

The Determinants of Inflation in Sudan

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1. Introduction

Sudan experienced economic instability during the 1970s through the mid 1990s characterized by a high and volatile rate of inflation. The period between 1971 and 1990 is dominated by the occurrence of double-digit inflation averaging about 29%. A series of reforms were introduced during this period including devaluations, price and import controls and rationing. However, these efforts were largely unsuccessful, and triple-digit inflation persisted to the 1991–1996 period. Sudan is included by Fischer, Sahay and Végh (2002) among the 25 countries in the world that experienced episodes of very high inflation crossing 100% growth rate per annum. Among the main factors that could have contributed to inflation developments are the monetization of the fiscal deficit; the successive devaluations of the domestic currency, which in turn increase the costs of imports including imported capital and intermediate inputs; and the supply shocks relating to back-to-back droughts during 1983–1984 and 1993–1994.

Inflation in excess of 100% per year is disruptive and no country can practically tolerate such price growth. The pressures of the situation compelled the government to initiate economic reform in 1997, and the International Monetary Fund (IMF) started to monitor this programme in 1998. The reform emphasized the unification of the foreign exchange rate and fiscal consolidation. The inflow of foreign direct investment (FDI) attracted by the advent of the oil sector and the inflows of oil revenues helped the stabilization efforts and inflation receded to single-digits as from 2000. The real gross domestic product (GDP) growth showed strong response to these developments.

The stabilization was reached mainly through fiscal retrenchment and exchange rate anchoring. However, the challenge ahead relates to the credible commitment for maintaining the internal and external balances that ensure sustained low inflation and robust output growth. Hence, it is vital to improve understanding of the determinants of inflation in Sudan that may enhance such policy endeavours.

An attempt is made in this paper to analyse the underlying sources of inflation in Sudan, a key factor in establishing macroeconomic stability. The intention is to provide answers to the following questions: what are internal and external causes of inflation in Sudan, and how have they been propagated and evolved through time? What are the remaining bottlenecks for the success and sustainability of the current stabilization efforts in fighting inflation? Most of the previous studies on inflation in Sudan draw on the monetarist model, or aversion of it, augmented with cost-push elements. Very few of these studies, if any, explicitly incorporate the effect of foreign price measured in domestic currency in the analysis of inflation dynamics.

This paper uses data over the 1970.1–2002.4 period and hence updates most previous studies and adds to the exposition by considering temporary and more prolonged factors that affected inflation in Sudan. Some of these factors have a short-term influence, for example, episodes of aggregate demand shocks. Others have medium- to long-term effects such as the observation of the purchasing power parity (PPP) and convergence of the domestic price to the foreign price. Such a modelling strategy is more general compared with that in previous studies; more important, it examines both the short- and long-run determinants of inflation paying attention to both aggregate demand and supply sides of the economy. In particular, the use of quarterly data permits in-depth analysis of the lagged effects of key economic variables on inflation adjustments.

The empirical investigation follows two steps: first, the Johansen (1988) maximum likelihood cointegration analysis is applied to identify long-run relationships in two sub-systems of variables pertaining to the monetary sector and a pass-through relation, within the PPP framework. The second stage of the investigation combines the two sub-systems within a general dynamic error correction model (ECM). Sequential reduction of the general model is then applied to establish a stable parsimonious ECM of price growth.

The main results were that inflation in Sudan is determined in the long run by the exchange rate and foreign price. Inflation is also propagated in the short run by the pass-through from the exchange rate as well as from foreign price; the contemporaneous and lagged money growth; and by the deterioration in expectations. The proxy variable included in the restricted ECM to examine the impact of the level of economic activities and liberalization of foreign exchange, suggests that an increase in the level of economic activity lowers inflation in the short run, while liberalization of foreign exchange rate exerts an upward pressure on prices. The dummies entered to account for the effects of droughts during 1983–1984 and 1993–1994 suggest that agricultural supply is negatively affected and in turn significantly contributes to inflation. Similar results are obtained by studies on inflation experiences of other comparator countries (see for example, Chhibber, 1992; Adam, 1995; Liu and Adedji, 2000; Durevall and Ndung'u, 2001; Nachege, 2001; Sacerdoti and Xiao, 2001).

The findings suggest that the policy of defending the exchange rate reform, although it contributed to bringing inflation down, may not be sustainable in the long run due to the sluggish adjustment of the real exchange rate towards equilibrium. The authorities need to develop sound indirect monetary instruments to supplement the policy of exchange rate anchoring. Fighting inflation also depends on the ability of policy to reduce the effects of supply shocks emanating from droughts and foreign price movements as reflected in the costs of imported inputs.

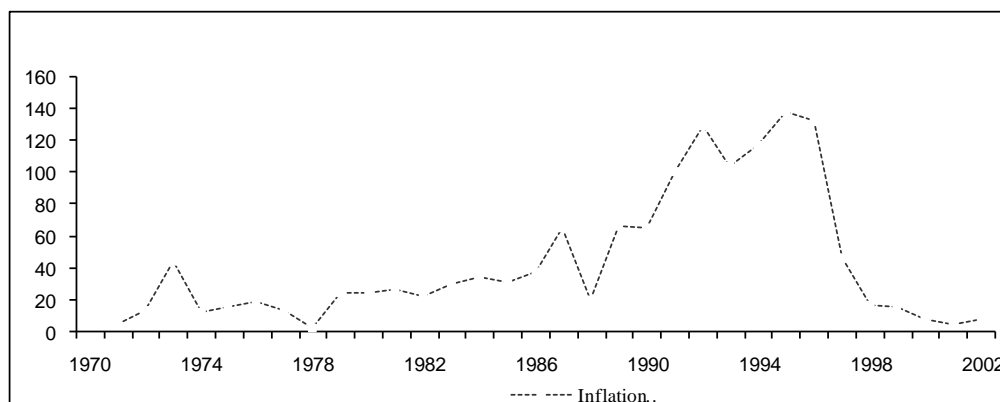
The rest of the paper is organized as follows: the next section gives a brief background on the proximate sources of inflation in Sudan. Section 3 presents a brief survey of previous studies on the macroeconomic determinants of inflation in Sudan; Section 4 outlines the analytical framework and the econometric methodology; and Section 5 presents the results of the empirical analysis. The final section summarizes the major findings and discusses their policy implications.

2. Proximate sources of inflation in Sudan

In general, the persistence of an annual inflation rate of 40% or more over two consecutive years or more, and negative real GDP growth during the same period are known symptoms of macroeconomic instability. In terms of these performance indicators, Figure 1 suggests that inflation developments in the country since 1970 can be roughly divided into three periods: first, a period of moderate to high inflation from 1970 to 1988 with an annual inflation rate hovering around 20–30% except in 1973 and 1987 where it grew by 44% and 67% respectively. Second, there is a process of very high inflation during 1989–1996. Third, inflation receded to 17% average rate over the period 1997–2002.

Table 1 presents both annual and sub-period changes of the major factors that are likely to influence inflation in Sudan. Overall, it appears that the moderate macroeconomic stability between 1970 and 1988 is fragile in view of the high fiscal and current account deficits.

Figure 1: Developments of inflation in Sudan, 1970–2002¹



1. See Appendix A for the definition and source of the variable.

The exacerbations of these internal and external imbalances reached the crisis stage during 1989–1996. The mean rate of inflation during this sub-period was about 107% and the real GDP growth was negative. However, on the heels of the economic reform since 1997, supported by the inflows of FDI and the increase in oil revenues, inflation receded to single digits and the real income growth recovered during 1997–2002. The rest of this section briefly reviews macroeconomic performance and the policy stance over each of these sub-periods.

Table 1: Selected macroeconomic indicators for Sudan, 1970–2002

Period	CPI inflation (%)	Real GDP growth (%)	Change in nominal money (M1) (%)	Change in nominal money (M2) (%)	Change in parallel market exchange rate (%) ¹	Change in the premium (%)	Ratio of fiscal deficit to GDP (%)	Ratio of current account to GDP (%)	Change in terms of trade index (%)	Real imports growth ²	Real exports growth ²
1984	35.0	-8.7	18.3	19.6	35.4	16.17	-13.6	-0.7	7.6	-17.3	-1.5
1985	31.5	-6.5	50.0	64.3	37.1	10.4	-14.6	1.1	8.2	-32.5	-40.2
1986	37.9	5.0	41.0	43.1	26.5	30.1	-13.6	-0.3	9.6	28.4	-8.2
1987	65.4	9.5	32.8	23.1	5.9	-14.5	-10.7	-1.6	12.4	-11.7	47.3
1988	20.0	6.9	44.4	30.4	151.1	122.0	-16.3	-3.0	18.0	17.1	-2.9
1989	66.7	5.8	68.5	67.7	82.3	-38.7	-11.1	-0.6	4.7	-11.9	25.7
1990	65.1	-19.2	46.4	59.2	26.7	120.2	-1.9	-1.6	7.2	-39.1	-46.2
1991	101.3	-13.9	60.2	127.6	14.9	67.1	-17.7	-3.1	-7.2	43.6	-18.7
1992	129.4	-8.2	61.2	110.3	636.7	-83.1	-7.5	-8.9	3.5	-8.3	4.1
1993	103.7	2.1	121.2	92.8	81.0	-30.9	-1.6	-8.7	1.6	13.4	28.8
1994	117.1	-7.3	53.8	15.9	22.8	-31.3	-3.8	-9.4	2.9	28.2	18.9
1995	138.1	0.7	71.4	45.7	72.8	-7.8	-3.4	-8.3	3.2	-4.1	6.7
1996	132.7	8.9	85.5	88.4	73.1	13.0	-2.1	-10.1	1.0	24.1	9.1
1997	46.7	6.8	31.6	31.6	2.6	-8.8	-1.4	-9.4	-6.1	2.1	-4.1
1998	17.1	6.2	28.7	24.0	32.4	7.4	-0.8	-9.4	1.2	24.3	2.8
1999	16.0	6.0	29.6	28.7	4.1	-1.4	-0.9	-4.4	1.6	-26.7	29.8
2000	8.0	9.3	-22.1	-3.9	3.9	-11.9	-0.6	-4.6	1.3	3.7	119
2001	4.9	6.8	6.0	16.9	12.0	-0.2	-1.7	-4.1	2.8	1.0	-7.0
2002	8.0	5.8	24.0	26.7	0.6	0.1	-1.0	-4.1	2.7	1.1	-1.0
1971-1988	24.0 (060)	1.51 (4.25)	28.50 (0.38)	29.38 (0.38)	26.55 (1.86)	9.51 (3.23)	-8.40 (0.48)	-2.94 (0.86)	6.27 (1.38)	2.97 (6.19)	-0.53 (41.29)
1989-1996	106.76 (0.27) ³	-3.89 (2.53)	71.03 (0.33)	75.95 (0.48)	126.29 (1.65)	1.06 (61.11)	-6.14 (0.93)	-6.34 (0.61)	-2.11 (2.00)	5.74 (4.63)	3.55 (7.04)

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Table 1 Continued

Period	CPI inflation (%)	Real GDP growth (%)	Change in nominal money (M1) (%)	Change in nominal money (M2) (%)	Change in parallel market exchange rate (%) ¹	Change in the premium (%)	Ratio of fiscal deficit to GDP (%)	Ratio of current account to GDP (%)	Change in terms of trade index (%)	Real imports growth ²	Real exports growth ²
1997-2002	16.78 (0.92)	6.82 (0.19)	16.30 (1.29)	20.67 (0.63)	9.27 (1.29)	-2.47 (2.80)	-1.07 (0.38)	-6.00 (0.44)	0.58 (5.74)	0.92 (17.72)	23.25 (2.10)
1971-2002	43.83 (0.94)	1.15 (6.62)	39.08 (0.53)	41.27 (0.65)	36.88 (1.40)	5.15 (7.53)	-6.46 (0.76)	-4.37 (0.77)	4.79 (1.87)	3.3 (6.02)	4.9 (6.0)

Note:

¹ The parallel nominal exchange rate is defined as the local currency per unit of the US dollar, hence positive change implies depreciation.

² Export and import are deflated by the foreign price index; see Appendix A for the definition.

³ The coefficients of variation are shown between parentheses.

Source: Bank of Sudan Annual Reports, World tables and IFS

The first burst of inflation during the period 1970–1988 is associated with the oil price increases in early 1970s. However, the economy

was not affected by the impact of these shocks immediately because the government managed to exploit the geopolitical position of the country at the time and attracted substantial FDI, especially from the surplus of the oil-rich Arab countries in a view to promote Sudan as a breadbasket for the whole region.

The peace agreement signed between the government and the southern rebels in 1972 encouraged the inflows of these foreign investments. Nonetheless, the FDI boom failed and by late 1970s the government had neither the foreign reserves nor the domestic resources with which to meet the politico-economic demands for spending following the peace and the debt servicing obligations. Accordingly, Sudan adopted a structural adjustment programme (SAP) with the support of IMF and the World Bank during 1978–1984. In general, these types of programmes usually emphasize outward orientation in strategy; especially export expansion to enhance the balance of payments and to eliminate the debt problem, nominal devaluation, aggregate demand retrenchment, and trade and institutional reforms to create an incentive structure consistent with the reform strategy. Notwithstanding, the instruments actively used in policy operations under SAP were fixed multiple exchange rate and controls including import and price controls.¹ In the early 1980s a parallel exchange rate was introduced along with liberalization measures that shifted imports and to some extent exports from the official to the parallel market. These reforms aimed at attracting the remittances of Sudanese nationals working abroad (SNWA) after failing to attract more investment funds from the oil exporting Arab countries; these efforts were largely unsuccessful (see Elbadawi, 1992a, 1992b).

The intensification of controls to repress inflation tolerated entrenched rent seeking, black markets and smuggling. The successive depreciations of the free exchange rate in the black market led to the vicious cycle of overvaluation of the official exchange rate and inflation and to loss of external competitiveness. During the period real export growth was negative, averaging 0.5%, and showed very high volatility, as indicated by the coefficient of variation of 41.3 (see Table 1).

The premium, defined as the ratio of the free exchange rate to the official exchange rate, grew on average by about 10% during 1978–1984. To indicate the extent of the parallel exchange market, Hussain (1986) notes that more than 80% of imports were financed from resources from the black market. Hence the increasing diversion of import financing towards the black market with a depreciated exchange rate implies increased cost of imports in the domestic economy. The resulting increases in the prices of intermediate imported inputs and consumer tradables fed the inflationary process, with serious implications for capacity utilization and growth in the country.

The budget deficit as a percentage of GDP averaged 8.4% during 1970–1988. The fiscal gap appeared to be financed by money creation thought to substitute for external credit which dried up in the late 1970s. For example, the base money grew during 1984–1988 by more than 37%, on average, and inflation started to run loose in the economy (see Table 1).

The macroeconomic imbalances and the policy failures of the period² were complicated by the outbreak of the civil war in 1983, ending 10 years of peace. The pressure of the situation not only resulted in economic U-turn but also induced massive political instability, for example, the sub-period witnessed four changes of the political regime in succession.

The second period of inflation during 1989–1996 opened with a political change in

1989. The new government was faced with a deteriorating balance of payments due to loss of competitiveness and the reversal of capital flow in terms of repayments of debts and services, and a large fiscal deficit. A National Economic Salvation Plan was introduced in 1990. The plan was a home-grown form of the SAP, albeit without IMF and World Bank support. It emphasized self-reliance as a new orientation in the development strategy. This was largely a reflection of the severe decline of the foreign finance. The main elements of the plan comprised: a) strict control of foreign exchange, including import and prices, and exports retention through Central Bank surrender requirements which furnish a base for export tax; b) adherence to a strict cash budget system; and c) privatization of the non-performing public enterprises. These measures appeared to reduce the fiscal deficit as a ratio of the GDP by two percentage points compared with the previous period, but remained high due to the burden of the civil war. The official exchange rate was occasionally devalued, but not merged with the free market rate which depreciated, on average, by about 126% during this period. The premium continued to be positive and exhibited considerable volatility (see Table 1).

The huge depreciation of the parallel market exchange rate indicates a basic disequilibrium in the foreign exchange market and trading system (see Elbadawi, 1994). It could be argued that the high inflation during the period is both a cause and result of this process. High inflation may cause the relatively fixed official exchange rate to be overvalued, which expands the size of the parallel market and the premium. In turn, the rise in the premium increases demand for money due to an increase in the domestic currency cost of foreign exchange, which feeds inflation. More important, it has been shown that the dual exchange system can indirectly influence price movements through the quasi-fiscal deficit of the central bank operations. The direction of change depends on whether the Central Bank is a net buyer of foreign exchange, that is, collector of implicit tax or a net seller, that is, provider of implicit subsidy (see Pinto, 1991; Morris, 1995). These linkages are empirically evaluated in this paper.

In 1992 the government liberalized the foreign exchange by allowing the official exchange to reflect its market value. As a result, real export reverted its declining trend over 1992–1996. However, other institutional failures remained, for example, export licensing and the Central Bank surrender requirement. The overall balance of payments continued to be in deficit; the ratio of the current account deficit to GDP averaged 6% over the period due to expansionary domestic policies; and the negative shock to the terms of trade declined by about 4%. Other factors also contributed to this external imbalance. First, the drastic drop in gum Arabic production, which is a key export, due to reintroduction of government monopoly of export marketing in 1992 and the sharp decline of livestock export in 1993, due to an outbreak of Rift Valley Fever, (RVF). Second, the withdrawal of IMF balance of payments support and the loss of the IMF seal of approval. The combined effects of these internal and external shocks caused inflation to grow by phenomenal records over 1988–1996, negatively affecting economic growth. As seen in Table 1, real output growth was negative and volatile, with a recorded average decline of -3.9% and a coefficient of variation of 2.53.

The third episode of inflation development followed the reform initiated in 1997 which focused on reducing inflation; lifting the remaining imports and prices controls; fiscal consolidation; and streamlining the banking system. IMF started to monitor this programme in 1998. Because liberalization of trade and foreign exchange are essential

components of the reform, the Central Bank of Sudan significantly reduced the surrender requirements, and in some cases eliminated the surrender applicable to selected exports.

The reform initiatives coincided with a substantial inflow of FDI associated with the commercial exploitation of oil and the increase of oil money as an important source of revenue. The combined effects of these developments provided an enabling macroeconomic environment.³ Real export including oil grew, on average, by 23.3% during the period. The growth in M2 (Table 1) declined by about 55 percentage points compared with the previous period and inflation receded to a single digit as from 2000. The real output grew by 6.8%, on average, over 1997–2002 (see Table 1). Fiscal consolidation was at the centre of this reform effort: the large cuts in public spending had improved the fiscal stance and significantly curbed escalation of inflation.

The preceding discussion suggests that from the 1970s through the 1980s Sudan experienced a combination of shocks relating to the upsurge of energy prices, the negative consequences of the failed FDI boom in post mid 1970s and the outbreak of the civil war in 1983, all of which negatively affected the internal and the external balances. In particular, the fiscal deficit financing appeared as a key element determining the environment for monetary policy. Despite the introduction of Islamic financing model in 1984, the financial market remained relatively thin and characterized by entrenched guidelines for credit allocation. The effects of the continued deficit financing on price stability was a concern for the Central Bank and became a cause of worry by the early 1990s. A series of monetary reforms was introduced in 1992 and 1997 which enabled the Central Bank to engage effectively in dismantling controls, liberalizing the financial system and improving supervision and regulation of banks. Nonetheless, during most of the reform period the monetary conditions were tight; this largely reflects more the structural bottlenecks in the financial system than the efforts of the Central Bank (see Kireye, 2001).

In 1998 the Central Bank introduced the Central Bank Musharaka Certificate (CBMC) to streamline its long standing cost-free lending to the government and commercial banks. The certificates are short-run liquidity papers which the Central Bank trades with banks to smooth short-term fluctuations in liquidity and hence finish a base for open market operations. A similar Government Musharaka Certificate (GMC) was introduced in 1999. Both CBMCs and GMCs were only recently instituted and their combined size available for open market operations is too small to fully neutralize the effects of deposit changes on reserves money. Still, under the Islamic finance model, without *ex ante* interest rates, the Central Bank may use the monetary aggregates; change the reserve requirements; and pursue moral suasion and selective credit controls to achieve its objectives. Yet, to a great extent, the monetary policy in Sudan is based on the management of the exchange rate and the control of the monetary aggregates. Selecting an appropriate anchor within a comprehensive monetary framework relevant for the bank's objectives of sustained output growth and low inflation presents a challenge for the policy mix in the period ahead. This is crucial, especially because the recent rise of inflows of oil revenues may lead to money supply growth and hence inflation if the oil money is not appropriately sterilized following the developments in the real sector of the economy. Therefore, it is important to highlight the main channels through which the behaviour of the monetary aggregates affects inflation in a small open economy like that of Sudan with an underdeveloped financial sector and instruments of monetary policy.

3. Literature review

Inflation is an important macroeconomic indicator and is widely discussed in the literature. Both demand and supply side factors including policy variables and expectations affect inflation. Numerous studies on inflation in developing countries draw from the monetarist and structuralist approaches to provide an explanation for inflation. According to the monetarist view, given stable demand for money, inflation is a purely monetary phenomenon and can be controlled by curbing excessive growth of money supply. The structuralist approach distinguishes between basic or structural inflationary pressures and the propagating mechanisms that transmit such pressures. The identified key structural sources of inflation in these studies include distortionary government policies; foreign exchange bottlenecks; inelastic supply of food; the government budget constraint; and sectional disequilibria.

Early application of the monetarist model to explain the dynamics of inflation is found in Harberger (1963) for Chile. The monetarist hypothesis has also been tested in other less developed countries: London (1989) and Tegene (1989) for a group of African countries; Ndung'u (1994) for Kenya; Saini (1982) for Asia; and Vogel (1974) for Latin America. Many studies developed models augmenting the monetarist model with structuralist features. For example, Aghevli and Khan (1978) modelled the fiscal deficit as initiator and propagator of a cyclical process of money supply and inflation. Other studies examined the inertial and the supply side factors including cost-push elements and sectoral disequilibria (see, for example, Sowa and Kwakye, 1993; Jha, 1994; Adam, 1995; Liu and Adedji, 2000; Ross, 2000; Nachega, 2001; Sacerdoti and Xiao, 2001; Durevall and Ndung'u, 2001).

Studies on the sources of inflation in Sudan differ in their empirical models, sample period, modelled macroeconomic variables and hence their main results. However, there is a broad agreement on the following key factors affecting the rate of inflation: money growth, income growth and exchange developments.

Safi-Eldin (1976) implemented a version of the monetarist model using step-wise regression and annual data over the period 1960–1977. He points out that the observed variation in the rate of inflation is significantly explained by money supply and its lagged value, the real growth of GDP, and lagged inflation, indicating that the statistical evidence supports the hypothesis that inflation in Sudan over the period is a monetary phenomenon.

Hussain (1986) experimented with a hybrid model that includes typical monetarist variables augmented with wages and productivity as indexes measuring the cost-push elements. The model is estimated over the period 1967–1975 using annual data. The main result reveals that inflation in Sudan is of a demand-pull variety. However; as acknowledged, failure to obtain satisfactory results on the structural proxies may partly

reflect data deficiencies on these proxies, and may also reflect a more wage control policy regime during that period aiming to ease rather than trigger inflation.

Suliman (1989) uses the Aghevli and Khan (1978) type of model to examine the existence of a process of self-generating inflation in Sudan. The model allows for feedback from inflation rate to the real fiscal deficit. The model is estimated by three-stage least squares method using annual data over the period 1960–1982. Significant evidence of a symbiotic relationship between government deficit, base money and inflation is found.

Abdella (1994) applies a version of the “ideal stock of money” type of model over the period 1989–1994 using annual data. He points out that, “for the period under study, the growth rate of the nominal GDP is higher than the growth rate of the money supply except for year 1992 where the nominal GDP has grown by 108% corresponding to 143% for the stock of money” (Abdella, 1994:17). The main result is that inflation in Sudan during the sample period was not a pure monetary phenomenon.

Mahran and Gangi (1996) implemented a simultaneous model using two equations. The first equation related the growth rate of inflation to the parallel market exchange rate — denoted as domestic currency in US dollars — the rate of world inflation, the rate of government borrowing from the banking system and the rate of growth of GDP. The second equation related the parallel market exchange rate to the official exchange rate, the banks credit to the private sector, the rate of inflation, and the growth rate of the government expenditure. The model was estimated by two-stage least squares method using annual data over the period 1971–1991. The results reveal that government borrowing from the banking sector and the imported inflation contribute significantly to domestic price growth. In addition, the continuous depreciation in the free exchange rate is the most significant single variable contributing to inflation in Sudan. Furthermore, Mahran and Gangi (1996:20) indicate: “the free exchange rate itself is significantly influenced by the expansion in credit made available to the private sector, which is mostly used for speculative purposes in the foreign exchange market.”

Abdel-Rahman (1997) uses a variant of the autoregressive distributed lag (ADL) model for money (M1), price (CPI) and real GDP, along with a set of deterministic variables—these are impulse and interaction dummies. The results of the estimation of the model over the period 1970–1994 using annual data in rates of growth indicate that nominal money correlates positively with inflation in an almost one-to-one basis, whereas real output serves to depress inflation. However, the diagnostic tests indicate the presence of the ARCH effect, and the cumulative sum of residuals shows a number of possible breakpoints. The re-estimation of the model, with interaction dummies included, in error correction form improves the fit and confirms the depressing effect of income regardless of the breaks. While nominal money was found to be insignificant before 1982, its effect has increased sharply since then.

Motivated by the need to understand the impact of the livestock export ban of 2000, due to an outbreak of RFDV, on Sudanese inflation, Ramcharan (2002) applies multivariate cointegration analysis to food and non-food CPIs, M2, the first difference of the official exchange rate, livestock export revenues as an income scale variable, and the ratio of dollars to M2, as an index of currency substitution. The data is observed quarterly during 1994.1–2001.2. The standard cointegration tests are applied to two subsets of data with the eigenvectors normalized with respect to food and non-food CPIs respectively. The basic idea is to investigate the differential impact of the livestock export ban on these two

prices separately. The observed impact depends on the information set on which livestock revenues are conditioned; in the case of non-food inflation, it would be expected to act as an income variable, exhibiting positive long-run relationship with non-food inflation. In contrast, the reverse holds for food inflation. The intuition is: “the ensuing... decline in overall aggregate demand and the substitution away from the nonfood goods would then lower their prices, leading to large decline in inflation” (Ramcharan, 2002:9). Aside from the acknowledged missing variables bias, the results reveal that the dollarization index is not a significant determinant of food and non-food inflation in the long run while the rest of the variables are correctly signed and enter significantly in each sub-model. Overall, the short-run dynamics of the respective models showed that the export ban, by increasing the local supply of meat and lowering income, played a role in the observed decline in both food and non-food inflation, and through the exchange rate effect the ban may have had an impact on the economy.

This paper attempts to update most of these previous studies and adds to the exposition by considering a more general model of price determination. The next section outlines the analytical framework and the econometric methodology.

4. Analytical framework and econometric methodology

In general, inflation modelling is an inherently difficult task that is further complicated in the case of the Sudan by the observation that inflation developments differ over time in terms of the imbalances that caused it. For example, the excessive fiscal and monetary expansions, exchange rate regime changes, external shocks, drought shocks, the civil war and other institutional factors. Accordingly, any analysis of inflation over the review period has to acknowledge the need for testing and incorporating disparate factors and that some structural parameters may not be stable over time.

The paper relies on the proximate sources of inflation outlined in Section 2 for modelling the inflation process. The most important are: (i) the impact of domestic aggregate demand (for example, the monetization of the fiscal deficit and other causes for excessive growth in money supply); (ii) the impact of the supply side that emanates from the external sector and is transmitted via the price of imported intermediate inputs, including other foreign exchange institutional arrangements that result in import compression and import price increase and hence declines in capacity utilization and economic growth; and (iii) the impact of drought shocks which are transmitted to inflation.

Theoretically, the inflation process is often modelled as: (a) a mark-up pricing mechanism following the work of Duesenberry (1950); (b) an interaction of supply and demand for money, following the contribution of Harberger et al. (1963); and (c) a response to internal domestic (expectations) disequilibria or external “equilibrium exchange rate” misalignment pressures. Other modelling strategies involve combinations of the above factors. The model adopted here assumes that inflation originates from both the demand and supply sides of the economy. Various studies on inflation in developing countries represent the aggregate demand side by the demand for money relation. The influence from the supply side could be represented by the external sector. In a small open economy like that of Sudan, with underdeveloped local sources of inputs, the share of tradable inputs in production of consumer goods is large. It is more likely that changes in import prices pass-through to the consumer prices. Hence, the analytical model allowed overall inflation to adjust to long-run disequilibria in the money market and the external sector as well as to short-term impact of the variables determining these equilibrium conditions including other relevant factors. The rest of this section develops the econometric method in the light of this analytical framework.

PPP provides a presentation of the long-run price formation process in an open economy. Accordingly, the overall price level (P) can be expressed as a weighted average of the domestic price (P_d) and foreign price measured in domestic price (EP^f), that is:

$$P = P_d^\delta (E^f)^{1-\delta} \quad (1)$$

Equation 1 in log-linear form with lower case letters denoting logarithms is rewritten as:

$$p = \delta p_d + (1 - \delta)(e + p^f) \quad (1')$$

Here, e is the nominal exchange rate and δ stands for the share of the domestic component of price level which is essentially determined by the equilibrium condition in money market, expressed as:

$$M^s / P_d = M^d / P_d \quad (2)$$

where, M^s and M^d are respectively the nominal stock of money and money demand. The equation can be written in the following logarithmic form:

$$p_d = m^s - m^d \quad (2')$$

with m^d representing the log of demand for real money and m^s is the log of nominal stock of money.

The demand for real money for Sudan can be expressed as:

$$m_t^d = \beta_1 y_t - \beta_2 \pi_t^e + \beta_3 prem_t \quad (4)$$

where y is real income, π^e is expected inflation proxied by lag price growth, $prem$ is the parallel market premium and t is time index. The interest rate is prohibited in Sudan and the alternative rates of returns under Islamic finance are unlikely to influence demand for money due to the limited investment options and the distortion of the financial market. Even before the introduction of the Islamic model of finance, Domowitz and Elbadawi (1987) found that the interest rate on money is not only fixed in nominal terms, but is also constant and sometimes negative in real terms. Instead, they use inflation rate as proxy for the opportunity cost for money holding in their analysis of money demand for Sudan (see also Abdel-Rahman, 1994). The premium is included to measure the impact of parallel market exchange rate movements. A rise in the premium could increase demand for money, due to an increase in the domestic currency cost of foreign exchange or that

it may lead to a decline in demand for money, reflecting a currency substitution motive, due to depreciations of the parallel exchange rate. Other studies use a similar equation to describe demand for real money in developing countries (see Adam, 1992; Liu and Adedji, 2000).

Substituting (4) into (2') using the resultant expression in (1') and suppressing the time index gives:

$$p = \delta (m^s + y - \pi^e + prem) + (1 - \delta)(e + p^f) \quad (5)$$

Equation 5 establishes a general framework for the long-term movements of the aggregate price level, where both internal disequilibria in the money market and changes in foreign prices measured in domestic price jointly determine such movements. However, the dependent variables and some of the independent variables in the equation may be simultaneously determined, and it may be that they are non-stationary but render stationarity by first differencing.⁴ In such cases, the Johansen (1988) cointegration testing method and modelling could be used. This method is particularly relevant for testing to verify if there are any cointegration relationships and long-run equilibrium relationships among the variables. Hence, a distinction can be made between the short-run (first difference) and the long-run (lagged levels) effects. In addition, the ECM also permits the use of a general lag structure.

The following unrestricted vector autoregression (VAR) of order k can be used to represent the study variables:

$$x_t = \mu + \sum_{i=1}^k A_i x_{t-i} + \varepsilon_t; t = 1, 2, \dots, T \quad (6)$$

where $x = (p, m, y, \pi, prem, e \text{ and } p^f)'$ is the column vector of 7×1 dimension containing the endogenous variables; $A_i, i=1, \dots, k$, are 7×7 matrices of unknown coefficients; μ represents 7×1 vector of unknown deterministic terms (including intercepts); and ε is *IID* disturbance term with zero mean and constant variance.

With $I(1)$ variables, and using the first difference operator, $\Delta x = (x_t - x_{t-1})$, Equation 6 can be re-parameterized in the following vector error correction model:

$$\Delta x_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-i} + \beta' x_{t-1} + \varepsilon_t; t = 1, 2, \dots, T \quad (7)$$

$$\Gamma_i = \sum_{r=i+1}^n A_r \quad \phi' = (1 - \sum_{i=1}^k A_i)$$

where, α and β' (7,r) are respectively full-rank matrices of the adjustment factors and cointegrating vectors; with r being the number of expected cointegrating vectors.

Ideally cointegration estimation and analysis should be carried out through the full set of variables. However, not all the study variables are available in the required frequency to fit the estimation and analysis of the full system. The main challenge is the lack of quarterly observations on GDP; annual data on GDP were available and had to be interpolated. The interpolated GDP gives a series measuring the trend which is relevant for long-run analysis, but contains less information about the short-run changes in output. Instead the quantity index for power consumption (pc) is included to proxy the level of economic activities in the short-run dynamic model. This variable is used for several reasons. First, it is widely acknowledged that there is a close link between aggregate macroeconomic activity and power consumption.⁵ Second, it is arguable that power intensity of the real value added does not change significantly during the study period. Prior reasoning suggests that a rise in the overhead power use per unit of output, due for example to decline in capacity use, fall in maintenance investment etc., will be checked by the higher direct and indirect power costs.

The estimation of the standard PPP implied by Equation 1 poses another challenge. This version of PPP may not hold for Sudan due to the Balassa-Samuelson hypothesis and other factors, including transport costs, barriers to currency conversion and the presence of non-traded goods. These factors cause market segmentations and create a wedge among prices across countries, but if they remain constant over time the long-run PPP can be estimated including a positive constant term. In addition, the use of price indexes, as in this paper, justifies the presence of the constant. Thus, a sectoral approach is followed for testing the existence of cointegration in the subset of variables to allow for different assumptions about the restriction of the constant in the cointegration space per sub-system.

Accordingly, the vector x_i containing the endogenous variables in Equation 6 can be partitioned into two subsets, $(p, m, y, \pi \text{ and } prem)'$ and $(p, e \text{ and } p^f)'$, representing respectively the demand for real money and the PPP relationship. This method is equivalent to adding prior identifying restrictions to the full system while still allowing the analysis of the short-run dynamics within the entire system. Rather than conducting the analysis using the system of dynamic equations, a single equation ECM of inflation is developed and estimated. Such a modelling strategy is consistent with other studies (see for example, Ndung'u, 1993; Liu and Adedji, 2000; Durevall and Ndung'u, 2001; Nachega, 2001; and Sacerdoti and Xiao, 2001).

Assuming the existence of two cointegrating relations, the following general single equation ECM, similar to the ECM representation of data in Equation 7, can be computed after dropping $(\Delta\pi)$ and replacing the first difference of the interpolated y by the first difference of the log power consumption (Δpc) :

$$\begin{aligned}
\Delta p_t = & \gamma_0 + \sum_{i=1}^{t-1} \gamma_{1i} \Delta p_{t-i} + \sum_{i=0}^{t-1} \gamma_{2i} \Delta m_{t-i} + \sum_{i=0}^{t-1} \gamma_{3i} \Delta p_{t-i} + \sum_{i=0}^{t-1} \gamma_{4i} \Delta prem_{t-i} + \\
& \sum_{i=0}^{t-1} \gamma_{5i} \Delta e_{t-i} + \sum_{i=0}^{t-1} \gamma_{6i} \Delta p_{t-i}^f + \alpha_1 [m - \beta_1 p - \beta_2 y - \beta_3 \pi - \beta_4 prem]_{t-1} + \\
& \alpha_2 [\theta_1 e + \theta_2 p^f - p - \theta_0]_{t-1} + \sum_{i=1}^3 \gamma_{7i} S_{it} + \gamma_8 D_t + \mu_t
\end{aligned} \tag{8}$$

where μ_t is a white noise process with the usual properties; sc_{it} is a vector of seasonal centred dummies; and D_t is a vector containing two dummies over 1984.3–1985.1 and 1993.3–1994.3 to account for the impact of two episodes of drought on agricultural supply and the ensuing shortages of major food staples which are expected to influence price growth. The severity of these droughts and their effect on inflation is difficult to measure with precision. However, both irrigated and rainfed agriculture had been affected most during the specified periods (see Teklu, von Braun and Zaki, 1991; Mirghani, 1996). The other variables are defined as before.

In the case that all variables are I(1), then their respective summations in Equation 8 are all stationary and, if cointegration exists, the error correction terms, that is, the linear combinations of variables represented in the brackets, are also stationary. The short-run dynamics are captured by the summations over the first difference of variables. The long-run impact of the right hand side variables is measured by the two error correction terms; their coefficients show the strength of adjustment and disequilibria transmitted into the rate of inflation for each period.

The equation establishes the key links between the macroeconomic relationships underlying the inflationary process often noted in the literature (see Durevall and Ndung'u, 2001). Empirical testing of the pure monetarist model would require the variables entering money demand relation be significant both in the short- and long-run. However, this is equivalent to assuming a closed economy; or a perfect floating of exchange rate; and that imports and domestic goods are perfect substitutes. In the event that these assumptions do not hold for an open economy, inflation may be driven by persistent divergence from PPP in the long run. Hence, the coefficient of the error correction term, α_2 measures the extent to which deviations of the long-run domestic price level and its determinants from equilibrium in the external sector affect inflation in the next period. Price growth could also be affected by the dynamic terms on these determinants in the short run.

The premium is included in both the long- and short-run parts of the model, because in countries with a large parallel market for foreign exchange, such as Sudan, the premium indicates the extent of foreign exchange overvaluation (see Elbadawi, 1994). In this context, given the trade regime, the premium reflects the degree of foreign exchange controls; ease in controls lead to depreciation of the official exchange rate and to decline in the premium. Thus, the premium is included in the demand for money function in order to examine whether a rise in the premium increases the long-run demand for money due to an increase in the domestic currency cost of foreign exchange or if it

leads to a decline in demand for money, reflecting a currency substitution motive due to depreciations in the parallel exchange rate. It is also included in the dynamic part of the model to measure the impact of foreign exchange liberalization on inflation. However, the relationship between inflation and the premium is indirect and complex. Generally the inflation–premium link depends on the portion of traded goods allocated to the parallel market; the mechanisms of international reserves adjustment and money supply creation; and on the inflation elasticity of money demand. It is expected that for Sudan a decrease in the premium, following the 1992 unification, may reflect a short-run fiscal shock that raises inflation through monetization of the deficit to compensate for the loss of revenues from export surrender.

In the following section, the standard Johansen (1988) cointegration method is applied to identify the cointegrating vectors pertaining to the long-run part of the model. Based on the testing results, the ordinary least squares (OLS) technique is used to determine the data congruent dynamic inflation model for Sudan over the review period following an approach similar to Hendry's general-to-specific modelling strategy, (see for example, Hendry, 1995: 365).

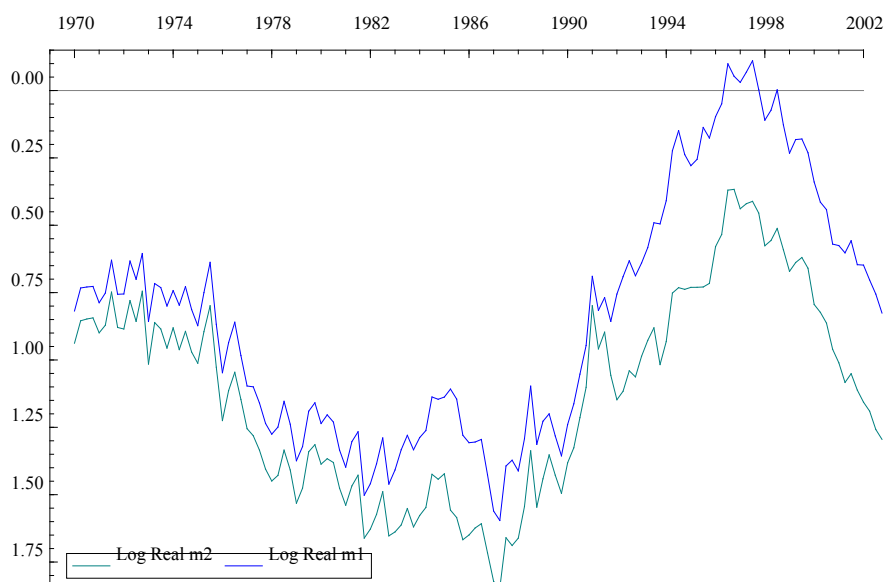
5. Empirical model

Time series properties

The empirical analysis used quarterly data for the period 1970.1–2002.4. The sources of these data and the definitions of the variables are presented in Appendix A. GDP was interpolated using the quadratic method. All variables were expressed in logarithms except the rate of inflation.

The way money is defined is important in estimating the demand for money. The logarithms of real $M1$ (narrow money) and $M2$ ($M1$ plus quasi-money) are plotted in Figure 2. It seems that both measures of money are closely related and exhibit similar patterns with respect to each other; this implies shallow financialization of the economy (see Kireye, 2001). The results also suggest that real money growth is weakened during the period of very high inflation 1989–1996 (Figure 2). Since the quantity theory relation is expected to hold in the long run, $M2$ was used in the analysis.

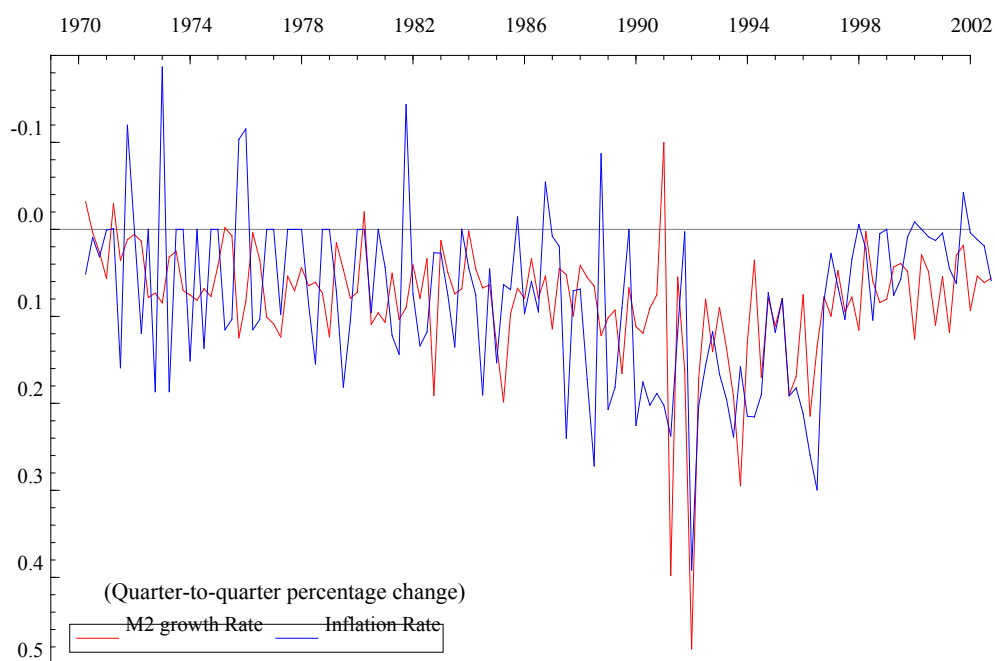
Figure 2: The log of real narrow money ($m1$) and broad money ($m2$), 1970.1–2002.4¹



¹ See Appendix A for the definitions and sources of the variables.

Figure 3 depicts the quarterly rate of growth of inflation and M2. As seen, CPI and the money series seem to follow each other closely and exhibit some seasonality. Centred seasonal dummies were used in the estimation instead of readjusting these series and hence disturbing their properties.

Figure 3: Inflation and money growth, 1970.1–2002¹

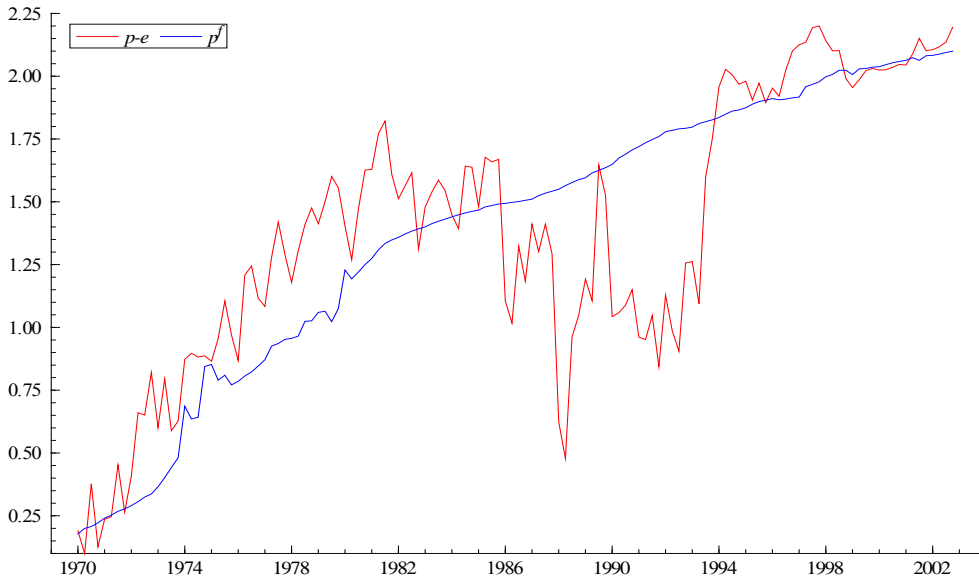


¹ See Appendix A for the definitions and sources of the variables.

In Figure 4 we see the matched means plot of log foreign price for Sudan, calculated as weighted average of trading partners' consumer price indexes and the logarithmic difference between domestic CPI and the log index of the trade weighted nominal effective exchange rate e . The two series roughly trend upwards and follow each other closely over time except during the period of high inflation. This implies that the exchange rate, the CPI or both often adjust to reduce the transitory deviations between p^f and $(p-e)$.

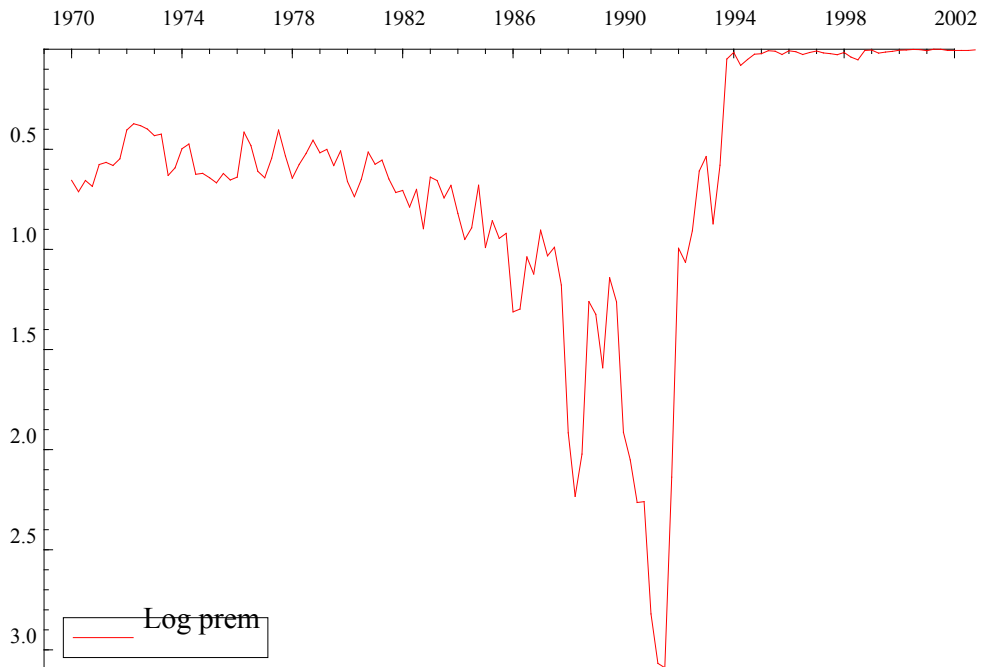
Figure 5 depicts the plots of the premium. The logarithm of the premium increased from the beginning of the sample, reached its maximum in about 1991 and then declined to almost zero as the gap between the official and the parallel market exchange rates narrowed in the post 1992 liberalization. Hence the inclusion of the premium is important to account for the impact of exchange liberalization on both demand for money and inflation.

Figure 4: The log of foreign price and the mean adjusted log CPI minus log nominal effective exchange rate, 1970.1–2002.4



Source: Author's calculations; see Appendix A for the definition of the variables.

Figure 5: Log of the premium (prem), 1970.1–2002.4¹



¹ See Appendix A for the definition of this variable.

Before cointegration was tested the standard Augmented Dickey Fuller (ADF)⁶ and Phillips-Perron (PP)⁷ unit root tests were used to determine the order of integration of the study variables (see Table 2). The results of ADF and PP testing do not uniformly agree on the choice of the order of integration of the study variables. However, both tests failed to reject the null hypothesis of unit root when the variables were tested in levels. The ADF test confirmed the null hypothesis for the domestic inflation and broad money in level and first difference, but the null hypothesis was rejected for the first difference of the nominal effective exchange rate at 5% significance level. The PP test confirmed the stationarity of the first difference for all variables at 1% significance level. The strong version of the purchasing power hypothesis is not supported by both testing procedures in the sample period. Therefore, based on the results of the unit root testing procedures, in the next sub-section the Johansen (1988) maximum likelihood approach to cointegration is applied to each subset of variables relating to the demand for real money and the PPP relation. This testing procedure can also be viewed as providing further evidence on the existence or otherwise of unit roots in the level of the variables per sub-system.

Table 2: Unit root tests statistics¹

Variable	Level			First difference		
	ADF-statistics	(Lag)	PP-statistics	ADF-statistics	(Lag)	PP-statistics
<i>p</i>	-1.960	(5)	1.161	-2.124	(3)	-9.251**
<i>y</i>	-2.017	(0)	-1.849	-8.201**	(1)	-12.720**
<i>m2</i>	-1.864	(7)	2.078	-2.471	(6)	-10.038**
<i>ner</i>	-2.444	(7)	0.992	-2.899 *	(7)	-10.313**
<i>rer</i>	-1.645	(6)	-2.453	-4.150**	(7)	-12.958**
<i>prem</i>	-1.946	(2)	-2.101	-4.569**	(6)	-8.914**
<i>p^f</i>	-2.328	(4)	-2.571	-4.675**	(2)	-11.861**
<i>pc</i>	-1.871	(4)	0.874	-3.506**	(5)	-13.386**
<i>inf</i>	-1.215	(7)	-2.497	-7.495**	(6)	-19.267**

Notes:

¹ ADF is the Augmented Dickey Fuller test. The null hypothesis is that the series tested contain unit root. Each variable is included with seven lags; the selected lag order is determined by the Akaike information criterion. The test includes a constant and a time trend for all variables in level and a constant for the variable in first difference. Four truncation lags were used in the PP test.

Asterisks * and ** denote rejection of the null hypothesis at 5% and 1% level respectively.

All variables are in logarithms except *inf* (see Appendix A for the definitions and sources of the variables).

Cointegration analysis

The Johansen (1988) approach to cointegration is sensitive to the lag length of the VAR underlying the analysis and to whether a constant and a trend are included, restricted or otherwise. Since none of the study variables can be considered a priori as exogenous, the specification search starts with an unstructural VAR per sub-system. In order to ascertain the lag length of VAR, 12 lags were initially included. The results of estimation for the test and selection of the lag length, using Akaike information criterion (AIC); Schwartz Bayesian criterion (SBC) and the log-likelihood ratio statistics (LR) are reported in Table B1 in Appendix B. As seen, AIC selects VAR order 11 for the monetary sector while SBC selects order 2 and LR test statistics accepts these

selections. In the case of the external sector, AIC suggests VAR order seven, SBC selects order one and LR test statistics reject all VAR order less than four. Overall, the results indicate that AIC and SBC criteria are in sharp conflict in determining the lag order of VAR to be used in cointegration analysis of both sectors of the economy. Thus, compromises are unavoidable. To avoid the problem of serial autocorrelation of errors of the individual equations entering the cointegration analysis, and in order not to run the risk of over-parameterization, a seventh-order VAR was used in the long-run analysis of the money market and four lags were used for VAR of the external sector proxied by the PPP relation. Estimation of the first VAR of the sub-system included constant seasonal centred dummies and step dummies entered unrestricted with no term on the trend. From the unit root testing results reported in Table 2, the proxy variables used to measure the PPP relationship for Sudan were not expected to form a linear combination. Hence, VAR underlying the analysis of this relationship was estimated with the constant entered restricted into the cointegration space, the seasonal centred dummies and the step dummies entered unrestricted. The results of the Johansen procedure are reported in Tables 3 and 4 for each sector.

Table 3: Cointegration testing and analysis of the monetary sector¹

Eigenvalues	0.28097	0.19173	0.15630	.091651	0.00535
Null hypothesis, Rank (Π) = r:	r=0	r \leq 1	r \leq 2	r \leq 3	r \leq 4
λ -max:	40.901**	26.39	21.07	11.93	.665
95% critical values/ ² :	33.64	27.42	21.12	14.88	8.07
Trace-statistics:	100.95**	60.05**	31.48	12.58	.665
95% critical values/ ² :	70.49	48.88	31.54	17.86	8.07
Normalized cointegrating vector:		<i>m2</i>	<i>p</i>	<i>y</i>	<i>prem</i>
	1	-1.187***	-0.840	0.475	0.689**
	(0.000)	(0.134)	(0.610)	(0.319)	(0.308)
Restricted cointegrating vector:		1-1.163	-1.000	0.456	0.663**
	(0.000)	(0.093)***	(0.000)	(0.300)	(0.284)
X^2 (1): 0.0732 [0.787]	1	-1.058	-1	-0.0000	1.001
		(0.048)	(0.000)	(0.000)	(0.262)
X^2 (2): 3.111 [0.211]	1	-1)	-1	-0.0000	0.999***
	(0.000)	(0.000	(0.000)	(0.000)	(0.250)
X^2 (3): 4.935 [0.177]					
Weak exogeneity test statistics					
$\alpha_{1i}=0$ for each variable/ ³					
X^2	3.950**	4.325**	2.37	2.587	3.058*
p-value	[0.047]	[0.038]	[0.123]	[0.108]	[0.080]

Notes:

¹ The estimation period is 1970.1–2002.4. See Appendix A for the definition of the variables. VAR underlying the analysis included seven lags of each variable, unrestricted constant, seasonal centred dummies and a step dummy for the foreign exchange liberalization taking the value of one over 1992.2 and zero otherwise. Asterisks ***, ** and * denote significance at 1%; 5% and 10% levels respectively; numbers in parentheses are symptomatic standard errors; and numbers in brackets are p-values of the X^2 -statistics.

² Testing is based on Microfit; using the critical values at the 95% and 90% levels based on those computed by Pesaran, Shin and Smith (2000) rather than Johansen–Juselius (1990) or Osterwald–Lenum (1992) values.

³ Weak exogeneity test statistics are examined under the assumption that $r = 1$ and so are asymptotically distributed as $X^2(1)$ if weak exogeneity of the specified variable for the cointegrating vector is valid; significant [p-value] denotes rejection of weak exogeneity (see Doornik and Hendry, 1984).

In Table 3, the results of testing using the money market variables (m , p , y , π and $prem$) indicate that three eigenvalues are greater than zero implying the existence of three cointegrating vectors. However, the λ -max eigenvalue statistics suggest that the null of no cointegration is rejected in favour of a single cointegrating vector at 5% level. According to the trace statistics the hypothesis that there is at most two cointegrating vector is not rejected. Detection of two cointegrating vectors in similar specification of demand for money is found in other studies (see for example, Kuijs, 1999; Liu and Adedji, 2000). The other cointegrating vector suggests that inflation forms a linear combination by itself. The subsequent analysis assumes the existence of one cointegrating relationship according to λ -max test statistics.

The normalized cointegrating vector corresponding to the long-run demand for money is shown in Table 3, ninth row. The estimated coefficient for price is near unity while that of income is below unity (Table 3). The estimated long-run coefficients for price level and the rate of inflation are statistically significant, but the other coefficients are not. Accordingly, restrictions are imposed on the estimated coefficients that are most likely to accept. The imposition of unitary restriction on the income coefficient is accepted $\chi^2=0.0732$ (0.787).⁸ The coefficient of the premium indicates possible negative influence on long-run demand for money, however, it is not statistically insignificant; the imposition of zero restriction on this coefficient is accepted $\chi^2=3.111$ (0.211). Thus, the currency substitution type of argument does not seem to hold as a direct explanation of long-run demand for real money in this specification. Finally, the usual homogeneity restriction between real money and real income accepts $\chi^2=4.935$ (0.177). The derived demand relationship is written as:⁹

$$m - p = y - 0.999*\pi \quad (9)$$

(0.250)

The restricted demand relationship of Equation 9 reveals that the income elasticity of M2 is unity in consistence with the quantity theory hypothesis. The semi-elasticity of real money with respect to inflation is strongly negative. Inflation appears to dominate demand for money. However, the order of magnitude is comparable to that of other studies (see, for example, Adam, 1995; Ozmen, 1998). The restricted cointegrating vector could be recognized as an extended Cagan money demand. Inflation appears to play an important role in weakening the demand for real money in Sudan, especially in form of holdings in the domestic banking system. Hence, it could be argued that escalation of inflation over the review period has contributed to undermining the financial deepening process.

Feedback from the cointegrating relationship can be examined using a weak exogeneity test. The p-values of the test statistics for the weak exogeneity of money, price, real income, the premium and inflation rate indicate that weak exogeneity can be rejected for money and prices at 5% significance level and for inflation at 10% level, but not for real income and the premium (see last row Table 3). Therefore, if a simultaneous system of equations is to be used then the error correction terms should be introduced for money and price equations only, implying no feedback from excess money to output. The

result confirms the long-run neutrality of money and that there is no long-run Phillips-type trade-off between inflation and output, which is theory consistent.

Table 4 presents the results of cointegration analysis for the set of the variables (e , p and p^f) representing the external sector. Testing based on λ -max and trace statistics do not uniformly agree on the existence of one cointegrating vector spanned by data. The trace statistics accept the existence of at most one cointegrating vector among the included variables at 5% significance level while testing based on λ -max confirms the existence of one cointegrating vector at 10% significance level. Hence, the subsequent analysis assumes that one cointegrating vector is supported by data.

Table 4: Cointegration testing and analysis of the external sector¹

Eigenvalues	0.14412	0.11429	0.01864
Null hypothesis, Rank (P) = r:	r=0	r \leq 1	r \leq 2
λ -max:	19.92	15.53	2.408
95% critical values/ ² :	22.04	15.87	9.160
Trace-statistics:	37.863**	17.942	2.408
95% critical values/ ² :	34.87	20.18	9.16
Normalized cointegrating vectors:	<i>Constant</i>	<i>e</i>	<i>p p^f</i>
	-1.464	1	-0.963***
	5.989	(0.000)	(0.114)
			(1.477)
Restricted cointegrating vectors:	-4.173***	1	-0.916***
1.000			
	(0.453)	(0.000)	(0.046)
			(0.000)
χ^2 (1): 0.359 [0.540]			
	-4.021***	1	-1
	(0.766)	(0.000)	(0.000)
χ^2 (2): 4.089 [0.129]			
Weak exogeneity test statistics			
$\alpha_{2j}=0$ for each variable/ ³			
χ^2	5.646**	3.578**	1.697
p-value	[0.017]	[0.038]	[0.193]

Notes:

¹ The estimation period is 1970.1–2002.4. See Appendix A for the definition of the variables. VAR underlying the analysis included four lags of each variable, restricted constant, unrestricted seasonal centred dummies and two step dummies to account for the first devaluation of the official exchange rate in 1978.3 and the rise in inflow of oil revenues since 1999.1.

Asterisks ***, ** and * denotes significance at 1%; 5% and 10% levels respectively; numbers in parentheses are symptomatic standard errors and numbers in brackets are p-value of the χ^2 -statistics.

² Testing is based on Microfit; using the critical values at the 95% and 90% levels based on those computed by Pesaran et al. (2000) rather than the original Johansen–Juselius (1990) or Osterwald–Lenum (1992) values.

³ Weak exogeneity test statistics are examined under the assumption that $r = 1$ and so are asymptotically distributed as χ^2 (1) if weak exogeneity of the specified variable for the cointegrating vector is valid; significant [p-value] denotes rejection of weak exogeneity (see Doornik and Hendry, 1984).

The normalized cointegrating vector is shown in the eighth row in Table 4. All the estimated coefficients have the expected signs; the constant and the term on domestic price level are significant. The coefficient on foreign price is higher than unity and is statistically insignificant; accordingly, the symmetry and homogeneity restrictions implied by the purchasing power hypothesis are imposed. The results of the validity of these restrictions are reported in rows 12 and 13. As seen, the two restrictions accept at $\chi^2 = 0.359$ (0.54) and $\chi^2 = 4.089$ (0.129) respectively. Thus, it seems that the weaker version

of the PPP is supported by data over the sample period. The restricted cointegrating vector can be written as:

$$e + p - p^f = 4.021 \quad (10)$$

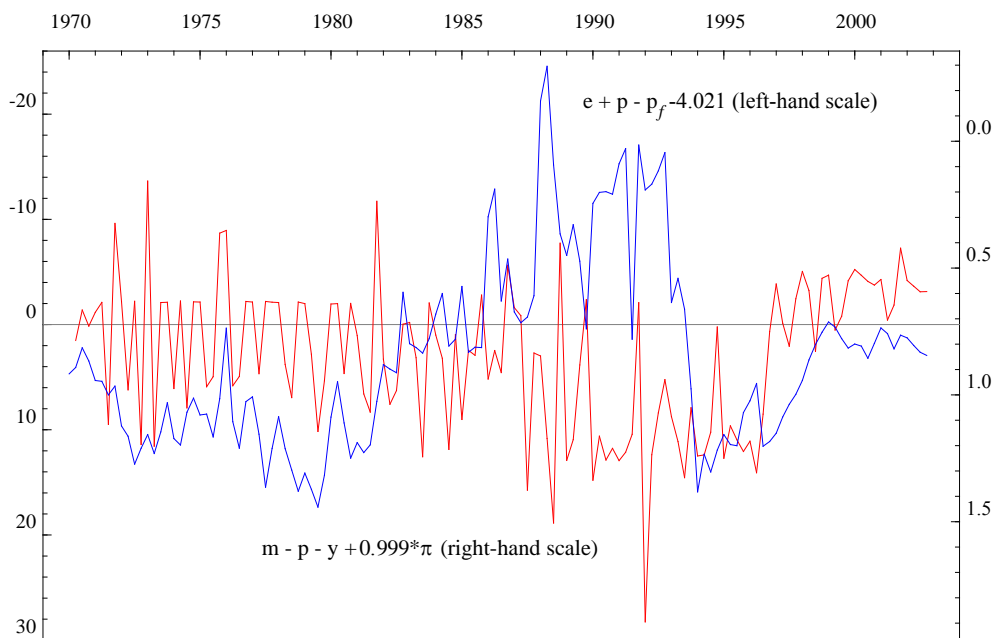
(0.31)

Following the standard interpretation, the significant constant implies that the long-term price differential between Sudan and its trading partners is attributable to the relatively high local non-traded costs; sales taxes and transport costs. The constant may also represent the missing fundamentals and a trend-like variable in the real exchange rate.

Testing for weak exogeneity hypothesis in this sub-system suggests that foreign price is weakly exogenous, while the hypothesis cannot be rejected for the exchange rate and domestic prices (see Table 7). This implies that these two variables move together to restore the long-run equilibrium following an exogenous shock which is consistent with the visual impression of Figure 4.

In sum, Johansen testing determined two cointegrating vectors in the sub-systems of variables. These relationships are interpreted as representing long-run real money demand and real effective exchange rate. In addition, restrictions based on economic theory are not rejected. This analysis assumes that the whole system is not fully simultaneous. The restricted cointegrating vectors are stationary according to the (ADF) test; Figure 6 shows their plots.

Figure 6: Restricted cointegrating vectors



Inflation model for Sudan

Inflation in Sudan, in the light of Equation 8, is determined by deviations from the equilibrium conditions — defined by two error correction terms $\alpha_1=[m-p-y+0.999*\pi]_{t-1}$, and $\alpha_2=[p^f+e-p-4.021]_{t-1}$ — augmented by the dynamics of contemporaneous and lagged difference of the system and relevant non-system variables. In particular, the interpolated income series is dropped. Instead, the quantity index for power consumption (pc) is included to proxy the level of economic activities. The unrestricted model is initially estimated with five lags of each variable, a constant term and seasonal centred dummies, along with two dummies accounting for impact of droughts during 1984.3–1985.1 and 1993.3–1994.3 on agricultural supply and the ensuing shortages of major food staples which are expected to increase inflation. The model is sequentially reduced by eliminating the coefficients on the variables with longer lags and small t-statistics. The F-test, the standard error of the regression and Schwartz criterion are used to check the model reduction process.

Table B2 in Appendix B presents the estimation results of the general model; the misspecification tests are reported in the table. The errors autocorrelation AR, ARCH error, non-normal error, heteroscedastic error and model misspecification are rejected. The unrestricted ECM, as an initial model, appears to perform reasonably well in terms of these tests. However, many coefficients are both economically and statistically insignificant; hence exclusion restrictions are used to simplify this general model into a parsimonious, economically interpretable and statistically significant ECM.

Table B3 in Appendix B presents a report of the model simplification progress; the statistics associated with the implied reductions are calculated for all model pairs and not only for adjacent models. The F-statistics for all model pairs indicate that none of the reduction steps is statistically significant, and the Schwartz criterion declines throughout these steps. In addition, the standard errors of the regression declined from 0.0675% in the general ECM to 0.06461% in the parsimonious model. Accordingly, it seems that the simplification process is statistically viable.

The reduced model is shown in Table 5; the misspecification tests are reported in the table. The errors autocorrelation AR, ARCH error, non-normal error, heteroscedastic error and model misspecification are rejected. The restricted ECM appears to perform well in terms of these tests and reasonably tracks the data. The estimated dynamic equation explains 61% of the variation in inflation. The coefficient on the error-correction term on the external sector, α_2 , is statistically significant and it implies that foreign prices, measured in domestic currency determine inflation in the long run.

Table 5: Estimation results of the restricted ECM for inflation in Sudan¹

Regressors	Estimated coefficients	Regressors	Estimated coefficients
Δp_{t-2}	0.165** (2.17)	Δp^f	0.431** (2.16)
Δm_2	0.175* (1.72)	$[p^f+e-p-4.021]_{t-1}$	0.038** (2.11)

continued next page

Table 5 Continued

Regressors	Estimated coefficients	Regressors	Estimated coefficients
$\Delta m2_{t-3}$	0.266** (2.61)	Constant	0.037* (1.71)
Δpc_{t-5}	-0.066** (-2.44)	sc1	0.001 (0.026)
$\Delta prem_{t-1}$	-0.078* (-1.90)	sc2	0.088** (4.67)
$\Delta prem_{t-5}$	-0.072** (-2.63)	sc3	0.105** (6.13)
Δe	0.113** (3.13)	D1	0.065* (1.70)
Δe_{t-1}	0.118** (2.02)	D2	0.082** (2.22)
Δe_{t-4}	0.067* (1.71)		

T=126 (1970Q1-2002Q4), R²=0.61, σ^2 = 0.06461 and DW= 2.11.

AR 1-5 F(5,104)=0.54308 [0.7432]: Test for serial autocorrelation of residuals (H0: no autocorrelation)

ARCH 1- 4 F(4,101) = 1.9120 [0.1142]: Test for autocorrelation conditional heteroscedasticity (H0: no heteroscedasticity).

Normality χ^2 (2) = 3.3750 [0.1850]: Test for normality of distribution of residuals (H0: normality).

χ^2 F(27,81) = 0.80866 [0.7283]: Test for heteroscedasticity (H0: no heteroscedasticity).

RESET F(1,108) = 0.14186 [0.7072]: Test for general misspecification of equation (H0: no misspecification).

¹ The variables sc1, sc2 sc3 are centred seasonal dummies, D1 and D2 are dummies over 1984.3–1985.1 and 1993.3–1994.3 respectively, taking the value of one over the specified quarters and zero otherwise. And t-statistics are in parenthesis, asterisks ** and * denote significance at 5% and 10% level respectively.

Source: Based on the result of general-to-specific search reported in Table B3.

Given that the error correction term affects both the price level and its rate of change, other things being equal, a 1% increase in foreign price tends to raise domestic price by 1% in the long run. The adjustment process towards this equilibrium is very slow; about 4% of disequilibrium is removed by adjustment in domestic price per quarter. In addition, a considerable short-run pass-through from exchange rate depreciation and foreign price increase affect the dynamics of inflation. The coefficient of the nominal effective exchange rate enters contemporaneously and with two lags suggesting that depreciation of the exchange rate causes inflation to rise¹⁰ and foreign price enters with a coefficient of 0.43. These results are similar to those obtained from cross-country studies, which indicate that a high inflationary environment, such as that in Sudan, leads to a high exchange rate pass-through to domestic price. For example, Choudhri and Hakura (2001) show, in a cross-country panel framework, that there exists a positive and significant correlation between inflation rates and the size of the pass-through. Other studies on CPI inflation find immediate and long-lasting impact of the external sector on inflation (see Robinson, 1998; Devereux, 2001).

Excessive money does not appear to determine inflation in the long run as the lagged error correction term on money market, α_1 , does not enter the restricted model. Nevertheless, the short-run money growth contemporaneously and lagged, has significant negative effects on inflation, with the sum of elasticities of inflation to money of 0.44%.

This finding is consistent with literature within the monetarist tradition. The standard explanation of high inflation is expansionary monetary policy. However the Sudanese monetary authority is limited on the use of the indirect instrument of monetary policy, due to accumulation of large excessive reserves in the banking sector over the review period, hence money growth is largely accommodating.

Results in Table 5 also show that liberalization of the foreign exchange market, reflected by reduced premium, hence negative $\Delta prem$, temporarily increased inflation. Thus, the immediate impact of decontrol of foreign exchange seems to contribute to revenue losses, because of removal of implicit export taxes rather than to revenue gains due to removal of importers subsidies from overvalued exchange rate. Therefore, the excessive short-run money growth largely reflects the liquidity impact of the fiscal operations driven by the attempts of the authorities to compensate for fall in revenue by an increase in monetary financing. Similar results are reported in Pinto (1991) for other comparator countries. Short-run money growth can also be explained by the attempts of the monetary authority to maintain constant real exchange rate in the face of the continually depreciating nominal exchange rate.

Inflation inertia¹¹ is found significant, lagged inflation enters with a coefficient of 0.17. The extent of inflation inertia is usually taken as measuring the consequences of indexation or inflation expectations. Price indexation has not been used in Sudan, but administrative price controls were common, especially before the 1992 liberalization. Hence, inertia largely reflects expectations, which in the presence of quantity and price controls might create self-enforcing expectations of increasing inflation. The reported evidence on deterioration in expectations implies that once inflation is initiated, it tends to have a life of its own. Calvo (1988), among others, notes that once the public expects high inflation to continue, it may become too costly for the government not to validate these expectations.

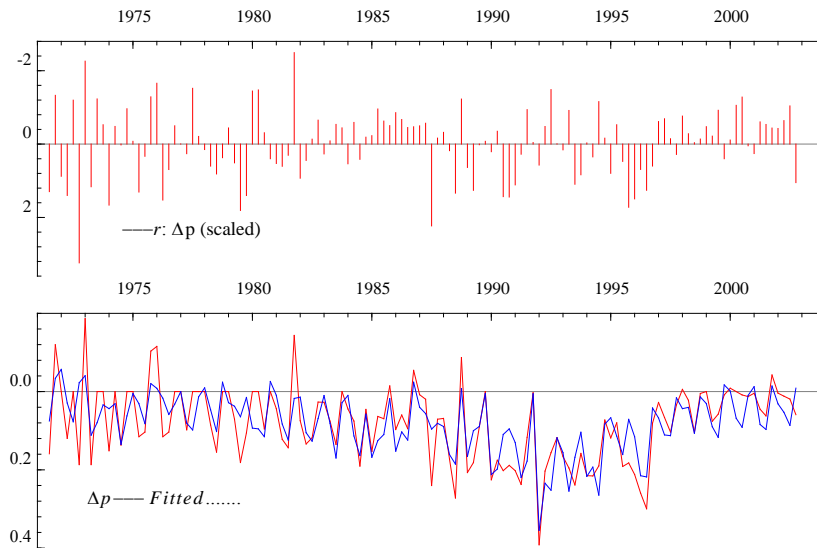
An attempt is made to control for the impact of real output growth on inflation. Power consumption is entered to proxy real GDP. The result shows that an upsurge in economic activities, as reflected in the growth of power consumption, exerts downward pressure on inflation. The two dummies entered to account for the impact of succession of severe droughts over 1984–1985 and 1993–1994 are also significant revealing that inflation is linked to large agricultural supply shocks due to crop failures.

Overall, it is evident that inflation in Sudan over the review period originated from the fiscal imbalances triggered by the aborted investment boom associated with the inflows of FDI in the mid 1970s and was propagated by monetary accommodation to the internal and external shocks and by its own dynamics.

The restricted ECM is estimated recursively with a default sample during 1970.1–2002.4 in order to examine its stability and the constancy of the estimated parameters. The results of the estimation are depicted in Figures 7–9. Figure 7 shows the plot of fitted inflation and actual inflation series together with the plot of the residuals standardized by their standard errors. These plots fairly confirm that the estimated ECM tracks the movements of inflation very closely. Figure 8 depicts the recursive estimates of the coefficients and their respective ± 2 standard errors. The plot suggests that all the estimated parameters are reasonably stable. Figure 9 pictures the one-step residuals and their ± 2 standard errors as well as Chow test statistics. As appears in the figure, almost all the residuals lie within the ± 2 standard error bands. The one step ahead and the breakpoint

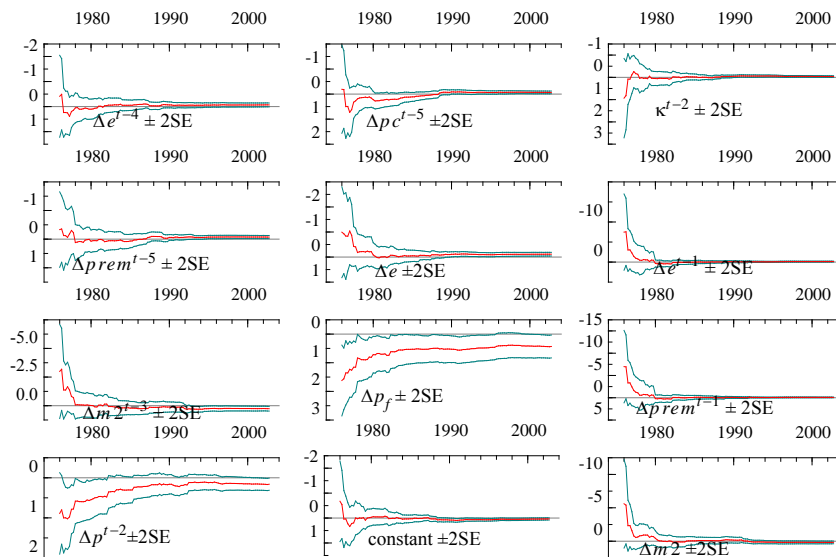
Chow statistics tests do not reject the stability of the parameters at 1% level. Accordingly, one can conclude that the stability of the model is acceptable. The subsequent section draws the main conclusions of the analysis and highlights their policy implications.

Figure 7: Fitted and actual inflation



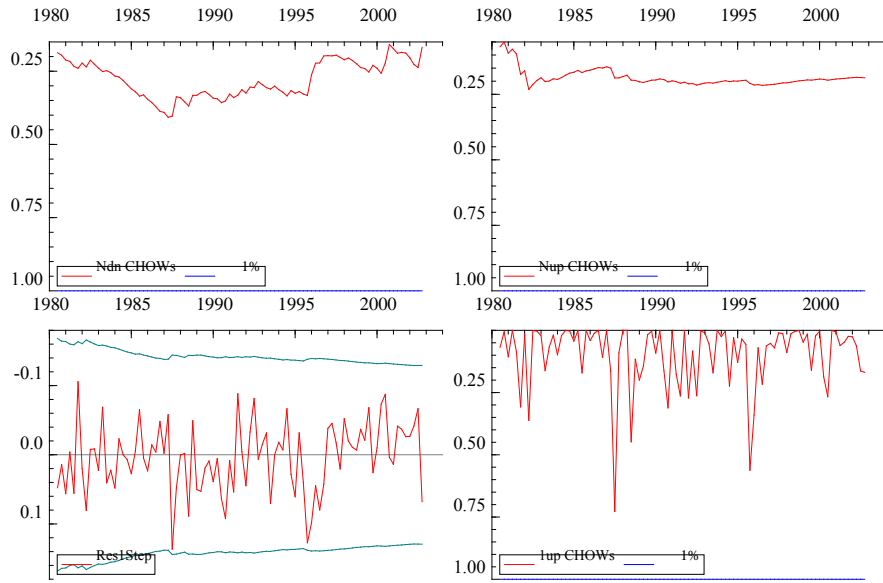
Source: Recursive estimates of the ECM default sample, 1970.1–2002.4

Figure 8: Recursive residuals



Source: Recursive estimates of the ECM default sample, 1970.1–2002.4

Figure 9: 1-step Chow tests and break-point Chow test



Source: Recursive estimates of the ECM default sample, 1970.1–2002.4

6. Conclusion and policy implications

Conclusion

This paper developed an analytical framework to shed light on the determinants of inflation in Sudan. The estimated model takes into consideration the long-run adjustments to disequilibria in the monetary and foreign exchange sectors, which together influence the evolution of inflation. The results of the estimation established a parsimonious statistically and economically viable ECM. However, dummies were used to allow the model pass testing at various stages of the estimation. The Sudanese economy had experienced structural changes during the review period, making it difficult for the short-term dynamics to fully gauge the impact of nominal rigidities. Hence, due to this limitation and because of the data shortcomings discussed earlier, the findings should be taken with care. Despite these caveats, the following main conclusions on the proximate determinants of inflation could be formulated.

First, the analysis of long-run relationships in the sub-systems of variables underlying the error correction modelling of the price equation confirms the existence of stable equilibrium in the monetary sector. The estimated coefficients suggest a strong influence of inflation in weakening the demand for real money in the long run, reflecting the negative impact of the administrative interventions in the return rates and assets yields structure. Furthermore, the cointegration test of the external sector equation confirms the existence of a weak long-run PPP relationship for Sudan.

Second, the disequilibrium in the external market appears to exert a long-run effect on inflation, and the response of inflation to this disequilibrium is very slow. Moreover, the short-run feedback from the nominal effective exchange rate and foreign prices movements to inflation are rather rapid. Rapid pass-through is attributable to the continuous devaluations during the review period, which led to some cost-push mechanisms from imported raw materials, particularly that the consumer industries in Sudan contain insignificant local value added. Continuous devaluations can also generate expectations of sustained future movements in the same direction and serve as an excuse for producers to adjust price upwards even for unconnected reasons.

Third, excess money does not seem to determine inflation in the long run. However, money growth significantly affects the dynamics of inflation. The short-run money growth could be attributed to the direct monetization of the fiscal deficit and to the liquidity impact of the exchange rate unification working through the quasi-fiscal deficit of the Central Bank. It could also be explained by the attempts of the monetary authority to maintain constant real exchange rate in the face of the continually depreciating nominal exchange rate.

Finally, the consecutive large agricultural supply shocks due to droughts are found to have a significant impact on the dynamics of inflation. In addition, deterioration in inflation expectations — within adaptive expectations/distributed lag specification — was found to be significant. The very high inflation episodes are fresh in the public memory and the internal and external shocks can exert a strong influence on the general price level.

The analysis in this paper can be further improved in a number of directions. First, it would be useful to analyse the dynamics of inflation through a system approach by addressing the acknowledged data limitations, which influenced the modelling strategy in this paper. Second, the precise price transmission mechanism in Sudan requires further investigations, especially in the context of the structural shifts, late in the sample period following the advent of the oil sector that could have influenced the process of price formation. Moreover, there is a need for analysis of the impact of these structural changes on the choice of monetary instruments and, more important, on transmission channels of monetary policy shocks. Finally, although the paper controls for the effects of droughts through dummies, further refined measures of these effects on agricultural production and food price inflation can be more informative.

Policy implications

The results of the model imply that both aggregate demand and supply side shocks play an important role in driving Sudanese inflation, which in turn is propagated by monetary accommodation to these shocks and by its own dynamics. The recent receding of inflation was made possible by commitment to macroeconomic stability following the IMF monitored programme initiated in 1997 and was further boosted by the advent of the oil sector. The empirical evidence on the temporary inflationary effects of foreign exchange decontrols suggests that sound fiscal management is a prime requisite for sustaining the success of the ongoing reform.

Despite the immediate inflationary effect of unification, the policy of defending the exchange rate reform, made possible by build-up of foreign reserves from oil revenues, contributed to bring inflation down. But, as suggested by the analysis, the exchange rate-based stabilization may not be sustainable in the long run due to the sluggish adjustment of the real exchange rate towards equilibrium. Even in the face of the presence of rigidities, sectoral disequilibria and inertial factors, which often result in accommodative monetary policy, the authorities need to fully develop sound indirect monetary instruments to supplement the policy of exchange rate anchoring.

The stabilization experiences in Latin America showed that, in situations of fiscal indiscipline, as in the case of Sudan during most of the review period, flexible exchange rates provide more fiscal discipline (see Tornell and Velasco, 1995). For example, under money-based anchoring of inflation the fiscal authority pays for high deficit today by enduring high inflation both today and in the future (see Sargent and Wallace, 1981). In contrast, with exchange anchoring the bulk of the fiscal burden is pushed to the future. Although the study does not control for the short-run transmission channels of monetary policy, it appears that money supply grows in response to exchange rate depreciation, which in turn has a negative impact on inflation. If this is the case, the design of monetary plan for inflation control, can be based on a hybrid regime of exchange rate and

monetary targeting. This strategy can furnish a base for greater exchange rate flexibility leading to more fiscal discipline and could lay the base for full inflation targeting. Such policy can easily be adopted to keep inflation under control while maintaining external competitiveness.

The main problem with this strategy is that the authorities may have discretion to move from one target to the other. The conflict between rule and discretion is not easy to resolve, however, building and maintaining reputation and credible commitment are crucial elements for any policy. It is arguable that Sudan has a history of monetary policy errors; developing experience in gauging the effects of monetary policy on inflation is of cardinal importance, especially in the context of the currently operating Islamic banking system.

Policies for GDP growth and low inflation in Sudan need to ameliorate the impact of the supply shocks. As shown, supply shocks driven by droughts are important determinants of inflation. Agriculture makes a major contribution to the economy and is the source of food staples but is subject to the vagaries of the weather. Hence, a serious national policy of buffer stock of staple food can ensure price stability. Obviously, additional measures to enhance agricultural supply and productivity are crucial for GDP growth and low inflation.

Notes

1. Brown (1989) referred to this SAP as an example of failure and of breaching the rule of uniformity in commitment to the standard IMF/World Bank conditionality.
2. These policy failures were not exclusively Sudanese. Similar policy failures and macro crises were documented for the sub-Saharan African countries during the 1970s and 1980s (see, for example, Elbadawi, 1992b; McKinley, 2001 and the references cited therein).
3. The inflow of FDI partially relinquished the negative effects of the economic embargo on Sudan since 1997.
4. In general a variable is said to be integrated of order n , written $I(n)$, if it needs differencing n times to render stationarity, that is, to be integrated of order zero, written $I(0)$.
5. See Elbirt and Domac (1998) and the literature cited therein.
6. See Dickey and Fuller (1979) for discussion and presentation of the test. However, it is known that ADF test has low power for the testing in small samples (see, for example, Pesaran and Pesaran, 1997).
7. See Phillips and Perron (1988) for discussion and presentation of the test.
8. Henceforth, the calculated chi-square statistic is followed by the symptomatic p-value in parentheses.
9. Henceforth, numbers in parentheses below the text equations are asymptotic standard errors.
10. From the definition of the nominal effective exchange rate used in this paper, a positive sign indicates depreciation.
11. Inflation inertia refers to the fact that current inflation depends on its past value.

References

- Abdel-Rahman, A.M. 1997. "Determinants of inflation and its instability in Sudan 1970–94". Working Paper No. 9721. Economic Research Forum, Cairo, Egypt.
- Abdel-Rahman, A.M. 1994. "Adjustments and error corrections in money demand during high inflation: A case study of Sudan". Working Paper No. 9419. Economic Research Forum, Cairo, Egypt.
- Abdella, M.Z. 1994. "The theoretical basis of the criteria for determination of the optimal stock of money". *El-Mugtasid Journal*, 15: 11–22. (In Arabic.)
- Adam, C. 1995. "Financial liberalization and inflation dynamics: Some evidence from Zambia". *World Development*, 23: 735–50.
- Adam, C. 1992. "On the dynamic specification of demand of money in Kenya". *Journal of African Economies*, 1: 233–70.
- Aghevli, B.B. and M.S. Khan. 1978. "Government deficits and the inflationary process in developing countries". *IMF Staff Papers*, 25: 383–416.
- Bank of Sudan, (BoS). "Bank of Sudan's annual report". Various issues, (in English, 1990-02 in Arabic). The Republic of Sudan, BoS, Khartoum.
- Bank of Sudan. "Foreign exchange developments: The official and parallel markets". Statistics Directory memos, (in Arabic). The Republic of Sudan, BoS, Khartoum.
- Brown, R. 1989. "The rationale and effects of the IMF stabilization programme in Sudan". In K. Bonnie Campbell, ed., *Political Dimensions of the International Debt Crisis*. MacMillan.
- Calvo, A. 1988. "Servicing the debts: the role of expectations". *American Economic Review*, 78: 641–67.
- Central Bureau of Statistics (CBS), Sudan. "National income accounts report". Various issues, (in English, 1990-02 in Arabic), The Republic of Sudan, CBS, Khartoum.
- Central Bureau of Statistics, Sudan. "Consumer price indices bulletin". Various issues, (in Arabic), The Republic of Sudan, CBS, Khartoum.
- Chhibber, A. 1992. "Exchange reforms, supply response, and inflation in Africa". In I. Goldin and L.A. Winters, eds., *Open Economies: Structural Adjustment and Agriculture*. Cambridge: Cambridge University Press.
- Choudhri, E.U. and D.S. Hakura. 2001. "Exchange rate pass-through to domestic prices: does the inflationary environment matter?" IMF Working Paper No. 194. International Monetary Fund, Washington, D.C.
- Devereux, M.B. 2001. "Monetary policy, exchange rate flexibility, and exchange rate pass-through". In Bank of Canada, 2001, ed., *Revisiting the Case for Flexible Exchange Rates*. Ottawa, Ontario: Bank of Canada.
- Dickey, D.A. and W.A. Fuller. 1979. "Distribution of the Estimators for Autoregressive time Series with a unit root". *Journal of the American Statistical Association*, 74: 427–31.
- Domowitz, I. and I. Elbadawi. 1987. "An error correction approach to money demand: The case of Sudan". *Journal of Development Economics*, 26: 257–75.

- Doornik, A. and D.F. Hendry. 1984. *Pcgive 8.0 Interactive Econometric Modeling of Dynamic Systems*. Institute of Economics and Statistics, University of Oxford. Oxford: University of Oxford.
- Durevall, D. and N.S. Ndung'u. 2001. "A dynamic model of inflation for Kenya 1974–1996". *Journal of African Economies*, 10(1): 91–124.
- Duesenberry, J. 1950. "The mechanics of inflation". *Review of Economics and Statistics*, 32(2): 144–9.
- Elbadawi, I. 1994. "The expatriate workers' remittance, parallel foreign exchange market and macroeconomic performance in Sudan". *Journal of African Economies*, 3(3): 481–512.
- Elbadawi, I. 1992b. "Real overvaluation, terms of trade shocks and the cost to agriculture in sub-Saharan Africa". Working Paper Series No. 831. Washington, D.C: The World Bank.
- Elbadawi, I. 1992a. "Macroeconomic management and the black market in foreign exchange in Sudan". Working Paper Series No. 859. Washington, D. C: The World Bank.
- Elbirt, C. and I. Domac. 1998. "The determinants of inflation in Albania". World Bank Working Paper No. 1930. The World Bank, Washington, D.C.
- Fischer, S., R. Sahay and C.A. Végh. 2002. "Modern hyper-and high inflations". *Journal of Economic Literature*, 40(3): 838–80.
- Harberger, A. 1963. "The dynamics of inflation in Chile". In C.F. Christ, M. Friedman, L.A. Goodman, Z. Griliches, A.C. Harberger, N. Liviatan, J. Mincer, Y. Mundlak, M. Nerlove, D. Patinkin, L.G. Telser and H. Theil, 1963, eds., *Measurements in Economics: Studies Mathematical Economics and Econometrics in the Memory of Yehundo Grunfield*. Stanford University Press, Stanford, California.
- Hendry, D.F. 1995. *Dynamic econometrics*. Oxford: Oxford University Press.
- Hussain, M.N. 1986. "Causes of inflation and the devaluation of the Sudanese pound". In R. Zaki, ed., *Inflation in the Arab World*. El-Kuwait: Arab Planning Institute.
- IFS. *International Financial Statistics*. Various issues. International Monetary Fund, Washington, D.C 20431, U.S.A.
- Johansen, S. 1988. "Statistical analysis of cointegrating vectors". *Journal of Economic Dynamics and Control*, 12(2/3): 231–54.
- Johansen, S. and K. Juselius 1990. "Maximum likelihood estimation and inference on cointegration with applications to the demand for money". *Oxford Bulletin of Economics and Statistics*, 52: 169–210.
- Jha, R. 1994. *Macroeconomics for developing countries*. First edition, Routledge, 29 West 35th Street, New York, NY 10001.
- Kireye, A. 2001. "Financial reforms in Sudan: Streamlining banks intermediation". IMF Working Paper No. WP/01/53. International Monetary Fund, Washington, D.C.
- Kuijs, L. 1999. "Determinants of inflation, exchange rate and output in Nigeria". IMF Working Paper No. WP/99/160. International Monetary Fund, Washington, D.C.
- London, A. 1989. "Money, inflation and adjustment policy in Africa: some further evidence". *The African Development Review*, 1: 87–111.
- Liu, O. and O.S. Adedji. 2000. "Determinants of inflation in the Islamic Republic of Iran—A macroeconomic analysis". IMF Working Paper No. WP/00/127. International Monetary Fund, Washington, D.C.
- Mahrn. H.A. and Y.A. Gangi. 1996. "Causes of inflation in the Sudan 1970–1991". *Eastern Africa Social Science Research Review*, 12(2): 13–24.
- McKinley, T. 2001. "Introduction to macroeconomic policy, growth and poverty reduction". In T. McKinley, ed., *Macroeconomic Policy, Growth, and Poverty Reduction*, New York: Palgrave.
- Ministry of Energy and Mining, (MEM). "Sudan energy handbook". Various issues, Research Department. The Republic of Sudan, MEM, Khartoum.
- Mirghani, M. 1996. "Time series of cereals and oil crops (1970–1996)". Ministry of Agriculture and Forestry. Khartoum, Sudan. NPUB, 1996.
- Morris, S. 1995. "Inflation dynamics and the parallel market for foreign exchange". *Journal of Development Economics*, 46: 295–317.

- Nachega, J.C. 2001. "Financial liberalization, money demand and inflation in Uganda". IMF Working Paper No. WP/01/118. International Monetary Fund, Washington, D.C.
- Ndung'u, N.S. 1993. "Dynamics of inflationary process in Kenya". *Ekonomiska Studier* No. 47. Department of Economics, Cöterborg University, Sweden.
- Ndung'u, N. S. 1994. "A monetary model of inflation: Kenyan case". *The African Development Review*, 6(2): 109–36.
- Osterwald-Lenum, M. 1992. "A note with quantiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistics". *Oxford Bulletin of Economics and Statistics*, 54: 461–71.
- Ozmen, E. 1998. "Is currency seigniorage exogenous for inflation tax in Turkey?" *Applied Economics*, 30: 545–52.
- Pesaran, M.H., Y. Shin and R.J. Smith. 2000. "Structural analysis of vector error correction models with exogenous I(1) variables". *Journal of Econometrics*, 97(2): 293–343.
- Pesaran, M.H. and B. Pesaran. 1997. *Microfit 4.0*. Oxford University Press 1997.
- Phillips, P.C.B. and P. Perron 1988. "Testing for a unit root in time series regression". *Biometrika*, 75: 335–46.
- Pick's Currency Year Book, (1970.1-79.4). Various issues. Pick Publishing Corporation, New York
- Pick's World Currency Report, (1980.1-1984.1). Various issues. New York Publishing Corporation
- Pinto, B. 1991. "Black markets for foreign exchange, real exchange rates and inflation". *Journal of International Economics*, 30: 121–36.
- Ramcharan, R. 2002. "Money, meat and inflation: Using price data to understand an export shock in Sudan". IMF Working Paper No. WP/02/84. International Monetary Fund, Washington, D.C.
- Robinson, W. 1998. "Forecasting inflation using VAR analysis". In S. Kim and T. Agebeyegbe, eds., *Econometric Modelling of Issues in Caribbean Economics and Finance*. CCMS: St. Augustine, Trinidad and Tobago.
- Ross, K. 2000. "Post stabilization inflation dynamics in Slovenia". *Applied Economics*, 32.2:135-149. Corrected
- Sacerdoti, E. and Y. Xiao. 2001. "Inflation dynamics in Madagascar, 1970–2000". IMF Working Paper No. WP/01/168. International Monetary Fund, Washington, D.C.
- Safi-Eldin, A. 1976. "The impact of inflation on socio-economic development of Sudan". ERC 1976 paper series. Economic and Research Council, Khartoum.
- Sargent, T, and N. Wallace. 1981. "Some unpleasant monetarist arithmetic". *Federal Reserve Bank of Minneapolis Quarterly Review*, 5: 1–17.
- Saini, K.G. 1982. "The monetarist explanation of inflation: the experience of six Asian countries". *World Development*, 10(10): 871–84.
- Sowa, N.K. and J.K. Kwakye. 1993. *Inflationary Trends and Control in Ghana*. AERC Research Paper No. 22. African Economic Research Consortium, Nairobi.
- Suliman, K.M. 1989. "Growth, financial deepening and self-generating inflation in Sudan 1960–1982". Unpublished Masters dissertation, University of Manchester.
- Tegene, A. 1989. "The monetarist explanation of inflation: the experience of six African countries". *Journal of Economic Studies*, 16(1): 5–18.
- Teklu, T., J. von Braun and E. Zaki. 1991. "Drought and famine relationships in Sudan: policy implications". Research Report 88. International Food Policy Research Institute, Washington, D.C.
- Tornell, A. and A. Velasco. 1995. "Money-based versus exchange rate-based stabilization with endogenous fiscal policy". NBER Working Paper 5300. National Bureau of Economic Research, Cambridge, Massachusetts.
- Vogel, R.C. 1974. "The dynamic of inflation in Latin America 1950–1969". *American Economic Review*, 64: 102–114.
- World Currency Year Book (1984.1-1993.4). Various issues. Brooklyn, New York: International Currency Analysis.

Appendix A: Definition of variables and data sources

- Y*: is income measured by output GDP (source: Central Bureau of Statistics, Sudan).
- P*: is the consumer price index, the weighted average indices of the lower middle and upper income groups, 1990=100, (source: IFS and Central Bureau of Statistics, Sudan).
- M1*: is nominal narrow money, (source: IFS).
- M2*: is nominal broad money, (source: IFS).
- Parallel exchange rate*: is period average, defined as a unit of the domestic currency per US dollars (Source: Pick Currency Year Book during the period 1970.1-1993.4; the relevant pages were provided by Jantz, R.; Alexander Library, Rutgers University and over 1994.1-2002.4 compiled from Bank of Sudan).
- Official exchange rate*: is period average, defined as a unit of the domestic currency per US dollars (Source: Bank of Sudan).
- PREM*: is the parallel market premium for foreign exchange rate, defined as the ratio of the parallel exchange rate to the official exchange rate.
- E*: is own calculation of the nominal effective exchange rate index, computed as
- $$E_{it} = \sum_{j=1}^n w_j \frac{E_{ijt} * 100}{E_j 1985}$$
- where w_{ij} is the trade share of Sudan (denoted by country i) with respect to its j^{th} trading partners, with $\sum_{j=1}^n w_j = 1$, and E_{it} is the index of effective exchange rate of country i . E_{ijt} is the market rate of exchange of the i^{th} currency in terms of the j^{th} currency, with the dollar being used as a numeraire currency. $E_{ij} 1985$ is the average value of E_{ij} over the quarters in 1985 and n is the

number of trading partners. From this definition it follows that an increase in the index records depreciation. The main trading partners for Sudan considered were: United Kingdom, Japan, Slovak Republic, Thailand, Turkey, Saudi Arabia, India, Singapore, Egypt and USA.

P^f : is own calculation of the foreign price index of Sudan, (denoted by country i), defined as the weighted average of the CPIs of

$$P_i^f = \sum_{j=1}^n w_j p_j$$

its main trading partners computed as P_i^f . The same weights and trading partners, used in the calculation of E are applied in the computation of this index.

PC : is an index of power consumption measured by the quantity consumed of diesel, gasoline, benzene and gas (in thousand metric tons of oil equivalent). (Source: The Sudanese Ministry of Energy and Mining).

π : is constructed as: $100*(P - P(-1))/P(-1)$.

Appendix B: Regression results

Table B1: Test and selection of the VAR order¹

Lag (p)	The monetary sector			The external sector		
	AIC	SBC	LR	AIC	SBC	LR
12	251.66	-199.95	NA	424.98	253.55	NA
11	256.80	-160.07	18.02 [0.84]	425.60	266.72	1 1 . 0 2
[0.27]						
10	243.54	-138.59	52.74 [0.37]	430.91	284.56	1 5 . 8 9
[0.60]						
9	231.02	-116.37	86.80 [0.17]	431.07	297.27	2 7 . 5 2
[0.44]						
8	230.49	-82.16	109.96 [0.23]	432.59	311.34	3 7 . 3 7
[0.41]						
7	227.15	-50.76	135.69 [0.24]	436.27	327.56	4 4 . 3 8
[0.50]						
6	231.54	-11.61	154.37 [0.39]	428.87	332.71	6 5 . 9 7
[0.13]						
5	226.54	18.11	181.61 [0.35]	433.52	349.89	7 1 . 7 1
[0.21]						
4	228.54	54.85	202.49 [0.44]	430.42	359.34	8 7 . 6 3
[0.11]						
3	236.65	97.69	217.82 [0.62]	431.89	373.35	9 7 . 5 5
[0.10]						
2	232.30	128.09	244.45 [0.59]	428.86	382.87	1 1 3 . 3 9
[0.05]						
1	166.07	96.59	327.25 [0.017]	430.03	396.58	1 2 3 . 7 0
[0.05]						
0	-631.81	-666.55	1074.1 [0.000]	-183.61	-204.51	9 4 3 . 5 0
[0.001]						

Notes:

1. AIC is Akaike information criteria; SBC is Schwartz Bayesian criteria and LR is the log-likelihood ratio statistics.

LR is determined for the VAR(K) process as $LR_{K,k} = (n - m) [\log |\hat{\Sigma}_k| - \log |\hat{\Sigma}_{K-1}|]$ $k=0,1,2,\dots,K-1$ and denotes for each lag k the sequential adjusted LR-test statistic, where n is the sample size and m is the number of parameters per equation under the alternative, $K(K > k)$. The p-value is in brackets, significant values imply rejection (see Pesaran and Pesaran, 1997). Twelfth lagged VAR is estimated for each sector. VAR for the monetary sector includes the variables m2, p, y, g and prem along with a constant, seasonal centred dummies and a step dummy for the foreign exchange liberalization taking the value of one over 1992.2 and zero otherwise. The external sector VAR includes e, p and pf, and a constant, seasonal centred dummies and two step dummies to account for the first devaluation of the official exchange rate in 1978.3 and the rise in inflow of the oil revenues since 1999.1. The estimation period is 1970.1–2002.4. See Appendix A for the definition of the variables.

Table B2: Estimation results of the general ECM for inflation in Sudan¹

Regressors	Estimated coefficients	regressors	Estimated coefficients
Δp_{t-1}	-0.225 (-0.747)	"e	0.123* (1.74)
Δp_{t-2}	0.194* (1.71)	"e _{t-1}	0.220** 2.71
Δp_{t-3}	0.020 (0.180)	"e _{t-2}	0.0168 (0.203)
Δp_{t-4}	-0.059 (-0.521)	"e _{t-3}	-0.112 (-1.43)
Δp_{t-5}	0.067 (0.594)	"e _{t-4}	0.127 (1.45)
Δm_2	0.0767 (0.556)	"e _{t-5}	0.115 (1.38)
$\Delta m_{2,t-1}$	-0.0298 (-0.212)	"p ^f	0.316 (1.23)
$\Delta m_{2,t-2}$	0.182 (1.24)	"p ^f _{t-1}	-0.083 (-0.330)
$\Delta m_{2,t-3}$	0.309** (1.96)	"p ^f _{t-2}	0.226 (0.887)
$\Delta m_{2,t-4}$	-0.157 (-0.987)	"p ^f _{t-3}	0.127 (0.491)
$\Delta m_{2,t-5}$	-0.111 (-0.766)	"p ^f _{t-4}	-0.088 (-0.366)
Δpc	0.029 (0.900)	"p ^f _{t-5}	-0.140 (-0.582)
Δpc_{t-1}	-0.044 (-1.30)	$[m-p-y+0.999*\Delta]_{t-1}$	0.002 (0.506)
Δpc_{t-2}	-0.007 (-0.178)	$[p^f+e-p-4.021]_{t-1}$	0.024 1.02
Δpc_{t-3}	0.005 (0.127)	Constant	0.035 (1.06)
Δpc_{t-4}	-0.005 (-0.155)	sc1	-0.014 (-0.477)
Δpc_{t-5}	-0.059* (-1.68)	sc2	0.078** (2.66)
$\Delta prem$	-0.015 (-0.254)	sc3	0.097** (3.86)
$\Delta prem_{t-1}$	-0.127** (-2.05)	D1	0.060 (1.43)
$\Delta prem_{t-2}$	0.043 (0.685)	D2	0.089* (1.80)

continued next page

Table B2 Continued

Regressors	Estimated coefficients	regressors	Estimated coefficients
Δprem_{t-3}	0.105* (1.70)		
Δprem_{t-4}	-0.074 (-1.10)		
Δprem_{t-5}	-0.129** (-2.03)		

T=126 (1970Q1-2002Q4), $R^2=0.67$, $\sigma^2=0.0675$ and DW=1.9.

AR 1-5 $F(5,78) = 1.8561$ [0.1117]: Test for serial autocorrelation of residuals (H_0 : no autocorrelation)

ARCH 1-4 $F(4,75) = 0.66589$ [0.6177]: Test for autocorrelation conditional heteroscedasticity (H_0 : no heteroscedasticity).

Normality $\chi^2(2) = 1.6869$ [0.4302]: Test for normality of distribution of residuals (H_0 : normality).

Xi^*Xj $F(79,3) = 0.062995$ [1.0000]: Test for heteroscedasticity (H_0 : no heteroscedasticity).

RESET $F(1,82) = 0.027521$ [0.8686]: Test for general misspecification of equation (H_0 : no misspecification).

¹The variables sc1, sc2 sc3 are centred seasonal dummies, D1 and D2 are dummies over 1984.3–1985.1 and 1993.3–1994.3 respectively, taking the value of one over the specified quarters and zero otherwise. And t-statistics are in parenthesis, asterisks ** and * denote significance at 5% and 10% level respectively. The estimation period is 1970.1–2002.4. Appendix A contains the definitions and sources of the variables.

Table B3: Summary of model reduction progress^{1,2}

Model	Null hypothesis			Maintain hypothesis (model number)						
	p	σ^2	SC	1	2	3	4	5	6	7
1	43	0.0675	-1.32	-						
↓				-						
2	39	0.0671	-1.43	0.736						
↓				[0.570] (4,83)						
3	34	0.06597	-1.61	0.540	0.389					
↓				[0.841] (9,83)	[0.855] (5,87)					
4	29	0.06533	-1.77	0.561	0.497	0.627				
↓				[0.887] (14,8)	[0.887] (10,87)	[0.680] (5,92)				
5	24	0.06521	-1.91	0.640	0.623	0.765	0.920			
↓				[0.864] (19,83)	[0.849] (15,87)	[0.662] (10,92)	[0.471] (5,97)			

continued next page

Table B3 Continued

Null hypothesis				Maintain hypothesis (model number)						
Mo- del	p	σ^-	SC	1	2	3	4	5	6	7
6	20	0.06520	-2.043	0.624	0.608	0.709	0.770	0.585		
↓				[0.899] (23,83)	[0.891] (19,87)	[0.759] (14,92)	[0.643] (9,97)	[0.674] (4,102)		
7	18	0.06469	-2.10	0.638	0.627	0.726	0.786	0.676	0.871	
↓				[0.898] (25,83)	[0.888] (21,87)	[0.761] (16,92)	[0.654] (11,97)	[0.669] (6,102)	[0.421] (2,106)	
8	17	0.06461	-2.13	0.648	0.641	0.739	0.801	0.719	0.913	0.999
↓				[0.893] (26,83)	[0.882] (22,87)	[0.755] (17,92)	[0.647] (0,647)	[0.655] (7,102)	[0.437] (3,106)	[0.319] (1,108)

¹ Seven exclusion restrictions were imposed sequentially on the general ECM, the following eight models were obtained sequentially: model 1 is the unrestricted ECM reported in Table B2, model 2 is model 1 excluding the fifth lag on Δp , $\Delta m2$, Δe and $\Delta p'$, model 3 is model 2 excluding the fourth lag on Δp , $\Delta m2$, $\Delta p'$, Δpc and $\Delta prem$, model 4 is model 3 excluding third lag on Δp , $\Delta p'$, Δpc , Δe and $\Delta prem$, model 5 is model 4 excluding second lag on $\Delta m2$, $\Delta p'$, Δpc , Δe and $\Delta prem$; model 6 is model 5 excluding first lag on Δp , $\Delta p'$, Δpc and $\Delta m2$, model 7 is model 6 excluding Δpc and $\Delta prem$ and model 8 is model 7 excluding the coefficient on lagged error correction term on the monetary equilibrium condition. α_1 .

² The first four columns report the model number, the number of estimated parameters, p , the regression standard errors, σ^- (in percentage) and the Schwarz Criterion, SC. The three entries within a given block of numbers in the last seven columns are: F -statistic for testing the null hypothesis (indicated by the model number to the left of the entry) against the maintained hypothesis (indicated by the model number above the entry), the tail probability associated with the F -statistic value (in square brackets) and the degrees of freedom for F -statistic (in parentheses).

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Abstract

This paper examines the main determinants of inflation in Sudan, using quarterly data during 1970–2002, by applying cointegration and error correction modelling. The analytical framework views inflation as responding to disequilibria in the internal and external sectors of the economy augmented by the dynamics of the variables determining the equilibrium relationships in these sectors. The results reveal that the external sector's disequilibrium matters for price growth. This signifies a strong long-run impact of foreign price and exchange rate on inflation, with slow adjustment to equilibrium. Inflation is also found to be perpetuated by feedback from the short-run nominal exchange rate, foreign price, drought shocks and deterioration in expectations. Money growth does not appear to affect inflation in the long run, but the elasticity of inflation to the short-run money supply is significant and relatively high. The findings suggest that a monetary-cum-exchange rule is more suitable for inflation control while maintaining external competitiveness. Fighting inflation also depends on the ability of policy to reduce the effects of supply shocks emanating from droughts and foreign price movements.

Key words: *Inflation, money demand, exchange rate, purchasing power parity, cointegration analysis, Sudan*

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