views. These took the form of the provision of the causes of the dismal empirical performance of the orthodox monetary approaches to exchange rate determination.

Among the reasons advanced to explain the poor performance of the monetary models were: firstly, that the constraints on the coefficients on relative variables, see...[1.5b], could explain the perverse signs on parameter estimates as it can lead to sign-reversals. This is the position held by Rasulo and Wilford (1980).

The authors have proven their stand; for estimations done by them on unconstrained monetary models led to the correct signs though the same results were insignificant because of the problem of multicollinearity.

Frankel (1982) attributes the dismal performance of the monetary models to model mis-specification: the exclusion of important explanatory variables from the model. Wanting to explain what he referred to as the "mystery of the multiplying Marks": the phenomenal appreciation of the Deutche Mark-US$, DM/US$, exchange rate in the face of increasing domestic relative money supply, Frankel (1982) argued that growing current account surplus in favour of Germany relative to the US during the 1970s, must have had an effect on the redistribution of wealth from the US to Germany; something that could possibly lead to a relative increase in the demand for the DM. In this case, the author was blaming the poor performance of the monetary models on mis-specification; that excluded crucial factors should be incorporated into the basic monetary models; so as to capture, say, the wealth redistribution effects.

Correcting for mis-specification via the incorporation of a wealth term and by not

constraining the coefficients, the author reported improved results: most of the coefficients were correctly signed (save that on the income terms), the explanatory power of the model rose as indicated by the higher value of the coefficient of determination, and that most of the estimates were statistically significant. The results were however faulty to the extent that they displayed inherent serial correlation.

According to Frankel (1984), the problem with the basic monetary models was that their reduced forms were based on relative demand functions that were unstable over time. Correcting the monetary models for that problem through the introduction of a relative velocity shift term into the model, better results were derived except for the noticeable problem of first order serial correlation.

Driskell and Sheffrin (1981) argue that the failure of the monetary models could be traced to the problem of simultaneous equations bias caused by the expected change in the real exchange rate used as one of the regressors. He therefore suggested the use of a rational expectations approach in redressing the problem. On trying that correction for simultaneity, the results did not support the RID -the monetary model upon which the study was based. That led the authors to blame the poor performance of the monetary models on the unrealistic assumption concerning the mobility of capital; the monetary models assume that there is perfect capital mobility (the neutrality of risk). The authors were of the opinion that more variables ought to be incorporated into the model; a risk variable in particular that could capture the more realistic assumption of imperfect capital flows was underscored.

Driskell (1981) studied the swiss Franc/US$ based on the SPMA model; using quarterly data over the period 1973 to 1977. Owing to the unavailability of quarterly data on the income variables, he dropped the same variables from the analysis. He adopted

the Cochrane-Orchutt method to correct for serial correlation. His findings were:

$$e_t = \underset{(2.82)}{2.22} + \underset{(3.65)}{0.43}e_{t-1} + \underset{(5.73)}{2.37}m_t' - \underset{(5.60)}{2.45}m_{t-1}' + \underset{(2.23)}{0.93}p'$$

$$+ 0.35u_{t-1}'\ ;\ R^2 = 0.99 \text{ Durbin's } h = 0.21;\ldots\ldots\ldots\ldots[1.9]$$

Given that $\Sigma\pi_i = 1.28$, an estimate that is not significantly different from unity at 95% confidence limit, it follows that the results conform to the underlying theory. Similarly, to the extent that the results on the coefficient on m_t' is greater than one, the results do support the perfect capital mobility assumption of the SPMA. More particularly, the same magnitude of the coefficient signals the incidence of short-run exchange rate misalignment (overshooting).

Other works which were in favour of the SPMA models were those of Wallace (1979), Haache and Townend (1981), and Backus (1984).

Branson et al (1979) estimated the following log-linear reduced form equation of the POBA:

$$e = \alpha_0 + \alpha_1 m + \alpha_2 m^* + \alpha_3 f + \alpha_4 f^* + \epsilon;\ldots\ldots\ldots\ldots\ldots\ldots[1.10]$$

The authors excluded the non-monetary asset variables because of the ambiguity of the variables' effect on exchange rate. They were studying the DM/USS. In their estimation process, using Ordinary Least Squares, OLS, the authors' proxies for monetary variables were narrowly defined money (M1). The foreign monetary assets were proxied by the cumulative current account balances.

The reported results, though supportive of the POBA, had acute problems of autocorrelation and simultaneous equations bias arising from domestic money supply and interest rates. The authors then corrected for simultaneity by specifying a simple reaction function and using Two Stage Least Squares, 2SLS, as their estimation technique.

This work is criticised on grounds that the non-monetary variables are arbitrarily

excluded from the model and that the use of cumulative current account balances as a proxy for the foreign assets variable can bias the results since irrelevant items on third party countries could creep into the analysis. Bisignano and Hoover (1983) set out to improve on the results derived by Branson et al (1979) by incorporating the necessary corrections.

Estimating the POBA on the Canadian Dollar/US$ over the period March, 1973 through December,1975; the researchers' results were comparatively better. Most importantly, the results showed that it is important to include the non-monetary assets in the analysis of exchange rate determination.

Wanting to ascertain the relative performance of the monetary models vis-a-vis the random walk models, Meese and Rogoff (1982), undertook a study on the British Pound Sterling-US$, £/US$, exchange rate to conclude that the monetary models have a high degree of explanatory power for the within sample exchange rate movements though they lack the same explanatory power without the sample period; an indication of the models' poor performance when it comes to ex ante exchange rate forecasting.

George W., (1986) undertook a study in which he wanted to determine whether or not speculative factors were at work in the determination of the Sterling-Dollar, £/US$, exchange rate over the period 1981/84. The author designed a non-parametric test for speculative bubbles. The application of the test revealed that during the period alluded to, the concerned exchange rate was characterized with a non-zero medium; signifying the presence of speculative bubbles. That, the author gives as empirical evidence to the effect that the noticeable £/US$ exchange rate movements during the period 1981/84 could not solely be explained by market exchange rate fundamentals. Precisely, the author found out that there was a negative rate of excess return on holding

three month forward contracts denominated in the British Pound Sterling.

Towe (1989) studied the Lebanese Pound exchange rate volatility during the period December, 1982 to May, 1988; his main objective being: to determine the relative roles of exchange rate fundamentals and speculation in the determination of the same exchange rate. Owing to the crucial nature of the Towe study to the present one, the former is accorded a relatively wider space than the rest of the empirical literature reviewed herein. Following is a fairly detailed review of the Towe study.

The author's model is based on the following simplifying assumptions:

1. domestic residents' asset-portfolios consist of three main assets: domestic currency denominated liquidity, foreign currency denominated liquidity, and domestic treasury bills;
2. such asset-holdings are dependent upon own- and cross-asset returns;
3. log-linear relationships exist between desired asset demands and the asset returns;
4. own-asset return elasticities are positive while cross-asset elasticities are ambiguous;
5. economic agents make gradual as opposed to instantaneous asset portfolio adjustments in the event of a dis-equilibrating occurrence, say, a change in the relative asset returns;
6. the small-country assumption holds.

From assumptions 1, 2, and 4 one gets the following general form of desired asset demand equations:

$$m^d(t)-p(t) = l(r(t), r^*(t), E[e(t+1)]-e(t), r^{tb}(t)); \quad [1.11]$$

$$m^{*d}(t)+e(t)-p(t) = l^{*}\{r(t),\ r^{*}(t),\ E[e(t+1)]-e(t),\ r^{tb}(t)\};\ldots[1.12]$$
(+) (?) (?)

$$tb^{d}(t)-p(t) = b\{r(t),\ r^{*}(t),\ E[e(t+1)]-e(t),\ r^{tb}(t)\};\ldots\ldots\ldots[1.13];$$
(?) (?) (?) (+)

where, $m^{d}(t)$ = desired level of domestic liquidity held by residents at time t, $m^{*d}(t)$ = desired level of nominal foreign currency liquidity (denominated in foreign currency) held by residents at time t, tb^{d} = desired nominal treasury bill-holdings by residents at time t, p(t) = domestic price level at time t, r(t) = nominal interest rate on domestic currency liquidity at time t, $r^{*}(t)$ = nominal interest rate on foreign-currency deposits at time t, r^{tb} = nominal interest rate on treasury bills at time t, e(t) = domestic currency price of foreign exchange at time t, and E[.] = expectations operator.

Applying assumption 3 and using matrix algebra (so model derivation is rendered concise) the general form of desired asset-demand equations reduces to:

$$x^{d} - Ay(t) = Br(t) + CE[y(t+1)] - Dy(t);\ldots\ldots\ldots\ldots\ldots[1.14];$$

where, x^{d} = vector of desired nominal asset demands, $x^{d'}=(m^{d},m^{*d},tb^{d})$; r = vector of exogenous asset returns, $r'=(r^{tb},r^{*})$; and y = vector of endogenous prices and returns, $y'=(e,p,r)$; while A, B, C, and D are coefficient matrices.

Upon the application of assumption 5 one obtains the following partial asset-portfolio adjustment scheme:

$$[x(t)-Ay(t)] - [x(t-1)-Ay(t-1)] = Q\{[x^{d}(t)-Ay(t)] - [x(t-1)- Ay(t-1)]\};\ldots[1.15];$$

where, Q = matrix of asset-portfolio adjustment coefficients that relate the difference between the desired and the actual stocks of each j^{th} asset to changes in the i^{th} asset's relative returns.

Effecting appropriate substitution for $x^{d}(t)$ in ...[1.15] from ...[1.14]

...[1.15];

...[1.16a];

where, ...[1.17a] captures three reduced form equations for the determination of the spot exchange rate, e(t), domestic price level, p(t), and the domestic nominal rate of interest, r(t). The regressors in ...[1.16a] being: expected future exchange rate, E[e(t+1)], and the exchange rate fundamentals: $z'(t)=(r^{tb}(t),r^{*}(t),m(t),m^{*}(t),tb(t),[m(t-i)-p(t-i)],[m^{*}(t-i)-e(t-i)-p(t-i)],[tb(t-i)-p(t-i)]$; for i=1,2,3,...,T, where i denotes the appropriate lag structure length in the estimable model.

From ...[1.16a] the deterministic exchange rate equation can be given as:

$$e(t) = \alpha E[e(t+1)] + \beta z(t); \quad \text{.....[1.17a]};$$

where, z(t) = as defined earlier, a vector of the exchange rate fundamentals, α = spot exchange rate elasticity of future expected depreciation of the domestic currency, β = vector of coefficients that capture the spot exchange rate elasticity of the k^{th} exchange rate fundamental or the same's i^{th} predetermined value.

Assuming that $|\alpha| < 1$, and that is a necessary condition for the presence of a speculative bubble or a speculative component of the exchange rate, the following forward rational expectations solution is derivable:

$$e(t) = \beta z(t) + E\left[\sum_{i=1}^{n} \alpha^{i}\beta z(t+i)\right] = f(t); \quad \text{.....[1.17b]};$$

where, $f(t)$ = the fundamental exchange rate solution or component.

In the event of there being a rational speculation bubble at time t, call it b(t), the forward solution to ...[1.17a] must reflect that accordingly. In other words:

$$e(t) = f(t) + b(t); \quad \text{.....[1.17c]};$$

for, $b(t+1) = \alpha^{-1}b(t) + \varepsilon(t)$ and $E[\varepsilon(t+1)] = 0$; meaning that b(t) takes a random walk (a non-stationary) data generation process.

To realize his objective, the author employed both parametric and non-parametric tests. The former was based on a Monetary-Portfolio-Balance Synthesis Model whilst the latter approach was confined to simple statistical tests for the presence or absence of rational speculation bubbles.

The reported results were not conclusive as to the presence of rational speculation bubbles; meaning that the Lebanese Pound was largely dependent upon exchange rate fundamentals -during the observed period.

The significance of the study relates to its adaptation to developing countries which are characterized with macroeconomic instability. The structural model adopted eschews most of the problems associated with polar models: those that are either strictly monetary or portfolio balance in approach.

Onis and Ozmucur (1990) opted to study the causal interactions between inflation and exchange rate. Their study was based on the vicious circle hypothesis (i.e under a floating exchange rate regime an initial changes in either the domestic or foreign economic tempo can set into motion cumulative reactions upon inflation and exchange rate movements.. Their object of study was the Turkish currency. The sample period is January, 1979 to December, 1987. Using their structural model, they realized empirical results that were supportive of the vicious circle hypothesis.

The four-equations that constitute the Onis-Ozmucur vicious circle hypothesis model are:

$$e(t) = f_1(P(t),ta/b(t),(R-R^*)(t),(O-O^*)(t),e(t-1)); \quad \ldots\ldots[1.18a]$$

$$p(t) = f_2(e(t),m(t),w(t),p^e(t)); \quad \ldots\ldots[1.18b]$$

$$m(t) = f_3(DCRE(t),P(t),x(t),D(m(t)));.....[1.18c]$$

$$x(t) = f_4(e(t)-p(t),y^*(t),x^s(t),D(x(t)));.....[1.18d];$$

where, e(t) = log of spot exchange rate at time t, p(t) = domestic price level at time t, ta/b(t) = trade account balance at time t (valued in foreign currency), $(R-R^*)(t)$ = national rate of interest differential, $(O-O^*)(t)$ = national rate of return on other comparable assets differential, p(t) = domestic price level at time t, m(t) = domestic monetary base at time t, w(t) = domestic wage rate at time t, $p^e(t)$ = expected domestic price level as at time t, DCRE(t) = direct credits to the public sector, x(t) = export earnings in foreign currency, D = distributed lag operator, e(t)-p(t) = real exchange rate at time t, $y^*(t)$ = economic conditions in the rest of the world (ROW) at time t, $x^s(t)$ = exportable surplus at time t, and D(x(t)) = predetermined values of x(t).

Dhaneshwar and Grennes (1991) undertook a study on the macroeconomic impacts of real exchange rate misalignment (RERMIS) and instability in Sub-Saharan Africa. The study, which covered the period 1970/87, basically used pooled time-series/cross-section data for 33 countries; Kenya included.

In estimating the degree of exchange rate misalignment, the authors used three indices: a PPP measure, a model-based measure, and a black market premia index.

The model-based index indicated that the KSH was overvalued during the sample period by 14.0% whereas the PPP-I and the BMP-I indices led to comparable figures of 13.6% and 16.9%, respectively.

Turning to the question of the macroeconomic impacts of real exchange rate misalignment (RERMIS), the authors did simple OLS estimations to conclude, generally, that it did show significant adverse consequences on macroeconomic performance in Sub-Saharan Africa.

Taking the coefficient of real exchange rate variation as a proxy for real exchange rate variability in the 33 countries, the authors concluded that like in the case of RERMIS, exchange rate variability adversely affected macroeconomic performance.

On the joint effects of the two features of exchange rate movements, it was realized that in the most part they reflect significant adverse effects on macroeconomic performance; indicating that the two do not represent one and the same thing though they are closely correlated.

This study is commendable on a number of respects: firstly, it applies recent developments in economic theory to provide a rigorous analysis of the macroeconomic impacts of exchange rate movements. More particularly, its findings could be more relevant to Sub-Saharan Africa as opposed to earlier studies that were too general as to the data used. Secondly, it provides empirical evidence on the validity of the real exchange rate "fundamentals" approach advanced by Edwards (1988). And thirdly, it successfully applies, though simple, a method of real exchange rate misalignment that is based on economic theory as opposed to the often used had hoc methods.

The study can, however, be criticised on grounds that though it is less general when compared to past studies on the same issues with regard to their applicability to Sub-Saharan Africa, it cannot be entirely dependent upon in guiding country-specific policy formulation and implementation. This is because its results are based on pooled time-series/cross-section data for as many as 33 countries.

Mcdonald and Taylor (1993) revisted the evaluation of the empirical performance of the monetary model by using monthly data to study the Dollar-Mark exchange rate over the period January, 1976 to December, 1990. Their study's empirical results refuted what had amounted to the disqualification of the monetary approach to exchange rate

determination. particularly, they adduced empirical evidence to the effect that the long run version of the FLMA model out-performs the random walk model; contrary to Meese and Rogoff (1983)'s findings. Analyzing the same exchange rate for the incidence of speculative bubbles, the authors rejected the null hypothesis about the existence of speculative bubbles. This results are also contrary to those derived by George W., (1986). But the superiority of the econometric analysis (i.e application of co-integration analysis and error correction models) applied in this study could be advanced as a case for the superiority of the same study over past ones.

2.3.2: Empirical Literature on the Kenyan Context

The empirical literature that squarely focuses on the Kenyan economy is scanty. Among the few accessible works are by Ayako and Manundu (1986), Mwamadzingo (1988), Onyango (1990), Maturu (1992 and 1993).

Ayako and Manundu (1986) designed a theoretical and empirical analytical framework within which they evaluated the impact of devaluation on inflation; in an open economy producing two goods: one tradable and the other non-tradeable. They adduced evidence to the effect that devaluation is strongly related to inflation.

Mwamadzingo (1988) made use of twenty-one sample observations on annual time series data for the period 1966-1986 to study the behaviour and macroeconomic impacts of the KSH exchange rate. The study adopted a simultaneous equations approach.

The exchange rate equation in the author's model was:

$$\underset{(+)(-)\ (+)\ (+)\ (+)\ (+)\ (-)\ (+)\ (-)\ (+)}{ER = f_1(X, M, CPI, MS, TOUR, IR, FPD, FR, PPP, KMOVT);} \quad \ldots[1.19];$$

where "ER" is either the nominal effective exchange rate (NEER) or the real effective exchange rate (REER), whereas "X", "M", "CPI", "MS", "TOUR", "IR", "FPD", "PPP", and "KMOVT" are: domestic exports, domestic imports, consumer price index (proxy for

domestic rate of inflation), domestic money supply, earnings from tourism, domestic real interest rate, foreign reserves, purchasing power parity, and capital flows, respectively.

Adopting a data admissible linear equation specifications for the model, and using 2SLS (in the LIMDEP Software), the following results in respect of the REER were obtained:

$$ER = \underset{(2.177)^{**}}{43.701} + \underset{(0.714)}{0.112CPI} + \underset{(1.195)^{**}}{0.010IMP} - \underset{(-0.197)}{0.002EXP} - \underset{(-1.677)^{*}}{7.513PPP}$$

$$+ \underset{(2.365)^{**}}{0.046TOUR} - \underset{(-2.244^{*})}{0.024MS} - \underset{(-1.292)^{**}}{0.284IR} + \underset{(2.825)^{***}}{0.030FR} + \underset{(2.754)}{0.035KMOVT} - \underset{(2.226)^{**}}{0.014FPD}$$

$R^2 = 0.881$, $R^2_{Adj.} = 0.762$, SEE = 1.059, DW = 2.249;

where *, **, ***, denotes coefficient(s) that are statistically significant at: 10%, 5%, and 1%, respectively.

On the issue of exchange rate misalignment, the author apparently defined exchange rate misalignment as the amount of deviation of the official nominal exchange rate from the real effective exchange rate (REER); expressed as a percentage of the latter. Using that as the real exchange rate misalignment index, the study found that during the fixed exchange rate regime the KSH was undervalued but became increasingly overvalued following the adoption of the managed float in 1982. For instance, the study reports that a Kenyan currency that was overvalued by a mere 27% (in real terms) in 1982 was overvalued the more over time that in 1986 the degree of overvaluation had shot up to 72%.

This study stands out as one of the most comprehensive in coverage. It is quite thought provoking; being one of the first of our country specific studies to address the issues tackled. The study is not without its shortfalls, however.

While it cannot be denied that a simultaneous equations approach to exchange

rate determination seems appealing, it cannot be fair to assume that single equation approaches to exchange rate determination lead to inefficient results, a priori; for, has it not been empirically established that the same single equation approaches do command a reasonable explanatory power; at least within the sample [Meese and Rogoff (1982) and Dhaneshwar and Grennes (1991)]?

Secondly, though the exchange rate determination results are quite significant as reflected in the coefficients of determination, it is interesting that the same results do report contradictory signs on some of the determinants; more particularly, on what would be considered to be an exchange rate "fundamental" [money supply (MS)]; it is interesting that the KSH exchange rate appreciates once domestic money supply increases. No adequate explanation is given by the author on this paradox.

Thirdly, in analyzing the impact of exchange rates on macroeconomic performance, the study relates what one can refer to as the "gross" or absolute exchange rate changes to macroeconomic target variables. In so doing, one cannot isolate the macroeconomic impacts of exchange rate misalignment (which the study singles out as a feature of the Kenyan currency at that time) from those of exchange rate volatility. It might have not been the objective of the study to pursue these issues, but they are relevant issues that needed and still need empirical consideration.

Fourthly, the study does not provide adequate space for the analysis of the question of exchange rate misalignment. In subscribing to that view, the author does attribute that shortfall to the limitations on the side of economic theory with regard to the measurement of exchange rate misalignment. Consequently, the author adopts an analysis of exchange rate misalignment whose results cannot be tested; for one, the approach is not amenable to inferential statistics and, secondly, given that only one kind

of real exchange rate misalignment index was used in the study, no comparative results were available to facilitate any visualization of the accuracy of the derived results'.

Onyango (1990) neither addressed himself to the KSH exchange rate determination nor exchange rate misalignment. Taking annual data for the period 1966/87, he examined the relative performance of external trade incentives in resolving the country's worsening balance of payments position. Viewed as one of the trade incentives, real effective bilateral exchange rates were found to impact positively on trade. The trade elasticities of bilateral exchange rates are however reportedly varied among trading-partner countries.

Maturu (1992) undertook a study on the amazing depreciation of the KSH exchange rate as exemplified in the KSH/£ bilateral exchange rate. The reduced form monetary model upon which the study was based did not yield adequate results. The empirical results were overridden with excessive serial correlation and multicollinearity. There was also a possibility of simultaneous equations bias in the results.

Though overridden with a number of limitations, the study provides some rudimentary evidence in favour of Mwamadzingo's contention that a reduced form model cannot do well in capturing the data generation process of the KSH exchange rate.

Maturu (1993) wanted to test the popular view that monetary indiscipline stands out as one of the prime "causes" of the depreciation of the KSH exchange rate; that is, the driving force in the study was to find out the role of domestic money supply in the KSH exchange rate patterns. Using OLS estimation of a reduced form monetary model, the results were once again poor in the sense that a perverse sign was reported on the monetary variable.

2.3: Empirical Literature: An Overview

Empirical analysis of exchange rate determination apparently gained momentum following the momentous experience of the flexible exchange rate regime of the late 1970s. This was particularly the case in respect of the major international currencies given that not many third world countries had deemed it befitting to liberalize their exchange rates. Thus, by and large, studies on exchange rate determination, during the late 1970s, were basically a domain (both in terms of areal coverage and the citizenry of the allied researchers) of the developed countries.

The key determinants of exchange rates are can be categorized into two as exchange rate market fundamentals and foreign exchange market psychology (Mcdonald and Taylor (1992)). Owing to the niceties of explicitly modeling the later, preference is accorded to the explicit modeling of exchange rate volatility in terms of foreign exchange market fundamentals. Both parametric and/or non-parametric hypothesis testing can be carried out to investigate the incidence of exchange rate speculation.

As for the evolution of methodological issues, the orthodoxy of applying reduced form equations was latter to be displaced by the adoption of structural models. Pushed further, this trend saw the formulation of highly integrated models of exchange rate determination.

In the case of estimation techniques, the predominance of OLS is far from concealed; especially in respect of empirical studies done during the 1970s. Though OlS is still being applied in exchange rate determination issues, apparently, any serious exchange rate modelling needs systems estimation techniques using powerful computer software.

END-NOTES

1. For example, Niso and Philippe (March,1990;pg.157) assert that "...[the long-run PPP is] a fundamental building block of most models of exchange rate determination."

2. Weisweiller (1972;pg.15) defines "hot money" surplus funds in the [domestic] money market which are usually channelled out of the affected country foreign short-term but highly profitable investments. This interpretation is akin to the Economist's "clever money" phraseology. See Economist, September, 19th, 1992.

3. See Mcdonald and Taylor (1992;pg.4-5).

CHAPTER THREE: THEORETICAL FRAME-WORKS

3.1: Introduction

Broadly speaking, there are two basic methods of statistical analysis: regression and correlation analyses. This study applies regression analysis in implementing its stated objectives. Since regression analysis' fundamental basis is a soundly specified regression model, the formulation of such a models constitutes a matter of immediate concern in this chapter.

The formulation of the requisite models, entail systematic rationalization aided by both of the theoretical and empirical works reviewed in the previous chapter.

3.2: Determination of the KSH Real Exchange Rate Market Fundamentals Component

In modeling exchange rate movements, we can formulate either a model that captures both the exchange rate fundamental and speculative bubble components of the KSH real exchange rate[1]; simultaneously and explicitly or a model that captures the exchange rate fundamentals' component and subject the resultant empirical model to statistical tests on model mis-specification; which mis-specification, if any, would be attributable to the exclusion of the exchange rate speculation component. To add confidence to the results resultant from the application of the second approach, both parametric and non-parametric tests for the existence of speculative bubbles can be carried out. Whereas both approaches have their shortfalls[2], pragmatic considerations render the second approach preferable to the first.

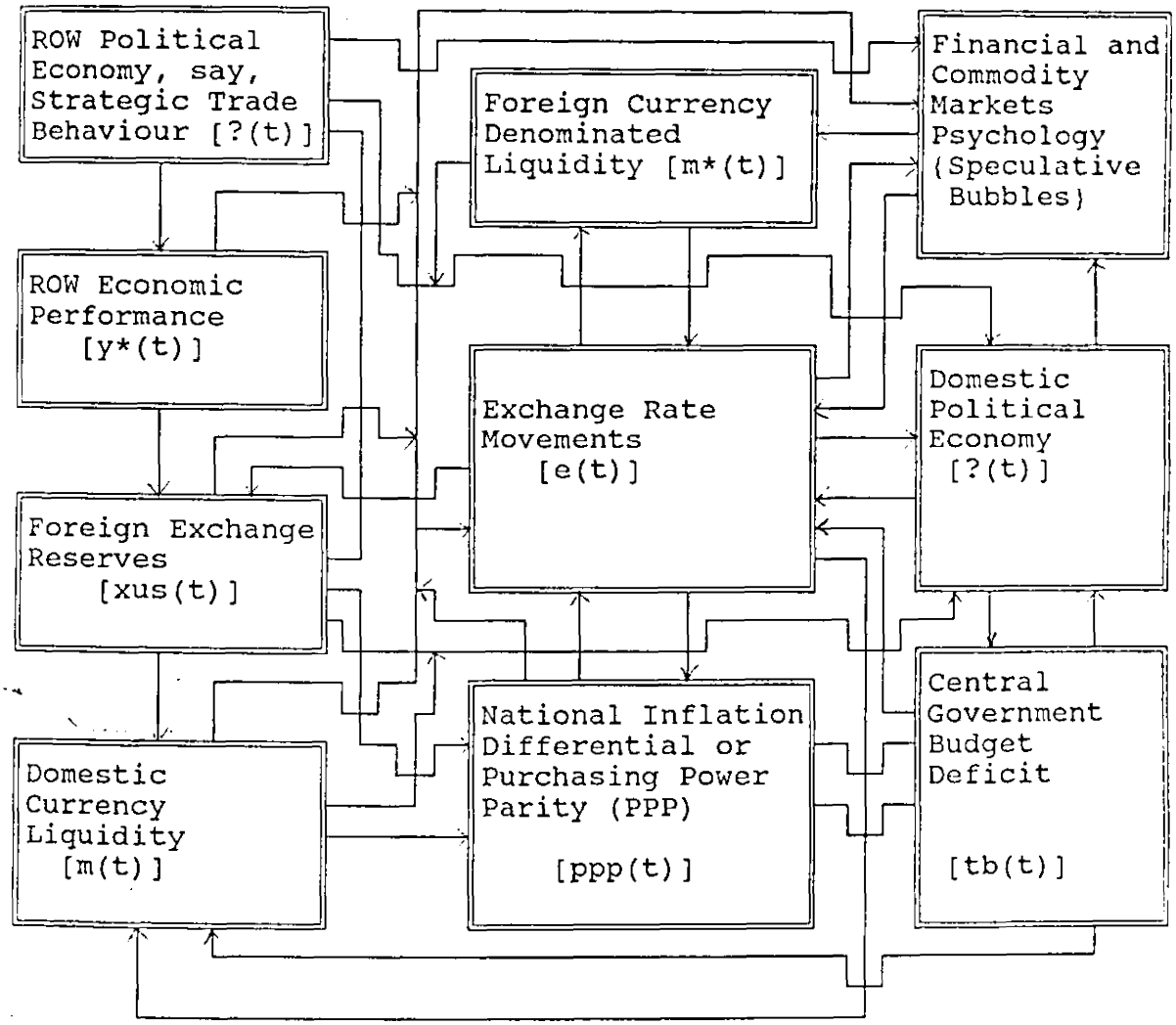
Given the successful empirical performance of Towe's monetary-portfolio synthesis

model; in its being applied to Lebanese data, and given also that the same author recommends the same model for the analysis of exchange rate volatility in other developing countries, the monetary-portfolio synthesis readily appears to be a candidate model for the determination of the KSH real exchange rate volatility. In the light of some of the macroeconomic peculiarities of the Lebanese and the Kenyan economies, however, together with some of the advancements in macroeconomic and econometric analysis, a wholesale application of the Towe model would not be wise.

One of the major sources of prospective adjustments to the Towe model so it could suit the Kenyan context relate to the postulates of the vicious circle hypothesis as enunciated by Onis and Ozmucur (1990)[3]. The Kenyan economy meets the minimum assumptions about the effective operation of the hypothesis; namely; Kenya's overreliance on external sources of both intermediate and capital goods and that she has a predominantly oligopolistic industrial structure[4].

Thus, a hybrid model that captures both the Towe and the Onis-Ozmucur models would be more appropriate in explaining the data generation process of the KSH real exchange rate than when either of the two models is applied in isolation. A schematic representation of the causal interactions and impact transmission mechanisms in the proposed Towe-Onis and Ozmucur model is provided as figure 3; below.

Figure 3: A Schematic Representation of an Integrated Towe-Onis-Ozmucur Model: Principal Interaction Links and Impact Transmission Mechanisms.



Source: author.

3.2.1: An Integrated Towe-Onis and Ozmucur Model: The URF Version

The prospective estimable model is resultant from the integration of the monetary-portfolio balance synthesis model,

...[1.16a], and the vicious circle hypothesis model, ...[1.18]. The integration process involves a modification of the Towe model. Such a model "cleansing" exercise is of a dual nature, namely; it involves the removal/ incorporation of irrelevant/ relevant variables from/ into the basic Towe model so conform to the peculiarities of the Kenyan economy.

Given the long drawn controls over the domestic financial sector, the domestic structure of rates of interest has more or less remained exogenous. Consequently, the treatment of the domestic rate of interest as being endogenous in Towe's model is not quite realistic in the Kenyan context. Such a line of rationalization renders the domestic rate of interest equation (that appears in the pure Towe model) superfluous. Hence, it should be excluded from the prospective integrated model. To the extent that the small country assumption is assumed to hold, one would be tempted to treat Kenya's export earnings to be exogenous. But once such export earnings are valued in foreign currency, they must surely inherit some element of "endogeneity" from the endogenous exchange rate[5]. An additional export earnings equation is therefore wanting in an enhanced monetary-portfolio balance synthesis model. Such an equation is rationalize against the vicious circle hypothesis model.

In integrating the Towe and the Onis-Ozmucur models, there is a need to reconcile the monetary concepts applied by the two types of studies (i.e money demand and money supply, respectively). Assuming monetary equilibrium in the Kenyan Context, and that money

supply is endogenously determined, the two monetary concepts reduce to one and the same thing. But one thing is clear, namely; the endogenously determined domestic money supply entails the inclusion of a domestic money supply equation into the prospective enhanced Towe model.

Upon effecting the proposed adjustments to the basic Towe model, the following log-linear dynamic system is realized:

$$y(t) = f\left(\sum_{i=0}^{m} \beta_i y_{(t-1)},\ \sum_{r=j}^{r} \pi_{m+j+1} w_{(t-j)}\right); \ldots\ldots\ldots\ldots [1.20];$$

where y(t) = a vector of the modelled variables and w(t) = a vector of the non-modelled variables

Even when the suggested modifications have been effected as to derive ...[1.20]; above, one finds that the resultant model is far from being completely specified. Two important considerations are still outstanding. Firstly, there is a need for determining the prospective estimable model's appropriate lag structure (i.e the values of m and r in ...[1.20). Secondly, upon effecting all the said corrections, the resultant deterministic model needs to be translated into an econometric model; by correctly incorporating respective constant and disturbance error terms.

3.2.2: Determination of the Estimable Model's Lag Structure

A number of approaches have been isolated for the determination of an estimable model's lag structure; whenever predetermined values of, say, the dependent variable or the explanatory variables enter the model as genuine regressors[6]. The approach that is adopted in this study is unorthodox and yet

straight forward.

The centre of the argument is that if a variable partly depends upon its history; all the way back to the j^{th} period, it should follow that any explanatory variable for the same dependent variable that has some appreciable contemporaneous impact upon the dependent variable must surely have its predetermined values influencing the corresponding predetermined values of the dependent variable. The predetermined values of the independent variables (i.e up to the j^{th} lag meaning that r=j) would also be expected to influence the dependent variable. Consequently, the lag structure to be adopted in a regression model for the depended variable should more or less equal the number of lags that tally with the historical self-determination of the dependent variable (i.e up to the j^{th} period lag).

In order to determine that critical lag structure (i.e the value of j), the dependent variable should be subjected to time series analysis. Such a time series analysis exercise could help one figure out the scope of the dependent variable's self-determination (i.e ascertain the value of j).

Upon establishing the critical number of lag periods, j, in accordance with the preceding rationalization, one shall have cleared, a starting phase in the eventual determination of the appropriate lag structure. The route to the appropriate lag structure, from here, involves adjusting such a value of j so one would give allowance for the required degrees of freedom, D^f, so that the appropriate lag structure, l may as well be less than r<j.

In order to determine the value of l, a pilot model that assumes the derived value of r is estimated. The statistical significance of the various lag lengths in the pilot model is then investigated. By following a step-by-step elimination of the statistically insignificant impact-multipliers; starting with the most insignificant of the insignificant; while re-estimating the pilot model iteratively so one would assess the progress made in a bid to formulating a parsimonious model, one would eventually strike the optimal lag structure, l^*; for $l^*<l$. Such a lag structure is reflected in the estimable model.

3.2.2.1: Univariate Time Series Analysis

As noted earlier, the prospective estimable model consists of four simultaneous equations: the real exchange rate, the domestic price level, the domestic currency denominated liquidity, and the domestic export earnings equations. Thus, there are equally four dependent variables whose time series analyses deserve careful consideration.

In undertaking time series analyses, one may opt for the use of any one (or set) of the four basic time series analysis models. The four models are: the i^{th} order autoregressive, AR(i), model; the i^{th} order vector autoregressive, VAR(i), model; the j^{th} order moving average, MA(j), model; and the (i^{th},j^{th}) autoregressive moving average, ARMA(i,j), model. For purposes of this study, it suffices applying first order autoregressive, AR(1), specifications. The general form of AR(1), a univariate time series analysis model, is given by;

$y_k(t) = \S y_k(t-1) + \nu(t)$; for $_k = 1, 2, 3, 4$;.....[1.21];

where, $y_k = k^{th}$ dependent variable that is being subjected to time series analysis, § = an autocorrelation coefficient, ν = disturbance error term, and t = time period index.

Once the relevant time series models have been estimated, using OLS in the PC-GIVE computer package, one should go ahead to make use of the PC-GIVE utilities for lag structure analysis so as to come up with the value of j (i.e the lag structure for which ...[1.21] estimates are statistically significant).

Rationalized against economic theory and the above approach to the determination of the appropriate lag structure, and by translating ...[1.20] into a stochastic system, the following Unrestricted form (URF) model was realized:

$$\alpha_{e0} + \sum_{j=0}^{1} \beta_{i,j,e} y_{i,(t-1)} + \sum_{r=0}^{4} \pi_{k,r,e} w_{k,(t-r)} + v_{e,(t)} = 0;.....[1.22];$$

where $_e$ = denotes the $_e$-th equation in the system for $_e = 1, 2, 3, 4$; $_i$ = denotes the $_i$-th endogenous variable in the system for $_i = 1, 2, 3, 4$; $_j$ = denotes the lag structure for the $_i$-th endogenous variable for $_j = 0, 1$; $_k$ = denotes the $_k$-th exogenous variable for $_k = 1, 2, 3, 4, 5, 6, 7$ and with $_{k+1}$ denoting a trend variable; α_{e0} = denotes a constant term in the $_e$-th equation where α_{e0} is not zero for all values of $_e$; $\beta_{i,j,e} = 0$ for all $_i$ is not equal to $_e$; $\beta_{i,j,e}$ is not zero for all $_i$ equal to $_e$ and that for all values of $_k$ and $_e$, $\pi_{k,r,e}$ is not zero. In the system, v denotes a vector of non-serially autocorrelated and innovation processes. On the other hand, y and

w are $_{e}xT$ and $(_{k+1})xT$ matrices of observations that constitute the data matrix for the system. Note that t = 1980:1 = 1, 1980:2, ..., T = 1991:3 = 47.

The Endogenous variables which constitute the above system, as captured in the vector y include: the KSH real exchange rate (e(t)), domestic inflation, (P(t)), domestic currency denominated money supply, (m(t)), and Kenya's export earnings expressed in base currency, US$, (xus(t)). On the other hand, the at least weakly exogenous variables that define the vector w are: Purchasing Power Parity, (PPP(t)), domestic residents' holdings of foreign currency denominated liquidity, (m*(t)), outstanding domestic central government public debt, (tb(t), regulatory arbitrage, (ra$(t)), domestic macroeconomic performance, (y(t)), macroeconomic performance in the Rest of the World, (y*(t)), and import prices of intermediate and capital goods, (p*(t)). In addition to these seven basic explanatory variables is a trend variable, T(t).

3.2.3: An Integrated Towe-Onis and Ozmucur Model: The Estimable Version

The incorporation of some of explanatory variables into the URF model have neither any theoretical nor logical justification. The presence of the latter feature renders the URF Model a purely statistical model whose results may be rated as being spurious. Hence the need to generate an econometric model from the URF Model via appropriate parameter exclusion restrictions. Through the imposition of relevant zero restrictions, irrelevant explanatory variables would be purged off the URF model's affected equations.

The above cleansing procedure results in the following econometric model:

$$e(t) = \alpha_0 + \alpha_1 e(t-1) + \alpha_2 m(t-1) + \alpha_3 tb(t) + \alpha_4 ppp(t) + \alpha_5 ra\$(t) + \alpha_6 y(t) + \alpha_7 y^*(t) + \alpha_8 m^*(t) + \alpha_9 ppp(t-4) + \epsilon(t); \ldots [1.23a];$$

$$p(t) = \beta_0 + \beta_1 p(t-1) + \beta_2 e(t-1) + \beta_3 m(t-1) + \beta_4 p^*(t) + \beta_5 tb(t) + \beta_6 y(t) + \beta_7 xus(t-1) + \beta_8 tb(t-1) + \beta_9 tb(t-4) + Æ(t); \ldots [1.23b];$$

$$m(t) = \pi_0 + \pi_1 m(t-1) + \pi_2 p(t-1) + \pi_3 tb(t) + \pi_4 y(t) + \pi_5 m^*(t) + \pi_6 xus(t-1) + \pi_7 tb(t-1) + \pi_8 tb(t-4) + \pi_9 m^*(t-4) + \dot{E}(t); \ldots [1.23c];$$

$$xus(t) = \delta_0 + \delta_1 T + \delta_2 xus(t-1) + \delta_3 e(t-1) + \delta_4 ppp(t) + \delta_5 y^*(t) + \delta_6 y(t) + \delta_7 ppp(t-1) + \hat{u}(t); \ldots [1.23d];$$

where T is a trend variable (instrumental variable for changes in foreign consumers' tastes and preferences), y* is level of macroeconomic activity in the Rest of the World (instrumented by USA's quarterly industrial production index) and the other variables retain their earlier definitions. Equations ...[1.23a] through ...[1.23d] are the real exchange rate, domestic inflation, domestic currency denominated liquidity, and domestic export earnings equations.

3.3: Estimation Techniques

The formal approach to determining an appropriate lag structure for a system of simultaneous equations model is to solve the model's associated identification problem. In doing that, both the order condition (i.e a necessary condition for identification)

and the rank condition (i.e the sufficient condition) need to be applied. According to the order condition, a behavioural equation is identified once:

$G - g_e + K - k_e > G - 1$; for i = 1, 2, 3, 4;.....[1.23];

where G = denotes the total number of endogenous variables in the model g_e = total number of endogenous variables in the $_e$-th behavioural equation (g_e = 1 for all $_e$; K = 164 is the total number of predetermined variables in the system, and k_e = total number of predetermined variables in the $_e$th behavioural equation.

Once the order condition is met with an inequality; for the $_e$-th behavioural equation, it follows that the equation is over-identified and the associated appropriate estimation technique is Two Stage Least Squares (2SLS). Should the same condition be met with an equality, then the affected equation is just identified. In that case the corresponding appropriate estimation technique either 2SLS or Indirect Least Squares (ILS).

The rank condition requires that:

$p(AB_e) = G - 1$;.....[1.24a);

where, A = matrix of parameters in the system of simultaneous equations model, B = matrix of exclusion parameter restrictions on the $_e$th equation, and G is as defined earlier.

Owing to the high degree of dimensionality in the URF model, it becomes cumbersome to the apply the rank condition as stated above. A more pragmatic representation of the rank condition is give below as ...[1.24b] through ...[1.24d].

$p(AB_e) = Min(G, R^*_e - r^*_e) > G - 1$; for $R^{*e} < G$;.....[1.24b]

$$p(AB_e) = Min(G - 1, R^*_e - r^*_e) > G - 1; \text{ for } R^{*e} = G; \ldots\ldots [1.24c]$$

$$p(AB_e) = Min(G - 1, R^*_e - r^*_e) > G - 1; \text{ for } R^{*e} > G; \ldots\ldots [1.24d]$$

where R^*_e = denotes the total number of exclusion parameter restrictions on the $_e$th equation, r^*_e = denotes the total number of exclusion parameter restrictions on the $_e$th equation that do apply to the rest of the equations so that similar explanatory variables ar excluded from all the behvioural equations in the system of simultaneous equations model.

From the URF model, $G = 4$, $g_e = 1$ for all values of $_e$, $K = 44$, $k_e = 10$ for all values of $_e$, $R^{*e} = 3$ for all values of $_e$, and $r^{*e} = 0$ for all values of $_e$. According to the specified estimable model, $G = 4$, $K = 38$, $g_e = 1$ for all values of $_e$, $k_1 = 10$, $k_2 = 10$, $k_3 = 10$, $k_4 = 8$, $R^{*e} = 31$ for $_e = 1$, 2, and 3, $R^{*4} = 33$, $r^{*e} = 28$ for all values of $_e$.

Upon the application of the order condition to the system of equations captured in ...[1.22], we established that the system is overidentified; for the order condition is met with an inequality once the appropriate substitutions are done into ...[1.23] (for all values of $_e$); meaning that appropriate estimation technique for the system is 2SLS. According to the rank order condition (i.e ....[1.24b]), $p(AB_e) = Min(4, 3 - 0) = 4 - 1$ for all values of $_e$; meaning that even under the rank condition, the URF model is identified.

Subjecting the estimable model to the order condition yields: for $_e = 1$, 2, and 3 ....[1.22] reduces to $31 > 3$; and for $_e = 4$ the

order conditio reduces to 33 > 3; meaning that the estimable model is also overidentified. Consequently, 2SLS would constitute the appropriate estimable technique for the estimable model. In order to determine whether or not that result on the order condition is confirmed tally with those of the rank condition, the estimable model was subjected to the rank condition (i.e applying ...[1.24d]). The following were the results: for $_e$ = 1, 2, and 3; $p(AB_e)$ = Min(4 - 1, 31 - 28) = 4 - 1; and for $_e$ = 4, $p(AB_e)$ = Min(4 - 1, 33 - 28) = 4 - 1. Hence, the estimable model is identified under the rank condition, too.

3.4: Data Type, Sources and Limitations

The empirical implementation of the estimable model requires high frequency time series data. Quarterly, time series data for the period 1980:1/1991:3 is accessible for most of the relevant variables. That renders it an appropriate form of the relevant time series data. The following coding scheme presents the definitions of the data variables and the data variables' corresponding data sources:

e(t) = logarithm of the KSH real exchange rate at time t expressed as an index, 1980:1 = 100; (estimates by author using basic data from IMF's International Financial Statistics, IFS);

m(t) = logarithm of domestic currency denominated liquidity-holding by domestic residents at time t expressed in index form, 1980:1 = 100; (instrumented by the logarithm of broad money

supply (m_2) whose data is accessible from IMF's IFS);

m*(t) = logarithm of foreign currency denominated liquidity-holding by domestic residents at time t expressed in index form, 1980:1 = 100; (instrumented by non-bank domestic residents' cross-border deposit holdings; data is available from the IMF's IFS);

r*(t) = nominal rate of interest on foreign currency denominated liquidity expressed in index form, 1980:1 = 100; (instrumented by the Euro-dollar rate of interest whose data is available from the IMF's IFS);

ra$(t) = national rate of interest differential expressed in index form, 1980:1 = 100; (instrument for regulatory arbitrage; data derivable from IMF's IFS); approximated by [r*(t)- r^{tb}(t)]; see r^{tb}(t) below;

r^{tb} = nominal rate of interest on government debt financial instruments expressed in index form, 1980:1 = 100; (instrumented by rate of interest on treasury bills; data derivable from the IMF's IFS);

tb(t) = logarithm of net claims on central government by domestic creditors at time t expressed in index form, 1980:1 = 100; (instrument for logarithm of outstanding domestic residents' holdings of central

government bonds and treasury bills; data available in the IMF's IFS);

p(t) = logarithm of domestic price level at time t (instrumented by Nairobi consumer price index, 1980:1 = 100; data available in the IMF's IFS);

p*(t) = logarithm of the price level in the Rest of the World (ROW) at time t (instrumented by consumer price index, 1980:1 = 100, in the USA; data obtainable from the IMF's IFS);

ppp(t) = national inflation differential at time t (instrumented by the logarithm of the absolute purchasing power parity i.e log[p(t)/p*(t)]);

xus(t) = logarithm of reporting country's export earnings in index form, 1980:1 = 100; (expressed in terms of foreign/base currency, say, US$; the basic data is available in the Central Bureau of Statistics' Statistical Abstract);

y*(t) = logarithm of ROW's rate of macroeconomic performance at time t expressed in index form, 1980:1 = 100; (instrumented by logarithm of USA's Industrial Production Index; data available from the IMF's IFS);

y(t) = logarithm of domestic Gross Domestic Product (GDP) at time t, expressed in index form, 1980:1 = 100; (the data on y(t) is retrieved from the log-linear money demand equation,

$m^d(t) = p(t) + y(t) + r(t)$; where $m(t)$, and $y(t)$ are as defined earlier and $r(t)$ is the opportunity cost of nominal money balances (proxied by $r^{tb}(t)$). Assuming equilibrium conditions to hold in the domestic money market so that money demand equals exogenous money supply, $m(t)$, $y(t)$ can be computed as a residual, namely; $y(t) = m(t) - p(t) - r^{tb}(t)$.

The major data limitation is that of the lack of a continuous series of appropriately dis-aggregated time series data. Such a lack of short term monthly data has led to the utilization of medium term quarterly time series. Proxies have been used to address the problem of lack of observations on some key variables.

3.5: Exchange Rate Determination: Tests for Speculative Bubbles

Whereas the estimable model in the preceding sub-section does explicitly capture the influence of exchange rate fundamentals in the determination of the KSH real exchange rate, it more or less remains silent on the relative role of speculative bubbles. This sub-section is devoted to the proposal of specific statistical tests for the presence or otherwise of a speculative component in the KSH real exchange rate.

The statistical tests are categorized into two: parametric and non-parametric tests.

3.5.1: Parametric Tests for Speculative Bubbles

In this sub-section, two parametric tests are proposed and

discussed. The parametric tests derive from the following rationalization;

(i) one of the necessary conditions for the presence of a speculative bubble in an exchange rate is that the same exchange rate's determination process must have a forward solution. Please refer to ...[1.17c]. Such a forward solution exists if and only if $|\alpha_1|<1$. Thus a test of the null hypothesis about there being no difference between the absolute value of the coefficient estimate for the parameter α_1 and unity would amount to an indirect way of testing for the presence or otherwise of speculative bubbles in the H=KSH real exchange rate. Acceptance/ rejection of the null hypothesis would be a manifestation of the absence/ presence of speculative bubbles.

(ii) Co-integration analysis has, in the recent past, emerged as one of the best tests for the goodness of fit of a regression model. Once an estimated model is co-integrated, it follows that the model does not suffer from mis-specification. Otherwise the model would be mis-specified should there be lack of co-integration. By modelling the fundamentals component of the KSH real exchange rate volatility to the exclusion of the speculative component, if any, the estimable model in the preceding sub-section must surely be mis-specified

... the $_k$th year of the sample period of 12 years and $k = 1, \ldots$
... of data points during the $_k$th (i.e for annual time series
... 12 whilst $d^k = 4$ for quarterly time series), n_k = the
... number of data points that yield excess (i.e ...
... of return on holding a three month forward contract in ...
... the assumption of simple efficiency in the KSH ...
...nge market, N_k = amount of deviation of excess rate of ret...
...ding a three month forward contract in KSH during the k^{th} ye...
... the null hypothesis that $(n_k - d^k/2) = 0$, Z_k = maximum ...
...t of deviation of excess rate of return to holding a three
... forward contract in KSH over the sample period of 12 years,
... Y = the minimum non-zero of the twelve cumulative freq...
...rs in George(1986)'s table of cumulative frequencies ...
...ross the Z_k^{th} row.

It should be noted that whereas the Z_k-statistic is calcula...
... the sample data, the value of the Y-statistic is ...
...e (1986)'s table of cumulative frequencies. Thus, ...
... the calculated value of the Z_k-statistic one is able ...
...value of the Y-statistic; which value of the Y-statistic ...
... used in conjunction with George's table of ...
...ificance-level-values of the Y-statistic to finally infer
...er or not the null hypothesis is accepted.

The decision criteria in testing the null hypothesis ...
...de very clear.

Within the body of George's table of cumulative fr... ...
...ation $a_k(Z_k)$ which provide a measure of the number of ...

equal or greater value of the Z_k-statistic (labelled in the same table along the extreme left-hand column) was realized in 10,000 simulations of 155 months each; for each sub-period of k years (labelled along the topmost row of the same table). This table provides the basis for the calculated probability of obtaining a value, call it "c", such that "c" is equal or more than the calculated Y-statistic. In other words $p(c>Y)_{Calculated} = 0.0001Y$. The calculated probability is then compared with the corresponding critical probability, $p(c>Y)_{Critical}$, as read from George's table of "significance Levels for Distribution of Y". Now for all $p(c>Y)_{Calculated} > p(c>Y)_{Critical}$, $p(c>Y)_{Calculated} < p(c>Y)_{Critical}$ and $p(c>Y)_{Calculated} = p(c>Y)_{Critical}$ the test reveals that there is: a positive, a negative, and a zero median for the excess rate of return on holding the KSH instead of a portfolio of assets denominated in foreign currencies; meaning, respectively, that the KSH exchange rate would be characterized with speculative bubbles during the sample period in case the reported empirical results conform with the first of the two alternatives. Otherwise, the exchange rate would be devoid of exchange rate speculation should the third of the three possible results be reported. Thus if the third of the above three alternatives is empirically realized, then the null hypothesis about a zero median would have to be accepted. Otherwise it would have to be rejected.

For those concerned with currency exposure management, it would be prudent to remain in long or short positions should either the first or the second of the test results be reported. They

neither stand to gain or loss if the exchange market is efficient; when the third of the three possible test results is realized.

3.5.2.1: Data Requirements for the Non-Parametric Test

From the foregoing outline of the test, it can be noticed that the basic data that is required to implement the test is time series on the excess rate of return on holding a three month forward contract in KSH. In other words one needs data on excess rate of return, x^*, such that:

$$x^*(t) = S(t+1) - f(t); \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1.26a];$$

where S(t+1) = the next period's (three months hence) observed/ spot exchange rate and f(t) is the three month forward rate of KSH real exchange rate agreed upon at time t. Owing to the poorly integrated nature of the forward exchange market facility in Kenya, the variable f(t) is not observable. Under such circumstances, we opt for the use of an observed correspondence to f(t). With the help of the simplifying assumption that economic agents form rational expectations about future exchange rates (i.e they have perfect foresight), f(t) can be set to be equal to the spot exchange rate at time t, S(t). Consequently, the operational definition for excess rate of return on holding a three moth forward contract in KSH is:

$$x^*(t) = S(t+1) - S(t); \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1.26b];$$

The necessary data on S(t) and S(t+1), the nominal KSH/SDR, is available from the IMF's IFS.

END-NOTES

1. The interpretation of the concepts of exchange rate fundamentals and speculative bubbles seem to be as diverse as there are economists; for the concepts' operational definitions vary with researchers' model specification. See Boughton (1987), George (1986), Towe (1989) and Onis and Ozmucur (1990) for a discussion on the concepts.

2. See Mcdonald and Taylor (1992) for a discussion of the alternative approaches to modelling both the exchange rate fundamentals and the speculative bubble determinants.

3. According to Onis and Ozmucur (1990;pp.135-36), the Vicious Circle Hypothesis states that "... under a floating exchange rate regime, an initial disturbance (either domestic or foreign) can set into motion a cumulative process of inflation and exchange rate devaluation, through which the exchange rate effect is rapidly translated into domestic prices and costs and back to the exchange rate."

4. See Maturu (1993); " Kenya's Trade Policy in a Transition: A Note." for a quick overview of Kenya's external trade policy during her post-independence era, 1963/1993. See also Gulhart et al (1985) for a note on Kenya's exogenous exchange rate devaluations that amounted to about 30% in real terms during the 1970s. The devaluations were geared towards domestic export enhancement.

5. See Ng'eno (1991) for a variant of such an export function for Kenya.

6. Harvey (1990;pp.225-8); The Econometric Analysis of Time Series.

7.This test suffers from the joint hypothesis tests dilemma. Since it is based on testing the for goodness of fit of the estimable model, lack of such goodness of fit can be apportioned between the exclusion of the speculative bubbles or inadequate modelling of the exchange rate fundamentals component. For this test to be a conclusive test for speculative bubbles, it must be presumed that the fundamental component of the exchange rate is appropriately modelled.

8. See George (1986); "A Test for Speculative Bubbles in the Sterling-Dollar Exchange Rate: 1981-84." In the American Economic Review, vol. 76, No.4 (September); 621-636.

CHAPTER FOUR: EMPIRICAL FRAME-WORKS

4.1: Introduction

In this chapter we present and discuss the empirical results derived from the implementation of the theoretical frame-works presented in the preceding chapter. Empirical results on the URF model are tackled first, followed by those on the estimable model.

4.2: Determination of the KSH Real Exchange Rate Fundamentals Component

4.2.1: Empirical Results on the urf Model

Keeping in line with the methodology provided in chapter three, one would expect the provision of empirical results on the URF model to preced those on the estimable model. Owing to the high dimensionality of the URF Model, only key empirical statistics shall be reported herein together with summary graphical results. In any case the pivotal role of the URF model results derives from its being a "parent" model(i.e that once proved to be data-congruent, the URF model does have the capacity to generate an econometrically estimable model; like the one specified in the previous chapter). Thus, the empirical results provided in respect of the URF model focus on demonstrating that URF model is data-congruent.

Upon the empirical estimation of the said model, it was found that the Trace Correlation and the Vector Alienation Coefficient stood at 99.26% and 0% respectively. Since these statistics'

interpretation is analogous to the Coefficient of Determination, (R^2), and Residual Sum of Squares, (RSS = $1-R^2$), respectively; in Ordinary Least Squares (OLS) analysis, it follows that the URF Model does explain 99.26% of the variations in the four modelled endogenous variables whilst the unexplained variation in the same variables is quite negligible as evidenced from the RSS. Such a "good" fit is demonstrated by the cross-plots of the actual and fitted values of the four endogenous variables; figures 4 through 7.

Figure 4: Actual and Fitted Real Exchange Rate Values,e(t); 1981:1/1991:3

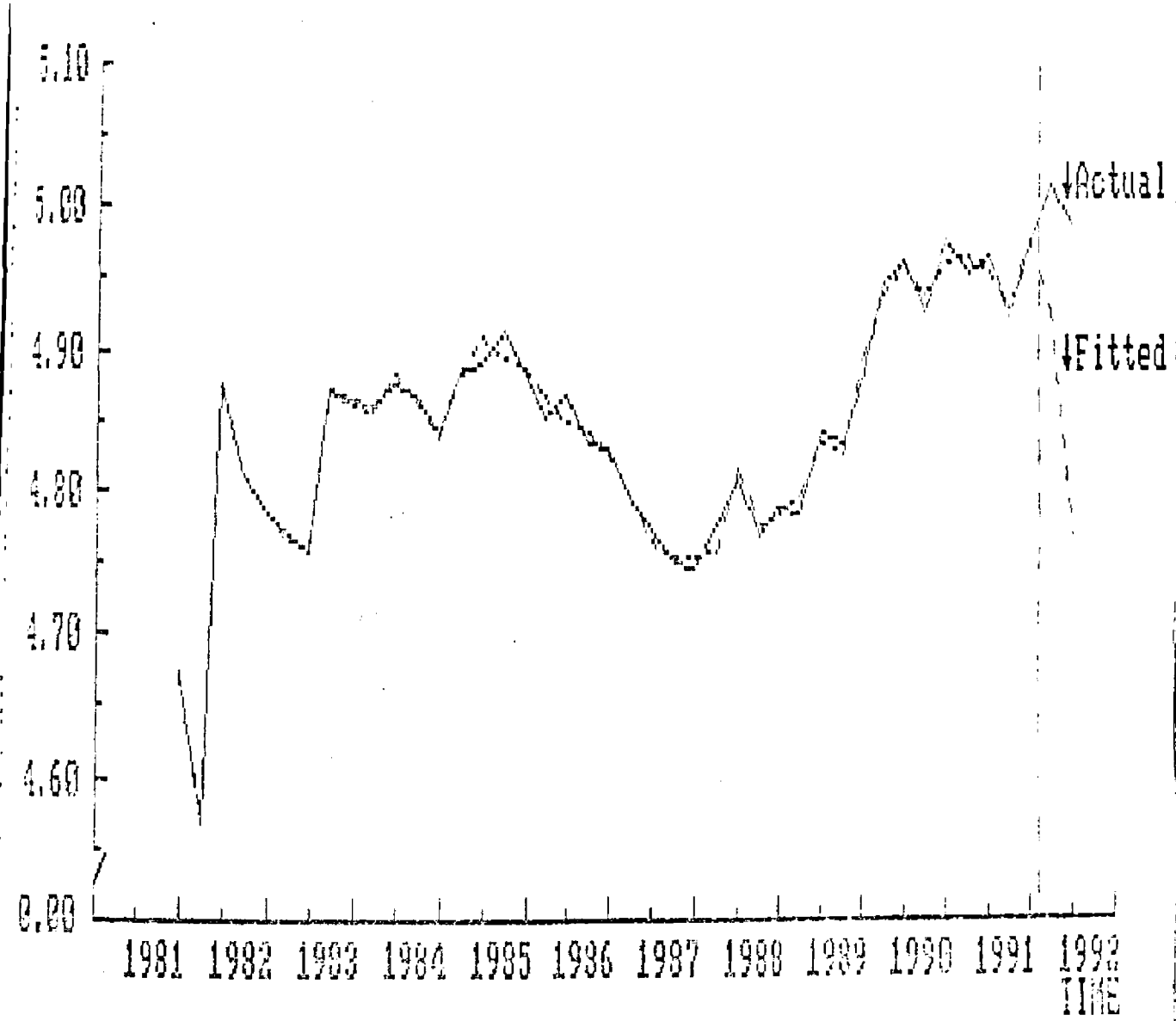


Figure 5: Actual and Fitted Domestic Inflation Values, p(t); 1981:1/1991

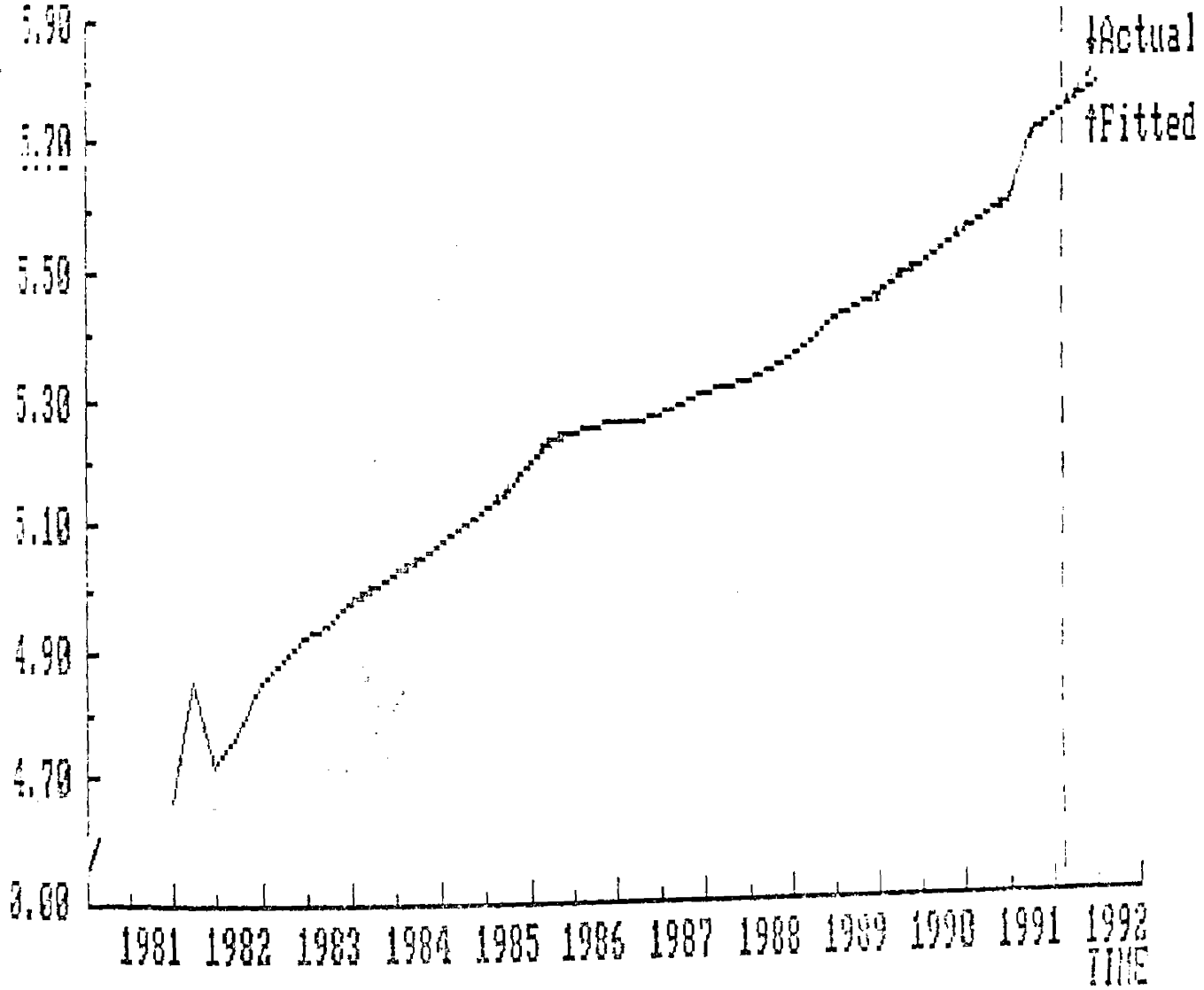


Figure 6: Actual and Fitted Domestic Currency Denominated Money Supply,m(t.

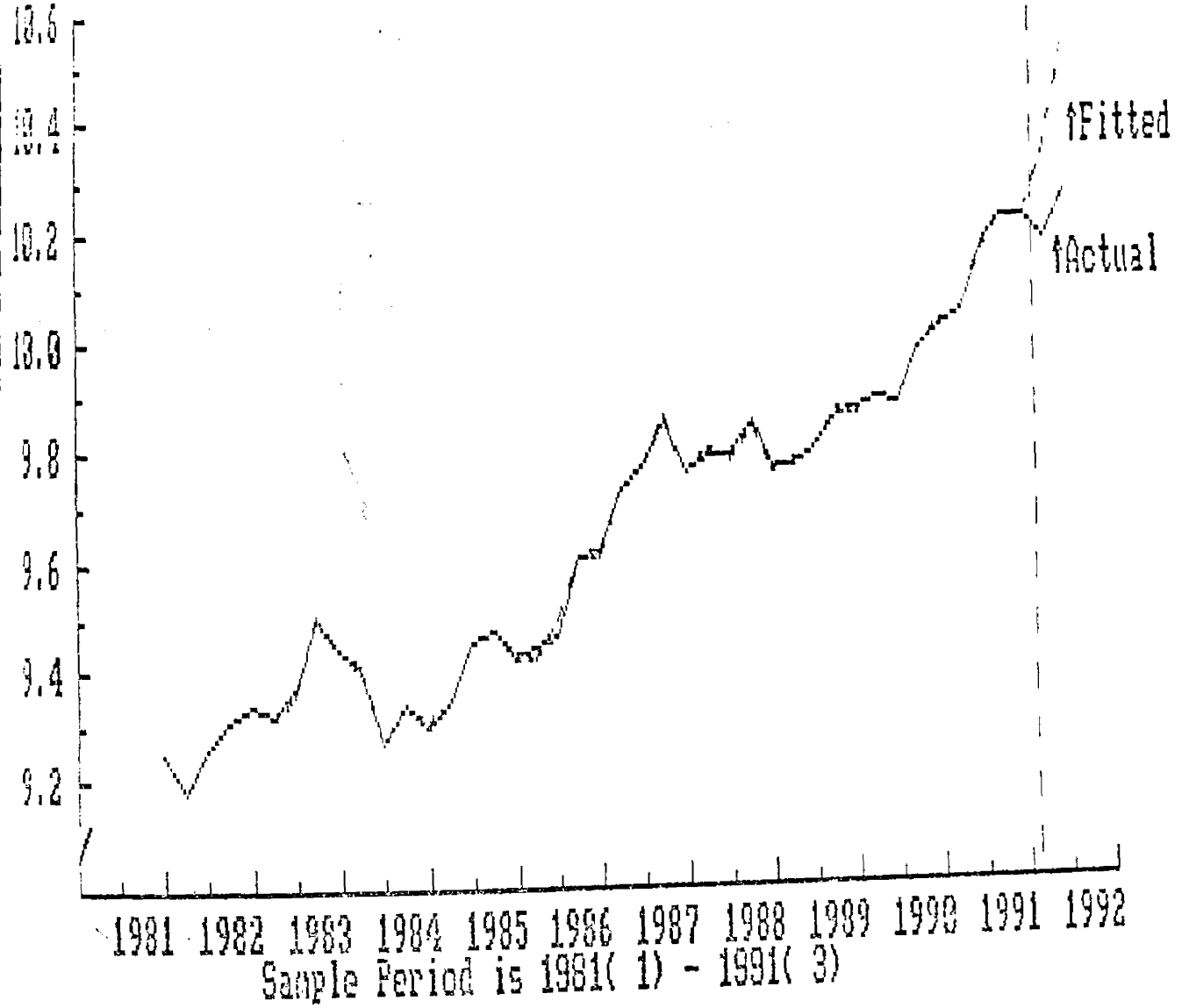
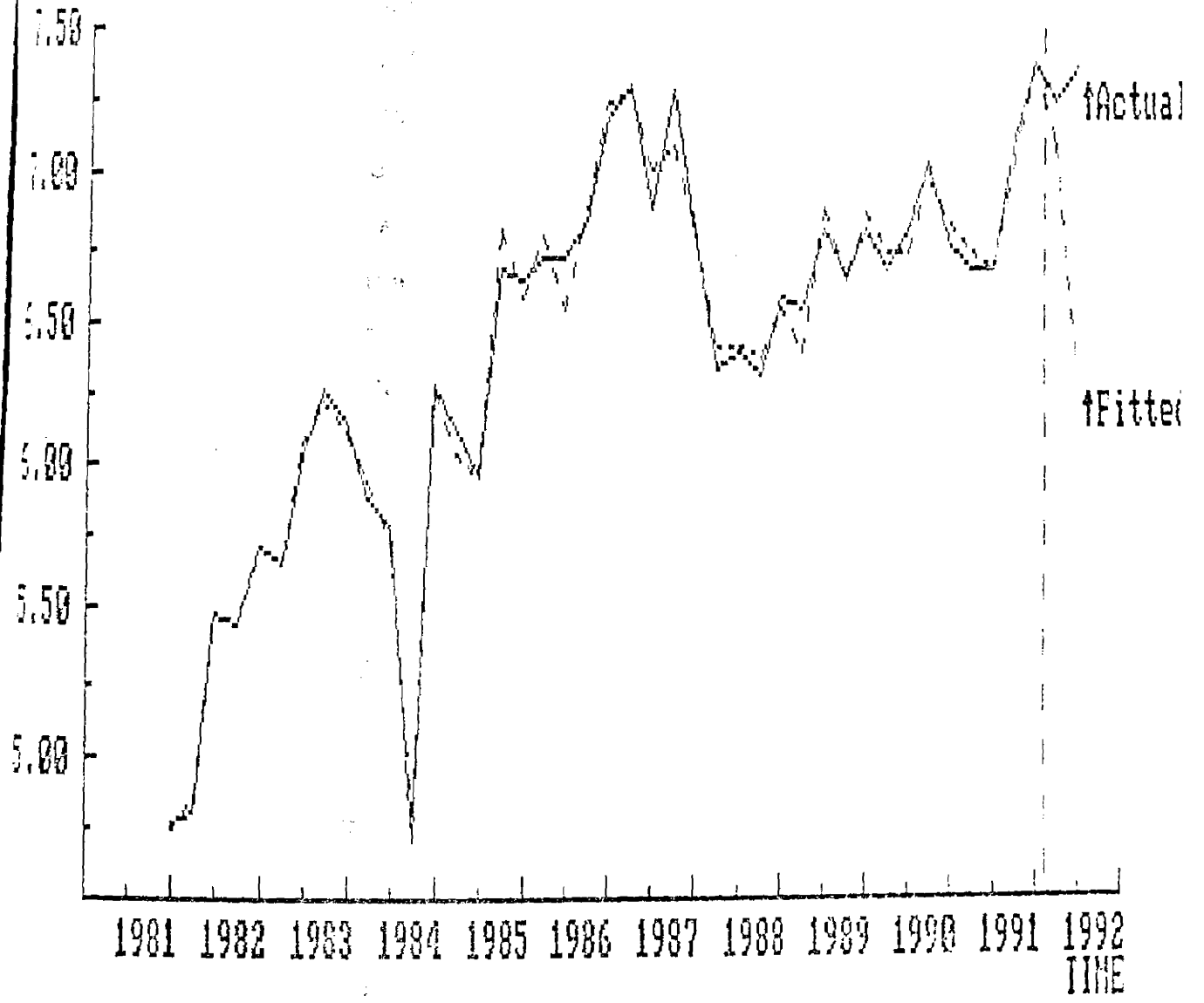


Figure 7: Actual and Fitted Domestic Export Earnings Values; 1981:1/1991:3



The correlation of the actual and the fitted values, which stood at 99.73%, 100%, 99.96% and 99.34% respectively, do provide further evidence on the goodness of fit of the system. The foregoing results do compare well with the correlation between the actual and the within sample simulated values of the model; for the respective figures are estimated at: 99.82%, 100%, 99.96, and 98.86%.

In spite of the goodness of fit of the URF model, a closer examination of the same empirical results reveals that whereas some of the explanatory variables are statistically significant others are not. Besides, other explanatory variables do report theoretically conflicting results (i.e some of the affected explanatory variables' parameter estimates that are perversely signed).

In order to investigate whether or not the URF Model is data-congruent; meaning that its vector of residuals is both white-noise (devoid of serial correlation) and an innovation process (homoscedastic), scaled residual graphs for the four equations were plotted. The graphs are reported below as figures 8 through 11.

Figure 8: Graph of Fitted Residuals, e(t)

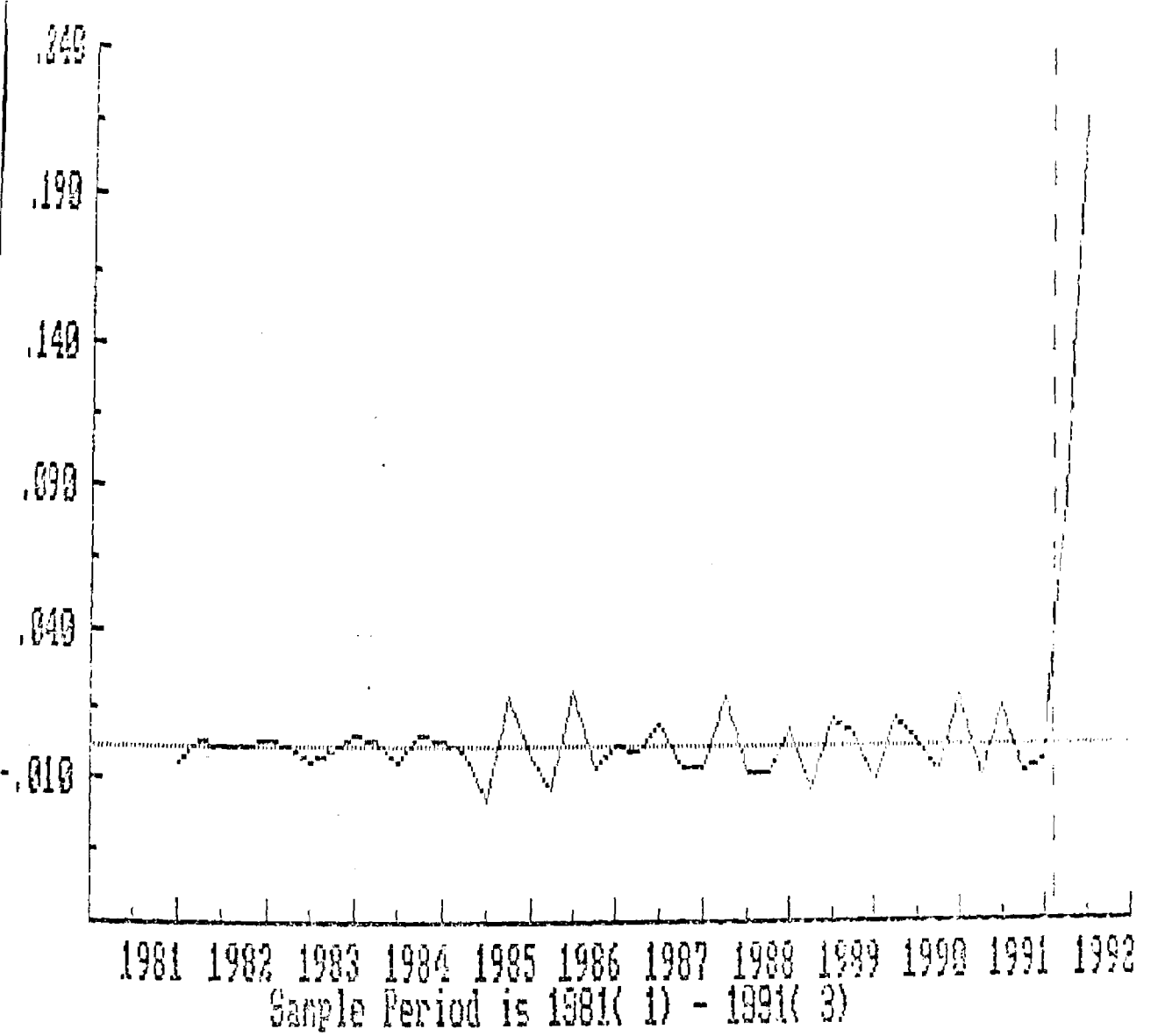


Figure 9: Graph of Fitted Residuals, p(t)

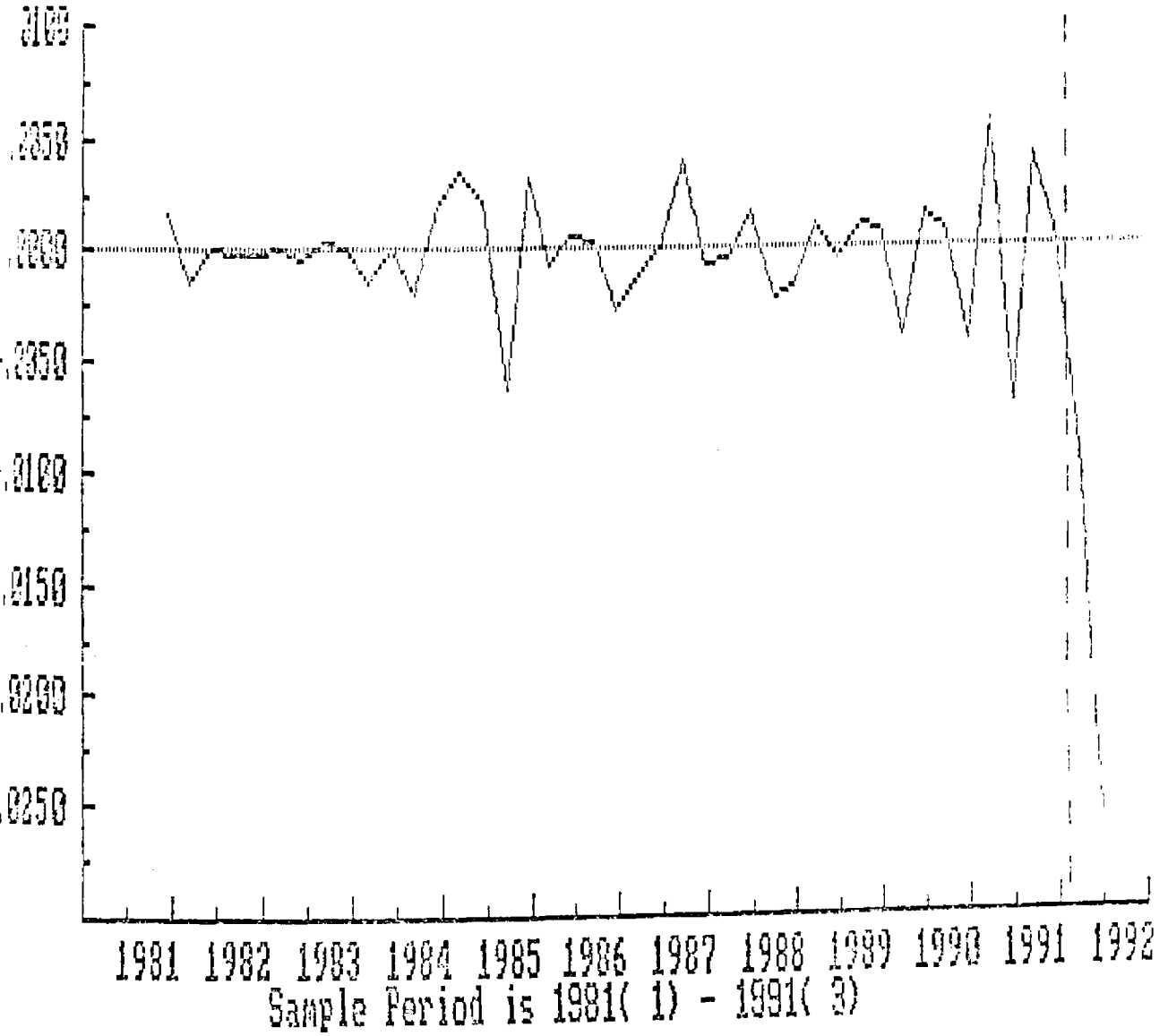


Figure 10: Graph of Fitted Residuals, m(t)

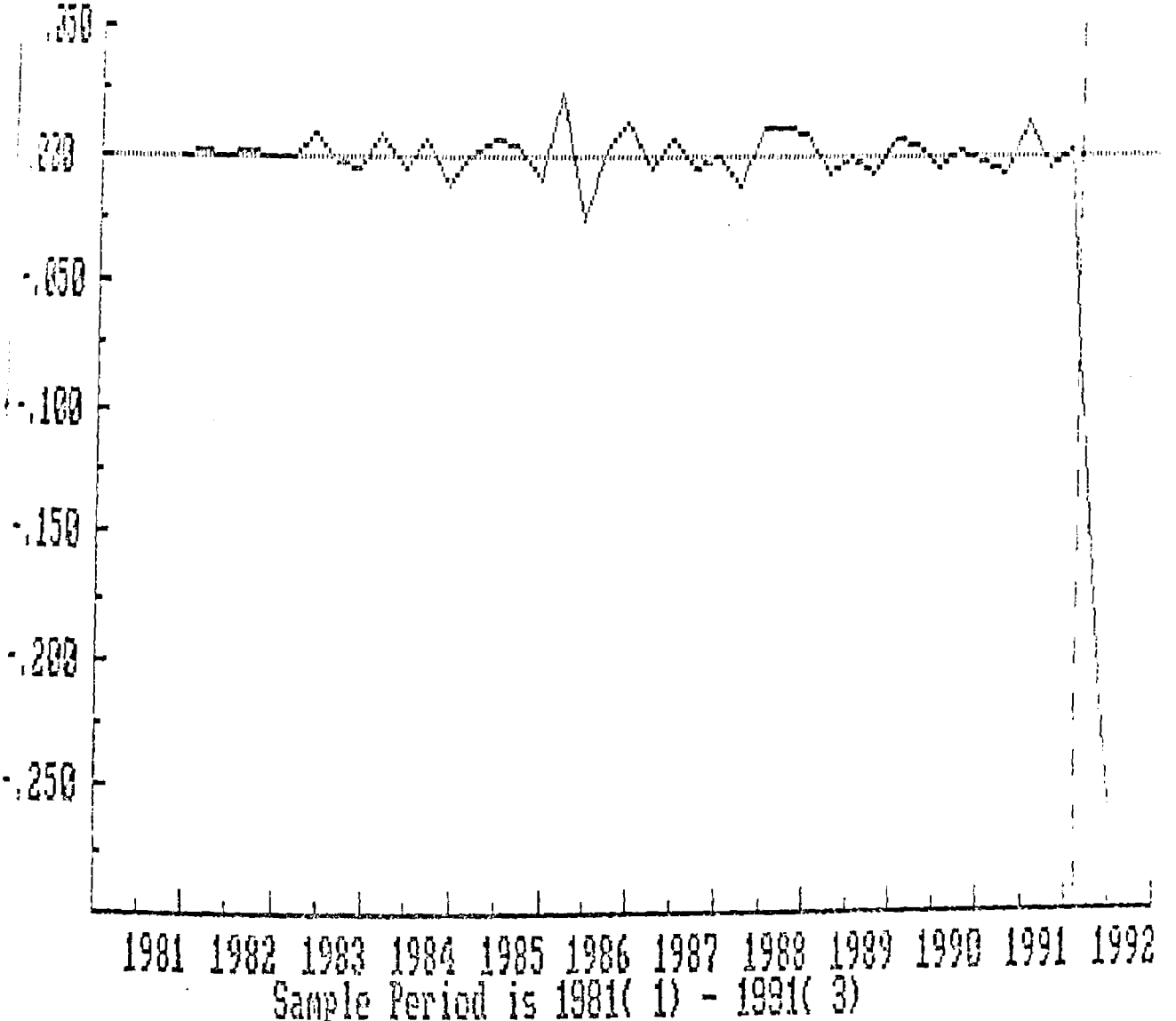
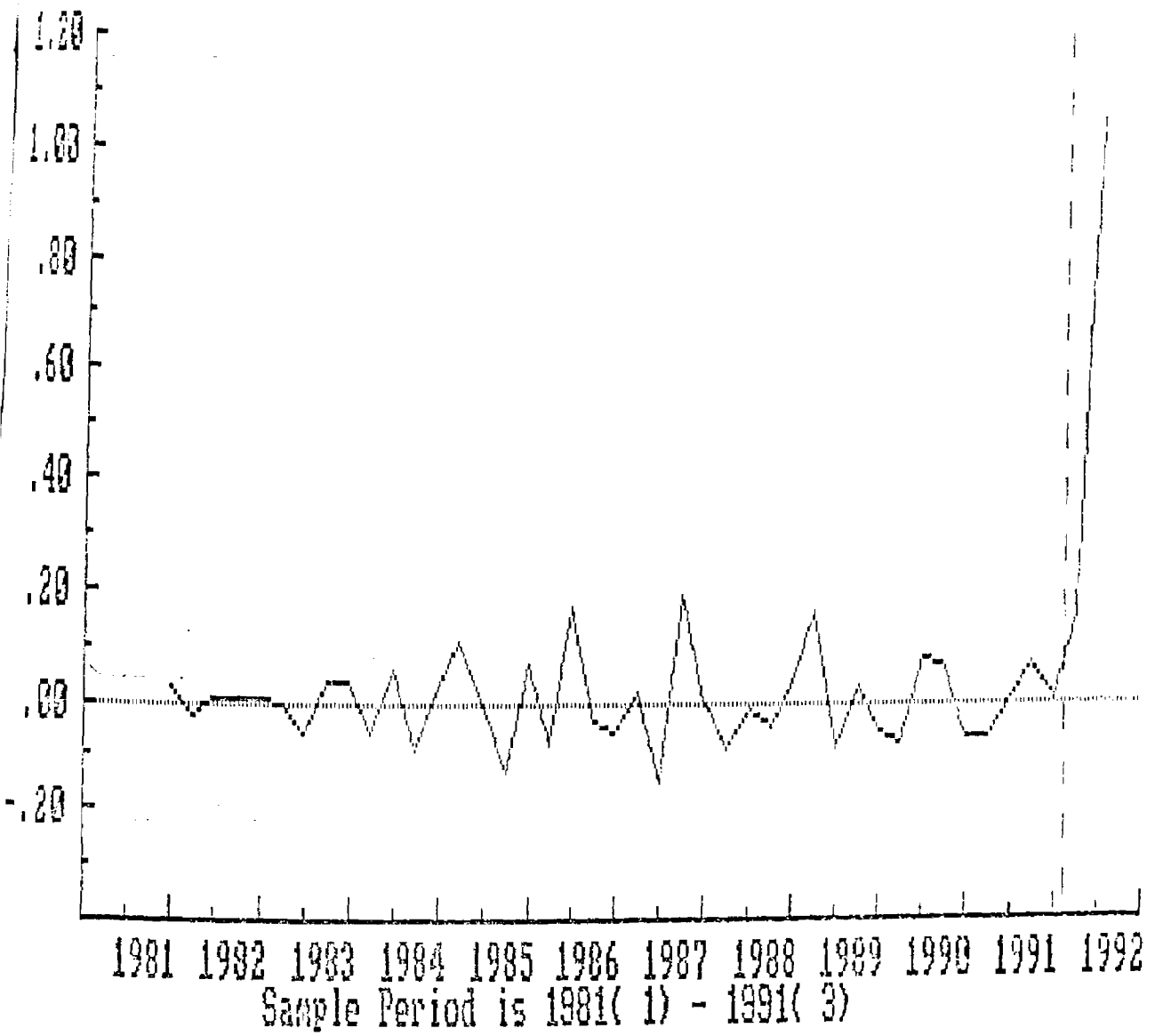


Figure 11: Graph of Fitted Residuals, xus(t)



Whereas the more or less constant amplitude of the scaled residual graphs (about the mean) over the sample period are indicative of the presence of homoscedasticity, the random nature of the manner in which the scaled residual graphs fluctuate about the mean is suggestive of the lack of any severe autocorrelation in the URF Model. Furthermore tests of the assumptions that v_t is identically and normally distributed with zero mean and a constant variance were in the affirmative.

4.2.2: Empirical Results on the Estimable Model

Upon the estimation of the estimable model (i.e ...[1.23a] through ...[1.23d]) using 2SLS, the following tabulated empirical results were realized:

Table 5: Empirical Results on the Real Exchange Rate Equation, e(t)

VARIABLE	COEFFICIENT	STD ERROR	T-RATIO	PROBABILITY
e(t-1)	0.49864	0.14540	3.429	0.0017
m(t-1)	0.11596	0.16986	0.683	0.4999
tb(t)	0.03609	0.04205	0.858	0.3973
ppp(t)	0.66494	0.35556	1.870	0.0709
ra$(t)	0.05613	0.04773	1.176	0.2485
y(t)	-0.15220	0.07289	-2.088	0.0451
y*(t)	0.50942	0.30526	1.669	0.1052
m*(t)	0.02025	0.09643	0.210	0.8351
ppp(t-4)	0.19259	0.32552	0.592	0.5584
Constant	-2.23058	2.64306	-0.844	0.4052

Table 6: Empirical Results on the Domestic Inflation Equation, P(t)

VARIABLE	COEFFICIENT	STANDARD ERROR	T-RATIO	PROBABILITY
p(t-1)	0.75605	0.08921	8.475	0.0000
e(t-1)	0.04653	0.11731	0.397	0.6944
m(t-1)	0.18656	0.06249	2.986	0.0055
p*(t)	0.43805	0.30130	1.454	0.1560
tb(t)	-0.05288	0.02406	-2.198	0.0355
y(t)	-0.00377	0.04155	-0.910	0.9282
xus(t-1)	0.00572	0.01633	0.350	0.7284
tb(t-1)	0.03517	0.01826	1.926	0.0633
tb(t-4)	-0.01881	0.01573	-1.196	0.2410
Constant	-2.54542	0.82743	-3.076	0.0044

Table 7: Empirical Results on the Domestic Currency Denominated Liquidity Equation, m(t);

VARIABLE	COEFFICIENT	STANDARD ERROR	T-RATIO	PROBABILITY
m(t-1)	0.51847	0.11090	4.675	0.0001
p(t-1)	0.47466	0.12307	3.857	0.0005
tb(t)	-0.07683	0.03597	-2.136	0.0407
y(t)	0.25309	0.05725	4.421	0.0001
m*(t)	-0.07913	0.13330	-0.594	0.5571
xus(t-1)	0.03881	0.01859	2.088	0.0451
tb(t-1)	0.00702	0.02620	0.268	0.7904
tb(t-4)	0.03579	0.02286	1.566	0.1276
m*(t-1)	0.18339	0.13518	1.357	0.1847
Constant	2.52697	1.04072	2.428	0.0208

Table 8: Empirical Results on the Domestic Export Earnings Equation, x(t);

VARIABLE	COEFFICIENT	STANDARD ERROR	T-RATIO	PROBABILITY
xus(t-1)	0.19185	0164860	1.164	0.2529
e(t-1)	1.07850	1.08240	0.996	0.3263
ppp(t)	-1.92145	2.00362	-0.959	0.3445
y*(t)	-1.73927	1.41354	-1.230	0.2272
y(t-1)	0.45566	0.43357	1.051	0.3009
ppp(t-1)	-4.38180	2.02805	-2.161	0.0381
Trend	-0.02823	0.02475	-1.141	0.2621
Constant	13.53001	8.63019	15689	0.1265

Before providing further empirical results, an interpretation of the foregoing seems worthwhile. This is done by examining the results as per the econometric model's estimated equations; one by one.

The KSH real exchange rate equation results are generally good on the basis of the following criteria: the appropriateness of the quality and quantity of the estimated coefficients; the magnitudes of the estimated coefficients' standard errors, t-ratios and levels of statistical significance as reflected in the reported corresponding probabilities.

On the basis of the quality of the parameter estimates (i.e the direction of the impact multipliers as captured by the associated coefficient signs), the observed KSH real exchange rate depreciation can be attributed to: the future expected rate of depreciation of the same exchange rate, e(t-1), the apparently excess stock of domestic currency denominated liquidity, m(t-1), the expansionary fiscal policies of central government, tb(t), the national inflationary differential that is captured by the purchasing power parity, ppp(t) and ppp(t-4), the dismal domestic macroeconomic performance, y(t), the relatively superior foreign macroeconomic performance, y*(t), the national interest rate differential or what has also been referred to as regulatory arbitrage, ra$(t), and capital flight or foreign currency denominated liquidity, m*(t). Other factors that are not explicitly incorporated into the model share among themselves a net autonomous appreciation effect on the KSH real exchange rate. That is reflected in the negatively-signed estimate for the exchange rate equation's constant.

As regards to the question of the relative performance of the above exchange rate fundamentals in the determination of the KSH

real exchange rate, the factors can be ranked according to their order of statistical significance thus: e(t-1), y(t), ppp(t), y*(t), ra$(t), tb(t), m(t-1), ppp(t-4), and m*(t). A change in each of these explanatory variables, cetris paribus, leads to corresponding direct changes in the KSH real exchange rate; save domestic macroeconomic performance, y(t), which, correctly so, reports an indirect effect on the KSH real exchange rate. A one percentage point increase in the individual explanatory variables, other things remaining equal, leads to a depreciation of the KSH real exchange rate by 50%, -15%, 66%, 51%, 6%, 4%, 12%, 19%, and 2%, respectively. It is instructive for one to take note that negative-depreciation means appreciation. Thus, -15% should be interpreted accordingly.

Following from the above empirical results on the KSH real exchange rate equation is the following single important implication: that the empirical results are supportive of the Towe-Onis and Ozmucur integrated model.

The empirical results in respect of the domestic rate of inflation point out that the proximate causes of domestic inflation are: expected rate of domestic inflation, p(t-1), expected rate of depreciation of the KSH real exchange rate, e(t-1), the stock of domestic currency denominated liquidity, m(t-1), imported inflation, p*(t), medium-term effects of fiscal policy, tb(t-1), and net domestic foreign exchange earnings, xus(t). Conversely, domestic inflation has apparently been moderated by: short-run and long-run effects of fiscal policy, tb(t) and tb(t-4), respectively;

and domestic macroeconomic performance, y(t). Autonomous domestic deflation amounts to 2.5% per annum.

The most crucial implication of the two equations' estimated results derive from the empirical interrelatedness of the KSH real exchange rate and domestic inflation. Whereas domestic inflation poses an appreciable direct impact on the KSH real exchange rate; via the national inflationary rate differential, ppp(t) and ppp(t-4), the KSH real exchange rate has, in turn, an equally appreciable direct impact on domestic inflation through the expected future depreciation of the KSH real exchange rate, e(t-1). In effect, then the Vicious Circle Hypothesis is operational in the observed persistent domestic inflation and depreciation of the KSH real exchange rate; meaning that the observed persisted domestic inflation and depreciation of the KSH real exchange rate constitute a dual problem. Luckily, the dual problem is mutually solvable. Apparently, it does not entail the kind of trade-offs associated with the Phillips Curve: the domestic inflation and domestic unemployment trade offs.

Concerning the implications of the empirical results on the resolution of the twin problem of persistent domestic inflation and the depreciation of the KSH real exchange rate, one should note, most importantly, that control variables were long incorporated into the estimable model; prior to the estimation of the same model. Interestingly, the compliance of the empirical results with the underlying theoretical frame work implies that redressing domestic inflation and exchange rate depreciation entails the

institution of a policy mix: fiscal, monetary, and incomes and pricing policy should be blended together to constitute an optimum remedy of the dual problem. The emphasis of the current central government budget on the observance of both monetary and fiscal discipline is not only good-intentioned but also gets an empirical basis.

The interpretation of the outstanding empirical results seems repetitive in the light of the foregoing way of doing it. It therefore suffices to note that the remaining equations' empirical result-interpretation is analogous to what has been done in respect of equations e(t) and p(t). In any case the express focus of this study is on e(t).

In order to supplement the tabulated empirical results, comparative graphs (of the kind provided earlier on in respect of the URF model) are provided below. The graphical results are presented as figures 12 through 15.

ure 12: Actual and Fitted KSH Real Exchange Rate Values; 1981:1/1991:3

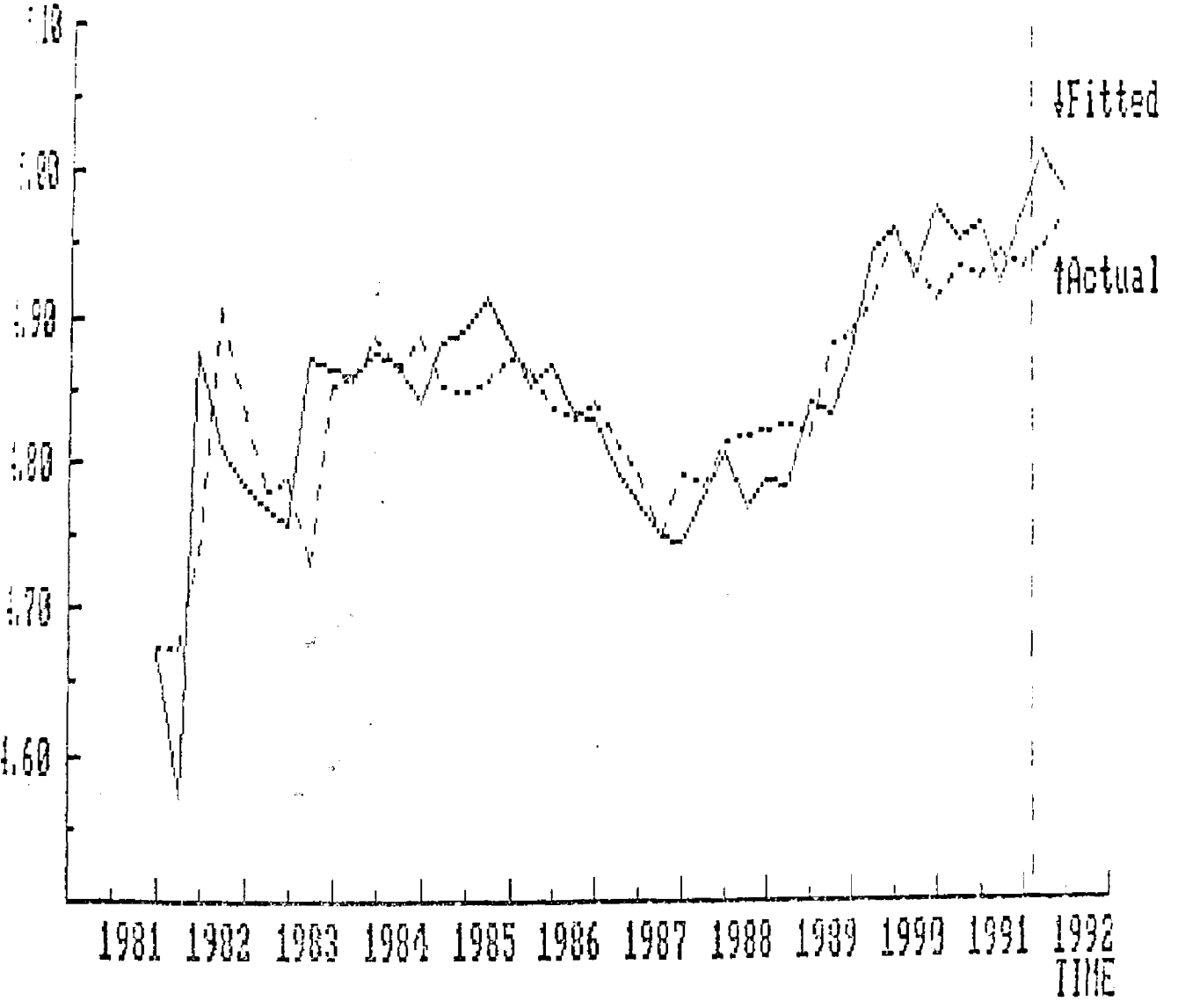


Figure 13: Actual and Fitted Domestic Inflation Values, p(t); 1981:1/199

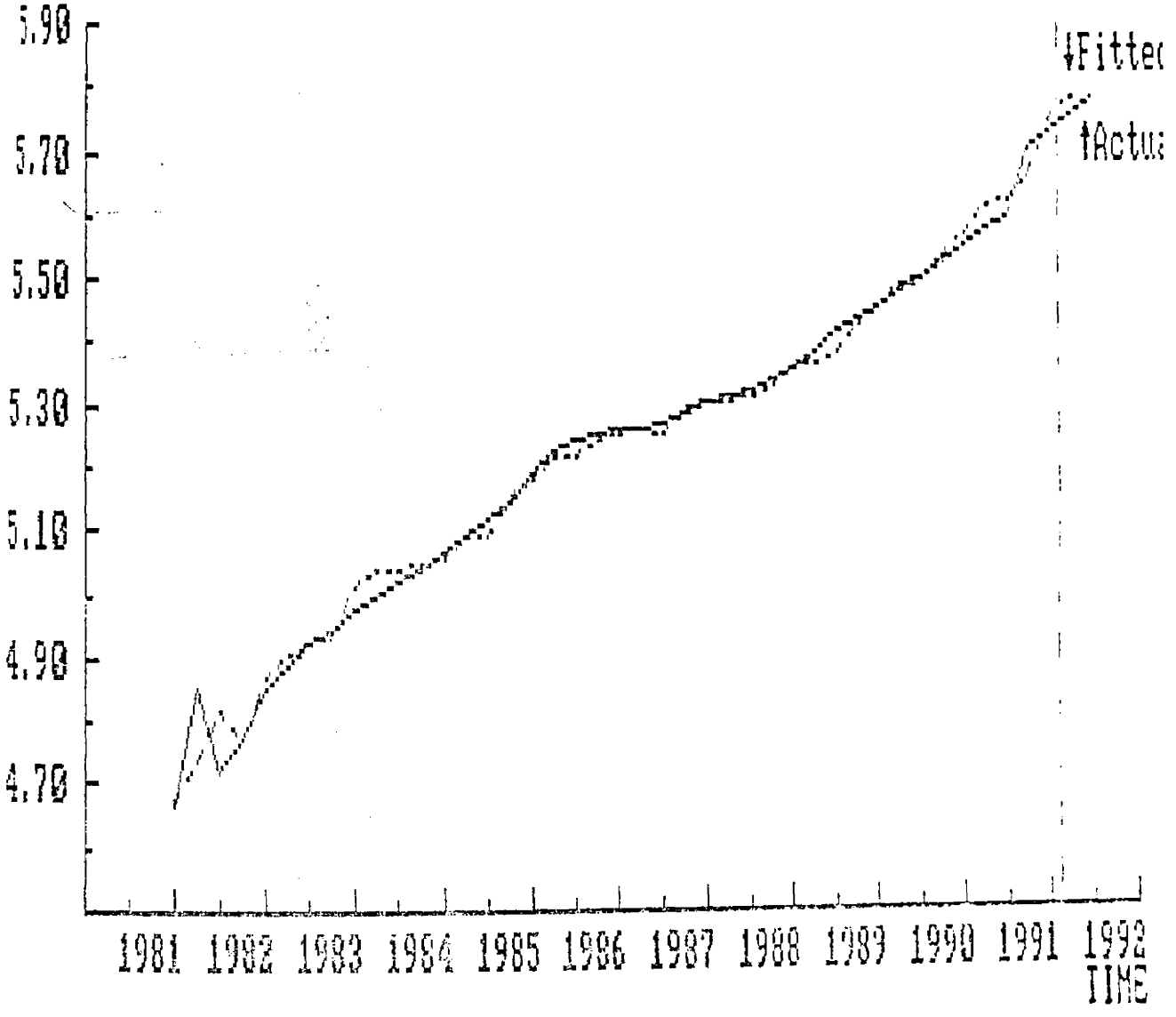


Figure 14: Actual and Fitted Domestic Currency Denominated Money Supply

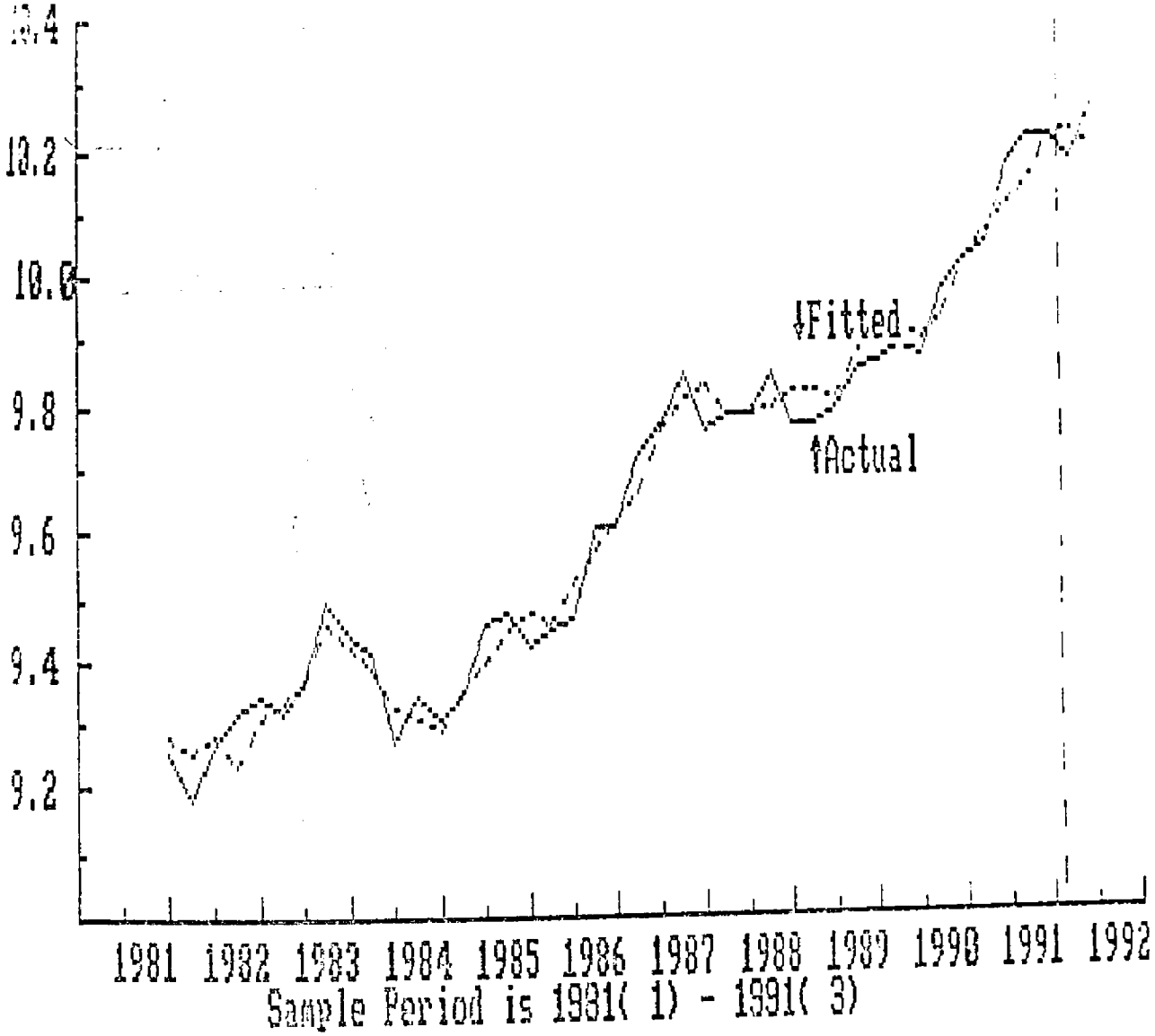
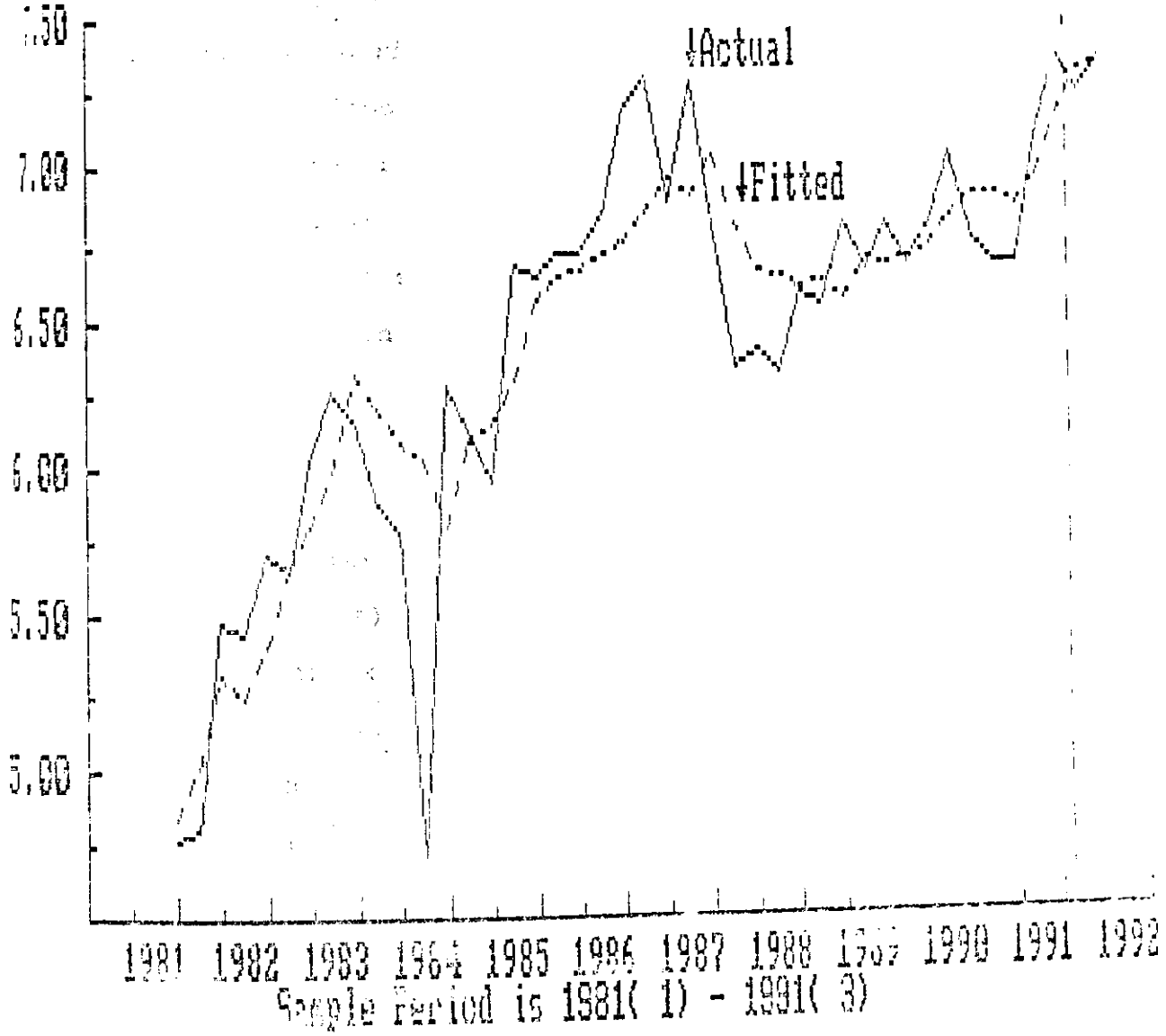


Figure 15: Actual and Fitted Domestic Export Earnings Values



The overall observation from the graphical presented empirical results is that they compare reasonably well with the tabulated ones. What is more about the empirical results in general is that with relatively fewer explanatory variables one is able to capture a good deal of the variations in the modelled variables. Consequently, the empirical frame-work is low-dimensional; meaning that it is parsimonious and hence more robust than the URF model.

It pays if one investigated the out-of-sample forecasting power of the empirical frame work. That is important as far as the feasibility of policy simulations, based on the empirical frame work, is concerned. In order to carry out stationarity analyses about the constancy of the parameter estimates, the estimable model is estimated over the sub-sample 1980:1/1991:3; less two forecasts. The empirical results in respect of this move were significant; for the Chow-statistic test (2,31) = 0.49 is significantly less than 2; meaning that the e(t) equation does provide reasonable ex ante forecasts - an index of the e(t) equation's stationarity. The $CHI^2(2)/2 = 0.71$ test, an F-test on parameter constancy for 2 ex ante forecasts does confirm the foregoing Chow-test results. The null hypothesis about parameter non-constancy is rejected in favour of parameter constancy.

4.3: Determination of the KSH Real Exchange Rate Speculative Component

4.3.1: Parametric Tests

4.3.1.1: Testing for the Feasibility of a Forward Solution

From the tabulated empirical results, please see table 6, $|\alpha_1|$

= 0.49864. Since the sample size is large, we carry out a two-tail normal distribution test of the statistical significance of the difference between $|\alpha_1|$ = 0.49864 and unity at the 95% significance limit. The null hypothesis, H_0, is:

H_0: $|\alpha_1|$ is not statistically different from unity, against the alternative:

H_a: $|\alpha_1|$ is statistically diferent from unity.

At the 5% significance level (given a two-tail test), $Z_{Critical}$ = 1.96 whilst $Z_{Calculated}$ = [0.49864-1]/0.14540 = -3.448143. Since, $|Z_{Calculated}| > |Z_{Critical}|$ the null hypothesis about $|\alpha_1|$ not being statistically different from unity would have to be rejected; implying that a forward solution for the KSH real exchange rate equation is feasible. That could also imply that the KSH real exchange rate does exhibit some element of instability. Such exchange rate instability would be indicative of the presence of a speculative bubble during the sample period.

In the light of the preceding empirical result, one can infer that the KSH real exchange rate movements during the sample period may not be entirely attributed to the exchange rate fundamentals. Destabilizing exchange rate speculation seems to have been another contributory factor.

4.2.1.2: Co-Integration Analysis

In order to adduce dependable evidence on the existence of co-integration in the KSH real exchange rate equation, a formal approach is needed. Out of the three basic tests for co-integration: the Durbin-Watson (DW) test, the Dickey-Fuller (DF)

test and the Augmented Dickey-Fuller (ADF) test, the latter is recommended for higher order systems like the one at hand. See Engle and Granger (1987) and Engle and Yoo (1987).

For purposes of this study all the three tests are carried out. In order to do that three regressions are necessary, viz: the co-integrating regression, and two co-integrating linear relations. The three respective regressions are provided below as ...[1.23a], ...[1.23b] and ...[1.23c].

$$e(t) = \alpha_0 + \alpha_1 e(t-1) + \alpha_2 m(t-1) + \alpha_3 tb(t) + \alpha_4 ppp(t) + \alpha_5 ra\$(t) + \alpha_6 Y(t) + \alpha_7 Y^*(t) + \alpha_8 m^*(t) + \alpha_9 ppp(t-4) + \epsilon(t); \quad ...[1.27a];$$

$$\delta\epsilon(t) = \hat{\varsigma}_1 \epsilon(t-1); \quad ...[1.27b];$$

$$\delta\epsilon(t) = \hat{\varsigma}_2 \epsilon(t-1) + \sum_{i=1}^{p} \phi_i \delta\epsilon(t-i); \quad ...[1.27c];$$

where δ denotes the first order difference time series on the disturbance error term in ...[1.27a] whereas $\hat{\varsigma}$ and ϕ_i are parameters to be estimated using OLS. In this case, p is set equal to 4. The DF and the ADF tests are t-statistic tests about the statistical significance of $\hat{\varsigma}$ in ...[1.27b] and ...[1.27c]. Note that the $t_{Critical}$ values are specially computed ones. In this case the Engle and Yoo (1987;pp.158) tables 2 and 3 are used.

Upon the estimation of ...[1.27], the following empirical results were obtained.

Table 9: Empirical Results on Co-integration Analysis

Variable	Coefficient	Std Error	t-Value
e(t-1)	0.49864	0.16721	2.98202
m(t-1)	0.11596	0.19534	0.59364
tb(t)	0.03609	0.04836	0.74627
ppp(t)	0.66494	0.40891	1.62612
ra$(t)	0.05613	0.05489	1.02259
y(t)	-0.15220	0.08383	-1.81565
y*(t)	0.50942	0.35106	1.45107
m*(t)	0.02025	0.11090	0.18259
ppp(t-4)	0.19259	0.37435	0.51445
Constant	-2.23058	3.03962	-0.73384

Based on the foregoing empirical results, one can now test the null hypothesis, H_0, against the alternative, H_1; viz:

H_0: The modelled and non-modelled variables in the KSH real exchange rate equation are not co-integrated (i.e ç^ is not statistically different from zero);

H_a: The modelled and non-modelled variables in the KSH real exchange rate equation are co-integrated (i.e ç^ is statistically different from zero);

The critical values for the co-integration test (for 5 explanatory variables, from tables 2 and 3 are 4.76 or 4.15, respectively; the former being the most conservative for small samples.

In order to supplement the results, the DW test is also carried out. The 95% confidence limit's critical value for higher order systems with a sample size of fifty is given as 1.03. See Engle and Yoo (1987;pp.158) table 4. Though the sample size used in

this study is forty-eight as opposed to fifty, the critical value corresponding to fifty is used as an approximation; in the face of the lack of the actual critical value for forty-eight.

From the results to the empirical frame work in ...[1.27a], $DW_{Calculated}$ = 2.39 whereas the $DW_{Calculated}$ = 1.03. Consequently, the null hypothesis about non-co-integration cannot be rejected; meaning that the KSH real exchange rate was characterized by the presence destabilizing speculation during the sample period.

From ...[1.27b] and ...[1.27c], $\hat{\varsigma}_1$ and $\hat{\varsigma}_2$ are calculated as -1.20297 and -0.85473, respectively. The critical value in respect of both hypotheses is 4.76. In conclusion, therefore, the null hypothesis about non-co-integration cannot, once more, be rejected; on the respective bases of the DF and the ADF tests.

The overall implication of the co-integration analysis' empirical results is that the KSH real exchange rate equation does have some mis-specification; which mis-specification may be attributable to the non-inclusion of the speculative bubble determinant of the same exchange rate. That provides further empirical evidence on the contention that the observed depreciation of the KSH real exchange rate could partly owe to destabilizing foreign exchange market psychology.

4.3.2: A Non-Parametric Test for Speculative Bubbles

This sub-section tests for simple efficiency in the KSH foreign exchange market. This amounts to the signs test on there being a non-zero median in the excess rate of return on holding three month forward contract in KSH. The relevant excess rate of

return data yielded Z_k = Max N_k = 4. It therefore follows that the Y- Statistic equals 9744; as read from table 1. See George (1989pg.626). This could give a calculated probability value of [(10,000-9744)/10,000] = 0.0256.

The significance level or critical value of the probability of obtaining a value of Y less than or equal to 9744 is given in George (1989)'s table 2 as being to the upper side of 0.20212 that corresponds to Y = 801 (the largest of the values of Y for which such critical values are provided). Hence the null hypothesis about the absence of simple market efficiency in the KSH foreign exchange market is confirmed against the alternative that a simple foreign exchange market efficiency (i.e a zero median for the excess rate of return on three month forward contracts denominated in KSH) prevailed over the period 1980:1-1991:3. The implication of this result is that there seems to have prevailed destabilizing foreign exchange rate speculation during the sample period. Speculative bubbles can therefore be offered as one of the determinants of the observed KSH real exchange rate movements during the period 1980:1-1991:3. The same empirical results on the KSH foreign exchange market inefficiency provides empirical evidence to the effect that the observed behaviour in financial institutions' and other firms' currency exposure management is not ill-conceived; the concerned parties are acting rationally in their quest for utility maximization. But as could be recalled, such speculation is destabilizing as it leads to even further depreciation of the KSH real exchange rate via m*(t) and, say, ra$(t). Please see the

empirical frame work; the KSH real exchange rate equation results in table 3; above.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1: Summary

The study at hand focused on the determination of the Kenya Shilling, KSH, real exchange rate movements during the sample period 1980:1-1991:3. The prime objectives pursued include: the formulation of the underlying data generation process of the KSH real exchange rate, the ascertainment of the relative roles of the KSH real exchange rate market fundamentals and speculative bubble determinants in the observed KSH real exchange rate volatility, the determination of the time series characteristics of the KSH real exchange rate data generation process, and the provision of an empirical explanation for the observed KSH real exchange rate movements; the persistent depreciation of the KSH real exchange rate, during the sample period, being the case in point.

Rationalized against the details provided in the introduction and the review of the literature (Chapters one and two, respectively), an integrated Towe-Onis and Ozmucur model is formulated. In the spirit of PC-GIVE Ver. 6.01's PCFIML Module for the estimation of structural models, an Unrestricted Form, URF, Model was formulated and estimated. Having been established to be data-congruent, the same URF model paved the way to the formulation of the econometrically estimable model.

The econometric model was subjected to Two Stage Least Squares, 2SLS, estimation techniques. A discussion of the empirical

results leads one to conclude that the KSH real exchange rate movements are not an entirely exchange rate market fundamentals' affair. Apparently, the empirical evidence point out to the fact that speculative bubbles did contribute their lot in the observed persistent depreciation of the KSH real exchange rate. Empirical tests about the presence, or otherwise, of speculative bubbles apparently confirm the contention that market psychology is another source of the KSH real exchange rate volatility.

Emergent from the empirical results were two key policy ramifications: that, one, in order to defend the KSH real exchange rate from further depreciation (whenever deemed desirable), a two-pronged approach (a double-edged sword of policy measures, as it were), should be instituted. Both direct and indirect interventionary measures are recommended. In pursuit of the former, it is apparently instructive for one to take note that the orchestrated full-fledged float of both the real exchange rate and the full relaxation of the foreign exchange controls may not necessarily be a panacea to Kenya's economic woes. If anything, it pays to note that the full relaxation of the foreign exchange controls in the face of an appreciable scope of destabilizing exchange rate speculation may be self-defeating. That leaves the value of the KSH at the mercy of foreign exchange market psychology.

Destabilizing speculative deals should therefore be legislated against. For instance, however sweet trade liberalization can be, foreign exchange decontrols that allow individuals to operate

foreign exchange accounts be it within or/and without the country need be regarded as "holy ground" that should be threaded with caution; at least in the meantime. This policy conclusion is in good taste with the Government legislations that govern the operations of the Foreign Exchange Retention Accounts Scheme, FOREX-A/Cs.

Secondly, the predominance of exchange rate market fundamentals in the determination of the KSH real exchange rate should correspondingly be a pointer to the significance of the application of indirect policy measures in the regulation of the KSH real exchange rate movements: be it ironing out the KSH real exchange rate irregularities or leaning the same exchange rate against the wind. Thus, excessive volatility in the key exchange rate market fundamentals, say, stock of both domestic and foreign currency denominated liquidity ought to be trimmed to manageable levels. It is in this line of thinking that the proposed monetary and fiscal policy measures advocated by government for the restoration of both monetary and fiscal discipline find empirical justification. Thus, indirect curative policy measures call for nothing more or less than the strict observance of both monetary and fiscal discipline.

Meanwhile, other aspects of restructuring the Kenyan economy may pay some dividends in the enhancement of the value of the KSH real exchange rate. "How?"- one may ask. Whereas a revitalized economy could mean improved domestic and external macroeconomic performance, improved domestic and external macroeconomic

performance could in turn translate into a reasonably stable KSH real exchange rate via the national macroeconomic-performance-differential factor. For instance, at least some moderate level of domestic and external macroeconomic performance may moderate foreign exchange market psychology in favour of the domestic currency. That could possibly curb the dollarization of the KSH through, say, regulatory arbitrage and general capital flight.

Additionally, the results are suggestive of the existence of a negative median in the excess-rate-of-return on holding three month forward contracts expressed in the domestic currency. Little wonder then that some international traders, as exemplified in some renowned Air Ways and even giant domestic Public Corporations opted for shifts in their asset portfolio in disfavour of the KSH. Unfortunately, that is to the further detriment of the KSH whose value may fall further.

Needless to say, the study has its limitations as discussed in chapter five. Consequently, areas of further research have been isolated below.

Nevertheless, the study has made a brave step in integrating both of the advancements in macroeconomic theory and econometrics to adduce empirical evidence on the stylized fact that both the exchange rate market fundamentals and speculative bubble determinants did play significant roles, though varied both qualitatively and quantitatively, in the determination of the observed KSH real exchange rate volatility. The application of an integrated econometric model together with the concept of co-

integration analysis are as to the theoretical advancements as the application of PC-GIVE's PCFIML Module is to econometric advancements.

5.2: Conclusions and Policy Implications

The following conclusions and policy implications were reached from the empirical findings:

1. The widely held view that monetary and fiscal indiscipline have contributed to the KSH real exchange rate depreciation is confirmed. This implies that indirect foreign exchange market intervention should be an ingredient of the tool kit of policy measures that could defend the value of the KSH; in the event of excessive KSH real exchange rate misalignment.
2. Regulatory arbitrage was a feature of the Kenyan economy during the observed period. This would mean that the recent de-regulation of the domestic financial market is commendable. It could possibly reduce national interest rate differential. That could apparently stabilize the value of the KSH.
3. The contention that the depreciation of the KSH exchange rate was inflationary during the sample period is a half-truth; for whereas the depreciation of the KSH was inflationary, domestic inflation was equally depreciationary of the KSH. The Vicious Circle Hypothesis about the persistency of domestic inflation and depreciation is empirically confirmed. In the quest to

defend the KSH real exchange rate, therefore, checking national inflation differential should be one of the key objectives. Exchange rate and domestic pricing policies are interdependent. Given that the KSH real exchange rate is positively interrelated with national inflation differential, the dual problem of undue real exchange rate depreciation and high rates of domestic inflation are mutually solvable. No trade-offs would be involved between defending the KSH exchange rate and curbing domestic inflation.

4. The observed KSH real exchange rate depreciation during the sample period should also be attributable, partly though, to the country's dismal macroeconomic performance and foreign exchange market psychology. In the face of destabilizing exchange rate speculation, indirect interventionary measures in the foreign exchange market need to be supplemented by direct intervetionary measures. Some element of government legislation on the domestic residents' operation of FOREX-A/Cs is warrantable; lest some foreign exchange dealers abuse foreign exchange deregulation by unnecessarily hoarding badly needed foreign reserves. Foreign exchange holdings need to be monitored as to the legality of such foreign exchange holdings, sourcing and the purpose for which the same foreign exchange is held.

5. The observed shift of KSH denominated assets to foreign

currency denominated assets in various institutions' asset portfolios is not ill-conceived. This eventuality has empirical backing. There is a negative rate of return on three-month forward-contract-holdings denominated in the domestic currency. The concerned could not help effecting asset portfolio adjustments in their quest for sound currency exposure management.

6. That domestic export earnings impact of the KSH real exchange rate movements is positive is suggestive of the fact that "devaluation works"; in the Kenyan context. In other words the Marshall-Lerner Condition holds (i.e a devaluation of the KSH real exchange rate could make domestic exports cheaper and domestic imports dearer. That could improve Kenya's trade account balance. This would render the observed depreciation of the KSH a necessary evil in view of the fact that Kenya has experienced a persistent unfavourable balance of payments position.

5.3: Limitations of the Study and Areas of Further Research

In spite of the efforts expended on ensuring that the study is complete, it must be conceded that the same study has inherent limitations. These limitations can be categorized into: data and methodological limitations.

High frequency time series data is normally suited for studies that focus on exchange rate volatility. Specifically, monthly time series data is the most appropriate since it could enable one

analyze short term variations in exchange rates. In the absence of a complete monthly time series data on all the key variables, one could not help applying quarterly time series data. Thus, the study is incapable of analyzing the short- and very-short term KSH real exchange rate movements.

Besides, observed data on key variables were not accessible. Approximate data (i.e data on observed correspondences or proxy variables were) was applied instead. For instance under stringent assumptions, one was able to retrieve some data for Domestic Gross Product, y(t).

In most of the previous studies on the KSH exchange rate, the concept of real effective exchange rate, as opposed to the concept of the real exchange rate, has been applied. One should therefore be careful when it comes to comparing such studies' empirical results.

The theoretical frame work applied in the current study does not incorporate all the impact transmission mechanisms; as depicted in the flow chart (i.e figure 3). It is felt that such an error of omission could prejudice the empirical results in spite of the fact that the realized empirical results are statistically significant.

The empirical frame work does also have its shortfalls. In the absence of the required critical values for the various statistical tests under co-integration and foreign exchange market efficiency analyses, approximate critical values were used. That leaves the empirical results open to deserved criticism; for the accuracy of

the empirical results would be questionable. Equally important is the fact that one may be sceptical about the extent to which the theoretical frame work circumvents the joint-hypothesis dilemma.

Although the KSH real exchange rate misalignment was guessed at as being one of the would-be determinants of the observed depreciation of the Kenyan currency, the study did not address itself to the question of the scope of the KSH real exchange rate misalignment; exchange rate overvaluation for that matter.

In the light of the above limitations, one could suggest that the same study be re-examined under an atmosphere of relative calm; without the resource constraints under which the current study has been undertaken. Most importantly, there is a need to empirically investigate the scope of the KSH real exchange rate misalignment. It may also be interesting if an empirical analysis into the choice of an optimum foreign exchange rate policy in the Kenyan context was undertaken. That could possibly reconcile opposed views on the desirability of Kenya's having shifted from a dirty-float exchange rate regime to the current fully-fledged-floatation of her exchange rate.

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APPENDIX: DATA MATRIX

DATA POINT	e(t)	p(t)	m(t)	xus(t)	m*(t)	tb(t)	ra$(t)	p*(t)	y(t)	y*(t)
1980:1	4.605	4.558	9.269	4.605	−0.693	7.483	0.000	4.569	0.106	4.605
1980:2	4.535	4.597	9.230	4.478	−0.511	7.441	0.483	4.589	−0.027	4.551
1980:3	4.564	4.608	9.235	4.575	−0.357	8.038	0.588	4.621	−0.218	4.530
1980:4	4.570	4.650	9.200	5.111	−0.248	7.910	0.254	4.642	−0.309	4.579
1981:1	4.671	4.669	9.255	4.769	−0.163	8.320	0.307	4.670	−0.280	4.599
1981:2	4.572	4.851	9.183	4.813	−0.139	8.111	0.300	4.694	−0.534	4.604
1981:3	4.877	4.723	9.265	5.482	−0.128	8.640	0.477	4.702	−0.614	4.608
1981:4	4.811	4.776	9.315	5.446	−0.139	8.589	1.023	4.701	−0.874	4.563
1982:1	4.786	4.851	9.343	5.723	−0.128	7.487	1.187	4.710	−1.160	4.531
1982:2	4.768	4.892	9.320	5.659	−0.117	7.421	1.192	4.710	−1.243	4.514
1982:3	4.759	4.922	9.376	6.031	−0.105	7.388	1.411	4.717	−1.255	4.506
1982:4	4.871	4.944	9.499	6.270	−0.083	7.841	1.766	4.717	−0.900	4.484
1983:1	4.866	4.975	9.444	6.158	−0.139	7.915	1.762	4.718	−1.278	4.508
1983:2	4.860	4.999	9.415	5.895	−0.094	7.814	1.680	4.721	−1.344	4.551
1983:3	4.877	5.026	9.272	5.795	−0.105	7.946	1.714	4.731	−1.510	4.599
1983:4	4.869	5.046	9.348	4.711	−0.139	7.660	1.669	4.734	−1.465	4.624
1984:1	4.840	5.071	9.307	6.282	−0.117	7.805	1.551	4.745	−1.509	4.661
1984:2	4.882	5.097	9.349	6.136	−0.163	7.702	1.392	4.752	−1.499	4.679
1984:3	4.891	5.119	9.456	5.968	−0.211	8.152	1.584	4.749	−1.295	4.695
1984:4	4.914	5.146	9.480	6.687	−0.186	8.037	1.706	4.747	−1.297	4.694
1985:1	4.884	4.884	5.195	6.655	−0.073	7.898	1.920	4.745	−1.438	4.609
1985:2	4.854	5.231	9.449	6.713	0.300	7.695	1.880	4.746	−1.571	4.702
1985:3	4.667	5.244	9.467	6.729	0.086	7.877	1.908	4.739	−1.513	4.707
1985:4	4.835	5.254	9.611	6.848	0.157	7.786	1.972	4.745	−1.407	4.712
1986:1	4.829	5.259	9.614	7.188	0.199	8.222	2.054	4.730	−1.443	4.713
1986:2	4.796	5.263	9.726	7.310	0.270	8.374	2.041	4.710	−1.292	4.712
1986:3	4.775	5.268	9.771	6.883	0.215	8.839	1.982	4.706	−1.131	4.710
1986:4	4.749	5.290	9.852	7.294	0.255	8.566	2.035	4.710	−0.991	4.721
1987:1	4.747	5.303	9.762	6.810	0.329	8.770	1.943	4.721	−1.183	4.728
1987:2	4.779	5.313	9.787	6.340	0.336	8.828	1.936	4.737	−1.190	4.730
1987:3	4.806	5.323	9.787	6.404	0.344	8.942	1.840	4.748	−1.206	4.758
1987:4	4.769	5.343	9.848	6.328	0.457	8.860	1.713	4.753	−1.167	4.777
1988:1	4.789	5.357	9.767	6.589	0.495	8.867	1.756	4.757	−1.286	4.786
1988:2	4.783	5.384	9.767	6.554	0.432	8.643	1.629	4.774	−1.337	4.797
1988:3	4.843	5.417	9.800	6.810	0.536	8.644	2.312	4.788	−1.327	4.814
1988:4	4.832	5.439	9.861	6.671	0.593	8.591	2.174	4.793	−1.286	4.826
1989:1	4.880	5.453	9.870	6.816	0.615	8.797	2.187	4.815	−1.309	4.831
1989:2	4.950	5.485	9.895	6.675	0.531	8.708	2.194	4.832	−1.330	4.839
1989:3	4.963	5.505	9.881	6.819	0.599	9.024	2.116	4.829	−1.370	4.842
1989:4	4.930	5.529	9.983	7.051	0.668	8.954	1.860	4.832	−1.281	4.835
1990:1	4.979	5.556	10.026	6.760	0.756	8.936	1.897	4.847	−1.279	4.836
1990:2	4.956	5.585	10.050	6.682	0.824	8.603	1.953	4.845	−1.326	4.846
1990:3	4.968	5.599	10.176	6.678	0.896	8.837	2.007	4.863	−1.233	4.856
1990:4	4.925	5.703	10.223	7.101	0.971	9.164	2.256	4.893	−1.335	4.857
1991:1	4.974	5.733	10.224	7.390	0.854	9.309	2.330	4.871	−1.449	4.812
1991:2	5.016	5.755	10.187	7.248	0.751	9.129	2.376	4.862	−1.471	4.819
1991:3	4.988	5.783	10.268	7.367	0.842	9.298	2.376	4.861	−1.409	4.835