The Central Bank of Sudan

Determinants of Inflation in Sudan: An Empirical Analysis

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CONTENTS

ABSTRACT

The objective of this study is to identify the fundamental determinants of inflation and examine the direction of causality among the variables in Sudan over period 1970-2008. The model estimation results show that all the variables carry correct signs and significant at least at the 5% level except the coefficient of nominal exchange rate. The coefficient of foreign inflation is the largest, followed by that of real output, implying that these are the most influential determinants of domestic inflation in the Sudan in the long run. The results of the error-correction model show that the coefficient of second lag of nominal exchange rate, first lag of real output and first lag of foreign inflation carry the correct signs. The coefficient of the error-correction term is significant at the 1% level and correctly signed, which suggests that about 21% of total disequilibrium in inflation was being corrected in each year over period 1970-2008. Furthermore, the results of the Granger causality test indicate a bi-directional causal effect between nominal exchange rate and money supply in addition to unidirectional causal effects running from domestic inflation to nominal exchange rate and real money supply, from real output to domestic inflation and nominal exchange rate, and from foreign inflation to domestic inflation, nominal exchange rate, real money supply and real output. Finally, although about 25.72% of forecast error variance in domestic inflation is explained by its own innovation, foreign inflation alone explains approximately half (49%) of total forecast error variance in domestic inflation.

1. INTRODUCTION

The dynamic interaction among monetary growth, exchange rate changes and inflation is a major cause of concern in many developing economies. Flexible exchange rate regimes are strongly believed to be independent source of inflation. Flexible exchange rate systems have a tendency of causing dynamic instability in which the exchange rate constitutes an independent source of inflation although Bilson (1979) argued that exchange rates simply respond more rapidly than prices to changes in the underlying economic conditions. Although changes in exchange rates appear to be the cause of subsequent movements in prices and wages, Bilson believed that the ultimate and probable cause of both the exchange rate depreciation and domestic inflation is expansionary monetary policy. As asset prices (exchange rates and interest rates) are determined in auction markets while wages and commodity prices are set on contractual bases, changes in the underlying economic conditions are first reflected in asset market, creating an impression that asset prices cause changes in prices.

An exogenous monetary expansion leads to a long-run cumulative causation among macroeconomic variables. Specifically, domestic monetary expansion exerts a downward pressure on domestic interest rates which initiates an incipient capital outflows as investors reshuffle their portfolios. This process in turn, raises domestic prices of imported goods which results in subsequent fall in domestic real money balances and wages. If the monetary authorities persistently accommodate the money demand by expanding money supply as a result of exchange rate depreciation, a new round of exchange rate depreciation is set in motion, resulting in a rise in domestic price level, resulting in fall in real money balances and wages. If this accommodative monetary policy is adopted and maintained as usually the case in many developing countries, the exchange rate-inflation spiral will generate and sustain a notorious vicious dynamic causal process of rising prices and depreciating exchange rate that can affect the economy in the long run.

This dynamic exchange rate-inflation interaction has always been a source of baffling confusion among policy makers when making a choice as to whether to stabilize the domestic price level or exchange rate system. As fluctuations in foreign exchange rates can be easily transmitted through import prices and input costs as countries are intertwined by international trade and investment, economic disturbances in one country can impose unpredictable repercussions on the economies of trading partners. Consequently, domestic consumers and foreign exchange markets can be adversely affected. For this reason, it is important to conduct an empirical study that analyzes the underlying economic conditions in an economy in order to provide a complete analysis of the nature of the dynamics among inflation, exchange rate depreciation and monetary growth.

The objective of this study is to investigate the fundamental determinants of inflation and identify the direction of causality among the determinants in Sudan by applying the cointegration and error-correction model on annual data over period 1970-2008. The application of Johansen cointegration system (Johansen and Juselius, 1988 and Johansen, 1990) has a number of advantages over other alternative methods (e.g., Engle and Granger, 1987). In addition to fully capturing the properties of the underlying data, Johansen method provides test statistics for the total number of cointegrating vectors and allows for testing restricted forms of the cointegrating vectors. Consequently, the results of the Johansen-Juiselus approach are invariant to the direction of normalization adopted since it treats each variable as an endogenous variable symmetrically. The technique also allows the detection of the presence or absence of equilibrium relationships among the variables.

A study on inflation such as this is critically important for a number of reasons. First, high inflation distorts income distribution that puts fixed income recipients at a disadvantage as their incomes may not cope with continually rising prices. Only individuals whose incomes rise faster than inflation experience rising real incomes. Secondly, high rates of inflation tend to encourage high

spending and borrowing at the expense of savings. In countries with accelerating inflation rates, consumers tend to increase spending at current prices as consumers expect prices to rise soon. Saving is adversely affected during high inflation as borrowers benefit at the expense of lenders when real interest rates fail to keep pace with inflation.

Thirdly, since investment can take place only in presence of saving, by discouraging saving, inflation diverts important resources from investment to consumption and speculative activities. Therefore, a fall in investment resulting from low saving will likely slow the growth of GDP as investment is an integral part of GDP, consequently, triggering a reduction in employment. In addition, inflation can distort the function of price as a market signal and this undermines efficient resource allocation. As a result, planning and investment decisions become more difficult to predict since firms are uncertain about the future course of price and costs during inflation times. As firms are unable to pass on the rising costs to the consumers, this will inch into firms' profits, forcing some of them to shut down or cut production and subsequently, employment. Finally, if the inflation is higher at home than that of the trading partners, domestic firms exporting to overseas markets become price uncompetitive while local producers may find it hard to sell in domestic markets as relatively cheaper foreign imports flood the domestic market. Declining exports and booming imports will, hence, cause the payments imbalances to worsen. Thus, high inflation will slow growth and employment through dampening effects on investment and the shrinking exports.

The study is organized in the following way. Section 2 is the brief overview of inflation situation of Sudan while section 3 describes the empirical model that will be employed in the estimation process. Section 4 will report the results of the estimated model and their discussion while section 5 presents the study summary and conclusions.

2. OVERVIEW OF INFLATION SITUATION IN SUDAN

Among the worst problems inherited by the Salvation Government in June 1989 was the malignant inflation that had invaded every corner of the economy. As the country was subjected to various economic reform programs in the late 1980s and earlier 1990s, government expenditures rose dramatically while tax and other revenues dwindled, resulting in worsening budget deficits. As the bulk of these deficits were financed through bank lending, this meant an accelerating domestic credit expansion which in turn, resulted in excessive monetary growth. For example, the biggest proportion of the deficit domestically financed rapidly rose from 64.7% in 1990 to 82.6% in 1991 although it dropped to 65.5% and 61.1% in the following two years respectively.

Table 1 reveals that money supply growth witnessed historic levels as the government was grappling with a host of socio-economic and political problems in period 1991-95. Money growth rates reached unprecedented record of 99.6%, 168.7 and 89.7% in 1991, 1992 and 1993 respectively, slowing down only after 1998 for the first time when the growth rose by approximately 22% although it increased to 33% in the following year. Other factors thought to have contributed to inflationary pressures in Sudan during this period include imported inflation and rapid exchange rate depreciation. It should be recalled that the Sudanese currency was pegged to the US dollar at the par value of US$ 2.8716//£S at the end of 1971, following the flotation of the British pound sterling and its subsequent depreciation by approximately 10%. However, as economic woes multiplied in late 1980s, economic performance started to deteriorate gradually, prompting the country to introduce the Structural Adjustment and Stabilization Program in June 1978. This program was accompanied by a number of measures related to exchange rate system in which the Sudanese currency was devalued from US$2.8716/£S to US$ 2.50 or approximately 15% devaluation. In addition, a subsidy of £S 0.1 per dollar for all remittances except those of cotton exports and a tax of £S 0.1 per dollar for all payments were imposed. This exchange rate

regime unified all the four exchange rate regimes which existed prior to this devaluation. They included (i) the official rate which was equivalent to US$ 2.8716/£S, which was applicable to cotton exports; (ii) the effective rate which was equivalent to US$ 2.50/£S that was applicable to all banking transactions except cotton; (iii) the incentive rate for Sudanese Nationals Working Abroad and (iv) the exchange rate for nil-value imports which ranged between £S 0.60/US$ and £S 0.65/US$ (see Figure 2).

Not long enough, on the 9th of November 1981, another round of devaluation was hastily announced and as a result, the exchange rate was unified at US$ 1.11 /£S. On November 15th 1982, the fourth round of the devaluation was announced as US$ 0.7692/£S to be followed by another devaluation policy under which the government withdrew licenses for private exchange bureaus in February 1983. Instead, commercial banks were authorized to set up foreign exchange bureaus to engage in attracting foreign exchange via official channels as a means of regulating exchange rate system. In March 1983, the government introduced free exchange rate regime to replace the parallel market exchange rate at US $ 0.56/£S for all foreign transactions whereas the official exchange rate was fixed at US$ 0.77/£S.

In January 1984, private exchange bureaus were reopened and the free exchange rate was devalued to US$ 0.47/£S whereas the official exchange rate remained at US $0.76/£S. Shortly in February 1985, another round of devaluation was implemented in which the exchange rate reached US$ 0.40/£S. On February 7, 1985, foreign exchange bureaus were closed once again and the free exchange rate was devalued to US$ 0.33/£S and in February 19, the official exchange rate was devalued to US$ 0.40/£S. These measures were reviewed in the second half of the year in which the free exchange system was devalued to between US$ 0.29/£S and US$ 0.33/£S.

At the beginning of 1986, a committee formed to deal in the resources of free foreign exchange market adjusted the purchase and selling rates at 0.29/£S and 0.40/£S respectively. On October

3, 1987, both the official and free market exchange rates were unified at 0.22/£S. On April 19, 1988, an exchange rate that dealt with transfers among private accounts was adopted which changed the rate from 0.30/£S to 0.24/£S and in October of the same year, the free market exchange rate system was reintroduced at 0.08/£S and to be determined in the future by the committee for foreign exchange market resources on daily basis, based on the market demand and supply conditions while the official exchange rate remained at 0.22/£S. In accordance with these measures, commercial banks were to sell 70% of their export proceeds at the official rate and the remaining 30% at the free exchange rate. These rates remained in force over period 1989-90 in which the official rate continued at 0.22/£S whereas the free rate was to be determined by a committee drawn from seven banks on daily basis, based on the market demand and supply conditions. Besides these two exchange rates, there were other rates such as personal account exchange rate based on an agreement with the Egyptian government and another rate designed mainly for students studying abroad etc.

More drastic measures were implemented in February 1992 when the government, upon concluding a new package of the structural adjustments programs with the IMF, unified exchange rate between US$1.01/£S and US$0.07 at the end of 1992. As fears that a continuous deterioration of the country's exchange rate may engender inflationary pressures mounted, the government intensified efforts for exchange rate liberalization and as a result, a multiple exchange rate system was adopted. But in October 1993, a dual exchange rate system was adopted based on the official exchange rate of £S 215/US$ in addition to the commercial bank rate fixed at £S 300/US$. Whereas this commercial bank rate was applied to the private sector receipts, imports and invisible transactions, all government receipts and imports were handled at the official rate. This exchange rate pattern generated discrepancies in exchange rates especially as the parallel exchange rate was still fixed at £S 505/US$ at the time.

Despite all these efforts, the Sudanese currency continued to depreciate against the US dollar and on 4/10/1997, the currency had fallen by 87% below the unified rate that was set in February 1992. As a result, the economy revealed serious deterioration in a number of areas among which were: (i) mounting scarcity of foreign exchange reserves caused by irresponsiveness of exports to various incentives offered, (ii) foreign aid stoppage; (iii) unstable domestic financial position as the government continued its borrowing from the Bank of Sudan for deficit financing that amounted to £S 34 billion in 1992/93. (iv) Large volumes of idle foreign exchange reserves possessed by the private sector relative to the country's resources. Such resources, instead of being utilized in the importation of the country's strategic needs at the extent required, contributed in speculative activities in foreign exchange market; (v) the continued exchange rate depreciation also raised the input prices for the production of export commodities which, in turn, raised the production costs.

In light of continuous exchange rate deprecation and ineffectiveness of the measures already taken on February 2, 1992, the government took additional measures on 15/10/1993 in relation to possession of foreign currency. Among these measures was the abolition of the free unified exchange rate which was adopted earlier on 3/9/1992 and instead, two exchange rate windows – one official exchange rate window in which exchange rate was to be determined by the Bank of Sudan and another one for exchange rate bureaus to be set by commercial banks – were set up with resources for each window identified. On 16/10/1993, the Bank of Sudan window exchange rate was set at US$ 0.0046/£S, that is £S 215/US$ while the exchange rate for exchange bureaus was set at US$ 0.0033/£S, or /£S 300/US$. Besides these two rates, a third unofficial exchange rate of £S 500/US$ was in application. All these measures implied a managed foreign exchange policy. Shortly in June 1994, the unified exchange rate system was restored once again in which every bank was allowed to announce its purchase and selling rates based on the market demand and supply. In tandem with these rates, the Central bank computed its weighted average rate as an average of all the rates announced by commercial banks,

Table 1.

Important Macroeconomic Indicators in Sudan in period 1977-2008

Year	NER SDD/ $US	M2	GDP at (Constant (Price	Inflation Rates = 2005) (100
1977	0.35	28.9	10.1	17.1
1978	0.40	32.9	12.9	19.2
1979	0.50	32.7	-3.8	31.1
1980	0.80	31.6	5.3	25.4
1981	0.91	27.4	6.5	24.6
1982	1.32	37.7	-1.4	25.7
1983	1.32	43.9	-1.9	30.6
1984	1.32	4.9	-9.3	34.1
1985	2.50	61.7	-19.1	45.4
1986	2.50	29.2	2.9	24.5
1987	4.55	52.8	6.6	20.6
1988	12.50 ,4.55	36.5	0.7	**64.7**
1989	12.50 ,4.55	**59.8**	-3.4	**66.7**
1990	12.50 ,4.55	**16.3**	-7.6	**67.4**
1991	12.50 ,4.55	**99.6**	-19.3	**122.5**
1992	97.43	**168.7**	-5.7	**119.2**
1993	215.00	**89.7**	5.4	**101.2**
1994	217.40	**50.9**	4.8	**116.0**
1995	832.00	**74.1**	5.4	**69.0**
1996	1,467	**65.2**	3.8	**130.4**
1997	1,805	37.0	6.4	46.6
1998	1,722.00	29.6	7.2	17.2
1999	2,378.00	24.6	6.3	16.2
2000	2,573.50	33.0	6.5	8.1
2001	2,614.30	26.0	6.1	4.9
2002	2,616.80	30.3	6.4	8.3
2003	2,601.60	30.3	5.6	7.4
2004	2,506.30	30.8	5.2	8.8
2005	2,305.30	43.5	8.0	8.4
2006	2,305.40	29.7	13	7.2
2007	2,013.30	10.3	10.2	8.1
2008	2,052.60	16.3	6.0	14.3

Source: Compiled from various Annual Reports of the Bank of Sudan.

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In 1995, to liberalize and develop the foreign exchange market further, all banks were permitted to determine their exchange rates in accordance with market demand and supply conditions. The Bank of Sudan was to buy 20% of its allotted share of export proceeds either by using its own announced rate or that of commercial banks, whichever one is lower, while purchasing the remaining 80% at its announced rate. The Bank of Sudan was to purchase all its allotted shares at the rates determined by commercial banks in addition to the margin of £S 3.0/US$. In addition, 26 special foreign exchange bureaus, known as Dealers Non-Bank Exchanges, were set up in September 1995 under which the Bank of Sudan weighted rate was computed from the volume of turnover plus rates from all commercial banks and bureaus. Consequently, as the foreign exchange markets became relatively active, the exchange rate depreciated further to approximately £S 832.0/US$ at the end of the year.

In 1996, two exchange rate regimes were adopted. Whereas the free market exchange rate reached £S 1467/US$, the parallel market exchange rate was £S 1805/US$. In 2000, the two exchange rates were unified at SDD 147.6/US$ which was applied over period 2001-2003. In 2001, the foreign exchange auction system was abolished and replaced by a system in which the Bank of Sudan was to replenish the commercial banks with the necessary resources. In addition, the Bank of Sudan was to announce an indicative rate and the band around which it was to be computed to the commercial banks and exchange bureaus on daily basis. Banks were permitted to freely set their rates different from the indicative rate, based on market conditions, provided that the margin allowed should not exceed SDD 0.7/USS$.

At the end of 2004, after a joint study by the IMF and the Bank of Sudan revealed that the currency was undervalued, the Bank of Sudan implemented a number of measures aimed at buttressing important foreign exchange companies or "main market players". As a result, the exchange rate appreciated to SDD 250.6/US$ and further to SDD 240/US$ in December 2005. In continuous

pursuance of its policy that aimed, among other things, at maintaining the stability of foreign exchange rate by adopting managed floating exchange rate policy, enhancing building up foreign exchange reserves, completing the unification of the foreign exchange market and its liberalization. Foreign exchange bureaus were allowed to deal with foreign contractors contracting with the government and the public sector institutions. In addition, a sale of foreign exchange for the purposes of transferring profits of foreign airway companies operating in the country was permitted. As a result of such measures, the Sudanese Dinar appreciated further from SDD 230.67/US$ in December 2005 to SDD 202.48/US$ at the end of 2006 and further from SDG2.0308/US$ at the end of 2007 although it slightly depreciated to SDG 2.091 during 2008 despite the financial crisis.

The Table also shows that economic growth recorded negative rates in the period 1987-88 although it registered some positive rates in period 1980-82. Another negative growth episode came in the period 1983-85 although the economy regained positive growth rates in period 1986-89. The country's GDP was declining continuously say by 7.6%, 19.3% and 5.7% in 1990, 1991, and 1992, respectively.

As a result or because of these programs, inflation rates accelerated, say from 19.2% in 1978 to 31.1% in 1979 although the rates moderated in the period 1980-82. Inflation dramatically jumped from approximately 21% in 1987 to about 65% in the following year, reaching the highest rates ever recorded in the period 1991-96. In other words, the highest inflation rates of 122.5% 119.2%, 101.2%, 116% and 130.4% in 1991, 1992, 1993, 1994 and 1996 respectively were unprecedented records. Inflation rates began to ease only in 1998 when domestic price level grew by approximately 17.2% down from 46.6% in the previous year.

The period 2000-2007 was characterized by a single-digit figure in which inflation rates never exceeded 9%. Only in 2008 has inflation recorded more than 14%, prompting fears that inflation

was on the rise once again if not stopped soon. A glance at Table 1 reveals that, except in the period 2000-2007, inflation rates in the Sudan have been far above two-digit figures.

In the same period, current account balance was revealing alarming figures. Although current account deficit figures were moderate in the period 1977-90, current account deteriorated remarkably in the period 1991-98, in which the rates exceeded 5% of GDP. As the country was undergoing series of economic transformation and rehabilitation programs that started in the 1970s, most of the country's imports were dominated by machinery and capital equipment, manufactured goods, means of transport, chemicals, foodstuffs, textiles and other materials. Imports of machinery, capital equipments, manufactured goods and means of transport accounted for approximately 75% of the import bill. On the exports side, cotton whose prices were in continuous decline worldwide was the main cash crop on which the country depended. As a result, the deficit between imports and exports was also in continuous rise, causing the country's current account to be in increasingly deepening and unsustainable deficit. Although the deficit figures were moderate in the period 1977-90, current account deteriorated remarkably in the period 1991-98, rising as high as 16.8%, 14.3% 11.7% and 10.4% of GDP in 1992, 1994, 1996 and 1998 respectively. In 2008, the current account deficit recorded 2.4% of GDP.

3. THE EMPIRICAL MODEL

In inflation literature, there have been more definitions on the subject than needed. Briefly, inflation is defined as a continuous and persistently sustained rise in the general price level, leading to continuous fall in the purchasing power of a given monetary unit. In other words, the generalized purchasing power of a given unit of money declines continuously so that it cannot purchase the same basket of goods and services over a given range of period. The usual approximate measure of inflation is the consumer price index, which weighs the prices of different goods and services

according to importance in a typical budget and then how much the prices of these goods have changed. Inflation can be caused by a variety of factors and for each factor there are several different theories that explain it. Although there may be various causes of inflation, traditionally, the broader classification is based on demand-pull and cost-push division.

Demand-pull inflation refers to a situation in which the level of aggregate demand grows faster than the underlying level of supply. Considering supply as the level of capacity, demand-pull inflation occurs when this capacity grows at a rate slower than the underlying demand. In other words, we have '*too much money chasing too few goods'*. As the aggregate demand exceeds aggregate supply, pressure builds on the price to rise. Demand-pull inflation may occur under full employment of resources and when the short-run aggregate supply is inelastic. In this situation, an increase in aggregate demand will lead to an increase in prices.

Aggregate demand may rise due to a number of reasons. A depreciation of exchange rate may increase the prices of imported goods and lower the prices of exports. If the country exports more than it imports, aggregate demand rises and, assuming the economy is already at full employment, higher aggregate demand will cause domestic prices to rise. Similarly, a reduction in taxes has the same effect. If direct taxes are cut, assuming that the Ricardian equivalence proposition does not hold, consumers will have more real income to spend so aggregate demand will increase. At the same time, a reduction in indirect taxes implies that consumers now feel richer and so will demand more goods and services. Both factors can cause aggregate demand and, thus, real GDP to rise above its potential level. Furthermore, rapid growth of money supply is another factor believed to cause inflation to rise.

Monetary economists, who strongly consider inflation to be a monetary phenomenon, believe that excessive growth of money supply beyond the need to finance the volume of transactions produced by the economy is a root cause of inflation. Finally, rising

consumer confidence and an increase in housing prices at home and faster economic growth abroad that boosts domestic exports are strong factors that can cause aggregate demand and, hence, prices to rise.

Cost-push inflation, on the other hand, describes a situation in which costs rise independently of aggregate demand. Cost-push inflation arises when businesses respond to rising production costs by raising prices in order to maintain their profit margins. It is very important to deeply understand why costs rise. If costs increase because the economy is booming, it is simply a symptom of demand-pull and cannot be regarded as cost-push inflation. If, for example, wages are rising faster because of a rapid expansion in demand, then they are simply responding to market pressures and this is regarded as demand-pull inflation causing costs to increase. However, if wages rise because of greater trade union power pushing through larger wage claims, this would be regarded as cost-push inflation.

A variety of reasons have been given as the sources of rising costs. First, if trade unions wield more power, they may be able to push wages up independently of consumer demand. As a result, firms will face higher costs and will, therefore, be forced to raise their prices to meet the higher wage claims and maintain their profitability. Second, if firms gain more power and are able to push up prices independently of demand to make more profit, this is cost-push inflation. This situation occurs when markets become more concentrated, moving towards oligopoly or, perhaps, monopoly. Third, as economies become more open, firms import a significant proportion of raw materials or semi-finished products for production. In this case, if the costs of imported materials and semi-finished products spin out of the firms' control, then firms will be forced to raise prices to pay for the higher raw material costs.

This situation could possibly happen for a number of reasons: (i) if the domestic currency appreciates faster, then domestic exports

become cheaper abroad and imports become more expensive at home and as a result, domestic firms will be paying more for their imports that include raw materials. (ii) If prices rise in the world commodity market, domestic firms will be faced with higher costs if they use these commodities (e.g., oil and metals) as raw materials. (iii) External shocks that might result from either a natural disaster that hits the site of the production or a political move by a group of countries to employ a resource as a political weapon. Finally, changes in indirect taxes (taxes on expenditure) increase costs of living and push up the prices of products.

In order to provide an appropriate framework for critically examining the impact of various exogenous variables on domestic price changes in Sudan, a simple model for determining inflation can be set up. The overall price level (P) is a weighted average of the price of tradable goods (P^T) and non-tradable goods (P^N), presented in a log-linear form as

$$p = \alpha\, p^N + (1 - \alpha)\, p^T \qquad\qquad (1)$$

where the weights α and 1-α represent the share of non-tradable and tradable goods respectively. With lower-case letters representing the logarithm of a variable (e.g., x = log(X), it is assumed that the price of tradable goods (p^T) is determined exogenously in world market. Mills and Pentecost (2000) have pointed out that domestic price level of tradable goods is based on a mark-up, μ, average costs, which consist of money wages relative to productivity, i.e., unit labor costs, W/A, and the domestic currency price of imports, P_m. (where $P_m = EP^*$). In this way, the domestic price level can be written as:

$$p^T = (1 + \mu)[(W / A)^\theta\, P_m^{1-\theta}] \qquad\qquad (2)$$

where W is the money wage, A is labor productivity and $\theta \leq 1$. Assuming, for simplicity, that the mark-up is zero and taking the logarithm, the domestic price of tradable goods can be expressed as

the product of wages, foreign price level and the exchange rate:

$$p^T = \theta\, w + (1-\theta)(e + p^*) \qquad\qquad (3)$$

This implies that increases in the nominal wages, exchange rate (depreciation) and foreign prices will lead to an increase in the overall price level.

The price of non-tradable (P^N) goods is assumed set in money market where demand for them is assumed to move in accordance with demand in the rest of the economy. As a result, the price of non-tradable goods is determined by the money market equilibrium condition in which real money supply (m^s/p) equals real money demand (m^d). This specification yields the following equation for non-tradable goods prices:

$$p^N = \beta\,(m^s - m^d) \qquad\qquad (4)$$

where m^s represents the nominal stock of money, m^d the demand for real balances, and β the scale factor representing the relationship between economy-wide demand and the demand for non-tradable goods. The demand for real money balances (m^d) is assumed to be positively related to real income, and negatively related to inflationary expectations and foreign interest rates in the following form:

$$md = f(y_t, \pi_t, r_{t+1}), \qquad\qquad (5)$$

where y_t represents real income, π_t represents expectations formed in period $t - 1$ of inflation in period t and r_{t+1} is the expected nominal foreign interest rate in period $t + 1$ adjusted by the expected changes in the exchange rate in period $t + 1$. According to money demand theory, an increase in real income stimulates money demand, whereas an increase in domestic opportunity cost variable (expected inflation) will lead to its fall.

Lucas (1976) has argued that rational agents will change their behavior with changes in policy stance, and hence, any inference that does not explicitly consider expectations is bound to make

systematic errors. As a result, the expected rate of inflation in period t, based on adaptive expectations, is included and modeled in the following adaptive expectation process:

$$E(\pi_t) = d_1(\Delta p_{t-1}) + (1 - d_1)\pi_{t-1} \tag{6}$$

where d_1 is a lag operator, $L(\pi_t)$ represents a distributed lag learning process for the economic agents and Δp_{t-1} represents the actual inflation in period t-1. If the weights in $L(\pi_t)$ are equal, then the situation could be described as adaptive expectations. In this way, people will form expectations on the basis of past inflation and past experiences in forecasting inflation. But if $d_1 = 1$ as usually assumed (Moser, 1995; Ubide; 1997), then, equation (6) yields the following reduced-form equation

$$E(\pi_t) = \Delta p_{t-1} \tag{7}$$

In expression (7), known as the naïve expectations, p is the log of the consumer price level and $E(\pi_t)$ is the expected rate of inflation. Similarly, based on the same assumption in respect to expectations formulation, it is assumed that the expected foreign interest rate (r_{t+1}), corrected for the expected change in the exchange rate, is equal to the observed rate in period t:

$$E(r_{t+1}) = r_t. \tag{8}$$

The above equation implies that an increase in expected future foreign interest rates (r_{t+1}) is assumed to lead to decrease in current real money demand as a result of substitution effects. Substituting equations (8) and (7) into equation (5) yields the following log-linear money demand function:

$$m_t^d = c_2\, y_t - c_3\, \Delta p_{t-1} - c_4\, r_t \tag{9}$$

Similarly, substituting equation (9) into equation (4) yields

$$p_t^N = \beta(m_t - c_2 y_t + c_3 \Delta p_{t-1} + c_4 r_t) \tag{10}$$

Equations (3) and (10) are substituted into (1) to obtain the following price equation:

$$p_t = \hat{\beta}\ (m_t - c_2 y_t + c_3 \Delta p_{t-1} + c_4 r_t) + \theta(1-\alpha)w_t + (1-\theta)(1-\alpha)(e_t + p_t^*) \tag{11}$$

$$p_t = f(\overset{+}{m_t},\ \overset{-}{y_t},\ \overset{+}{e_t},\ \overset{+}{r_t},\ \overset{+}{\Delta p_{t-1}},\ \overset{+}{p_t^*}) \tag{12}$$

With all the variables remaining defined as before, it is expected that an increase in nominal money, exchange rate, expected nominal foreign interest rates adjusted for the expected change in the exchange rate, expected inflation, or foreign prices leads to an increase in domestic prices in period t, while an increase in real output leads to a fall in domestic prices.

The short-run version of the above long-run equation can be specified as an error correction model:

$$\Delta p_t = \beta_0 + \sum_{i=0}^{n} \beta_{1i}\Delta m_{t-i} + \beta_{2i}\Delta y_{t-i} + \beta_{3i}\Delta e_{t-i} + \beta_{4i}\Delta p'_{t-i} + \beta_5 EC_{t-1} + v_t$$
(13)

where Δ represent the first difference operator, EC_t the error correction term for the price level and v_t a disturbance term.

There is extensive literature on the dynamic causal relationship among inflation, money growth and exchange rate depreciation presented in equation (13). Depreciation, mainly in medium-size and small countries, has a direct impact on domestic inflation via channels such as costs of imported materials, wages, aggregate demand and prices of import-competing goods. Depreciation, by raising the domestic-currency prices of imported materials, will raise domestic costs that are directly fed into domestic prices. This is because material prices rise as a result of a decline in interest rate that provokes a depreciation of the currency. Durevall and Ndung'u (1999), in their study of inflation in Kenya, observed that exchange rates, in addition to foreign prices and terms of trade,

were a "proximate" determinant of prices in the long run in Kenya. The study found that money only affected prices indirectly via the exchange rate.

Goldstein (1977), Bruno (1978), and Spitaeller (1978) and Ford and Krueger (1995) found a significant positive effect of import price changes on changes in the domestic rate of inflation in most of their studies. In a study of five industrial countries (the United States, the Federal Republic of Germany, Japan, the United Kingdom, and Italy), Goldstein found that import price did affect domestic prices via the costs of imported materials and wages. These empirical results provide compelling evidence that import price contributed to a rise in domestic prices in a majority of the countries studied. Similarly, Bruno (1978), using data from 16 OECD countries, found that the coefficient of import prices is the best single predictor for the change in domestic consumer price index. Based on this finding, the conclusion was that devaluation (depreciation) raises the price of imported inputs and thus the cost of production of the final goods. The consequent rise in the cost of living, in turn, raises nominal wage costs through indexation. The intended real devaluation could be nullified by both the wage-price spiral and the extent of disequilibrium in both the non-traded goods sector and the market for labor services. Ford and Krueger (1995) argued that a rise in import prices puts upward pressure on domestic prices either through the mechanical effect of raising the domestic currency value of imported goods that are present in the consumer price index or by causing wages to rise in response to prices, setting off a wage-price spiral.

Kim (1998) and Price and Nasim (1999) observed that when the CPI is below PPP condition, exchange rate depreciates, which feeds back into domestic prices via the PPP receptor. In case of Sudan, a recent paper by Moriyama (2008) that investigated the dynamics of inflation in Sudan found that inflation in Sudan is caused by both money supply and nominal exchange rate, with nominal exchange rate exerting a stronger impact on inflation than money supply.

4. ESTIMATION TECHNIQUES

Using the Granger representation theorem, we may present our vector error-correction model that will explain the short-run dynamic relationship of the inflation determinants. To gain insight into the relationship between inflation and its short-run and long-run determinants, this study employs the Johansen multivariate cointegration analysis (Johansen, 1988; Johansen and Juselius, 1990), specified as a VAR of order ρ model:

$$y_t = A_1 y_{t-1} + \dots A_\rho y_{t-\rho} + Bx_t + \varepsilon_t$$

(14)

where y_t is κ-vector of non-stationary $I(1)$ variables, x_t is a d-vector deterministic variables and ε is a vector of innovations. Johansen and Juselius (1990) reparameterized VAR in equation (3) to yield the following vector error-correction model (VECM):

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{\rho-1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t$$

where

$$\Pi = \sum_{i=1}^{\rho} A_i - I, \quad \Gamma_i = - \sum_{j=i+1}^{\rho} A_j$$

(15)

This Granger's representation theorem emphasizes that if the coefficient matrix Π, which gives the number of independent cointegrating vectors, has a reduced rank $r < k$, then there exists $k \times r$ matrices $\alpha \times \beta$ each with rank r such that $\Pi = \alpha\beta'$ and $\chi\beta'y_t$ is $I(0)$. r is the number of cointegrating relations (the *cointegrating rank*) and each column of β is the cointegrating vector whereas the elements of α are known as the adjustment parameters in the VEC model. Johansen method strives to estimate Π from unrestricted VAR and to test whether the restrictions implied by the reduced rank of Π can be rejected. In addition, Johansen (1990, 1995) constructed two associated likelihood ratio test statistics. The first statistic is the trace which tests the null hypothesis of r cointegrating relations against the alternative of k cointegrating relations, where

k is the number of endogenous variables, for $r = 0, 1, …$, k-1. The trace statistic for the null hypothesis of r cointegrating relations is computed as

$$R_{tr}(r \mid k) = -T \sum_{i=r+1}^{k} \log(1 - \lambda_i)$$

(16)

where λ_i is the i-th largest eigenvalue of the Π matrix in equation (16). The second statistic is the maximum eigenvalue, which tests the null hypothesis of r cointegrating relations against the alternative of $r+1$ cointegrating relations. The statistic is

$$R_{max}(r \mid r+1) = -T \log(1 - \lambda_{r+1})$$
$$= R_{tr}(r \mid k) - R_{tr}(r+1 \mid k)$$

for r = 0, 1, …, k-1.

(17)

5. THE EMPIRICAL MODEL RESULTS AND DISCUSSION

The empirical analysis is carried out using annual data from Sudan on domestic nominal money supply (M2), nominal GDP (Y) as a scale variable, nominal exchange rates (E), consumer price index (P) and foreign price (P*) over the period 1970-2008. The data were obtained from the Central Bank of Sudan and the IMF International Financial Statistics (IFS) database. Money supply and domestic output are measured in real terms using the consumer price indices (2005 = 100) as deflators. The sample sizes were determined by the availability of relevant data. We have also included two dummy variables: one for exchange rate system and another one for oil. Exchange rate dummy variable is set to equal one prior to 1978 zero otherwise while oil dummy equals 1 after 1999 and zero otherwise.

Table 1: Individual unit root test results

	ADF		Phillips-Perron	
Level				
Variables	Constant	Constant + Intercept	Constant	Constant + Intercept
Ln M1	*-3.418	-3.345	1.517	-1.489
Ln M2	-1.821	-0.734	-1.270	-1.343
Ln Y	-0.688	-1.476	-0.390	-1.259
Ln E	-0.188	-1.449	-0.394	-1.853
Ln P	-1.491	-3.093	-0.314	-1.754
*Ln P	-2.184	-0.234	-1.694	-0.464
First Difference				
Ln M1	-2.167	-2.165	**-4.137	**-4.111
Ln M2	-2.551	**-5.004	**-5.209	**-5.180
Ln Y	**-7.742	**-7.803	**-7.783	**-7.825
Ln E	**-4.358	**-4.287	**-4.343	**-4.272
Ln P	-2.102	-2.029	-2.114	-1.932
*Ln P	-1.934	-2.775	-1.934	-2.656

Note: **, and * refer to 1% and 5% level of significance. For ADF test, the adjusted t-statistics for 1% and 5% levels of significance are –3.6210 and –2.9434 when the test contains a constant while –4.2268 and –3.5366 respectively when the test contains a constant and a linear trend.   For Phillips-Perron test, the adjusted t-statistics for 1% and 5% levels of significance are –3.6210 and –2.9434 when the test contains a constant while –4.2268 and –3.5366 respectively when the test contains a constant and a linear trend respectively.

Prior to conducting the cointegration test, the series are subjected to a battery of unit root tests to make sure that they are stationary. The Augmented Dickey-Fuller and Phillips-Perron unit root tests were employed for that purpose. The results of these tests reported in Table 1 reject the null hypothesis for all the series at levels. However, with exception of M1 and CPI, both tests could not reject the null at the second difference. Therefore, although the variables were non-stationary at levels, we can conclude that they are stationary at the first difference or the series are $I(1)$.

After ascertaining that the series are stationary, the second step is to test for cointegration among the series. However, prior to conducting the cointegration test, the Akaike information criterion (AIC) and Schwarz Bayesian criterion (SBC) were employed for the lag selection. While the former suggests 4 years, the latter selects 2 years as the optimal lag length. Therefore, this study, considering the sample size (38 observations), employs two as the optimal lag length. As the Johansen procedure is notorious in over-rejecting the null hypotheses in small samples, however, Reimers (1992) recommends making adjustment for the degrees of freedom by replacing T, the sample size, by T- nk in trace and maximal eigenvalue test in equations (16) and (17) where n is the number of variables in the model including dummy variables and k, is the lag length. This adjustment could improve the small-sample behavior of likelihood ratio statistics. The results of cointegration test, which assumes no trend in the series with unrestricted intercept in the cointegration relation are shown in Table 2. While the λ_{trace} statistic identifies three cointegrating equations, the λ_{max} statistic indicates two cointegrating equations, suggesting that there exists at least two cointegrating relations among nominal exchange rate, real money supply, real output, domestic and foreign consumer price indexes.

Table 2: Results of Johansen's Test for Multivariate Cointegrating Vectors

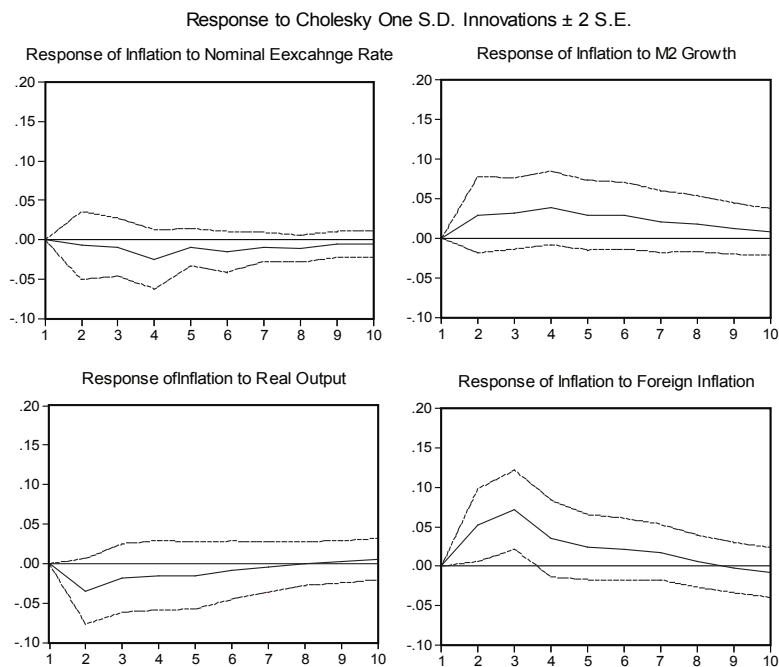| (Individual cointegration test: Johansen and Juselius (1990					
Null	Alternative	Trace Statistic	C V 0.05	Max-Statistic	C V 0.05
r = 0	r = 1	**114.87	69.82	**53.52	33.88
r <= 1	r = 2	**61.35	47.86	*26.97	27.58
r <= 2	r = 3	*34.38	29.80	20.94	21.13
r <= 3	r = 4	13.44	15.49	7.16	9.160
r <= 4	r = 5	6.28	3.84	6.28	3.84

.Notes: The symbols *(**) indicates rejection at the 95% (99%) critical value

After establishing cointegration among the variables, we normalize on the domestic consumer price equation since this is the variable of interest and so the first estimated eigenvector forms the maximum likelihood estimate of the cointegrating vector, β. The long-run inflation equation is obtained as presented below[7]:

$$LnP = \underset{(0.105)}{0.032 LnE} + \underset{(0.264)}{1.278\ LnM2} - \underset{(0.616)}{3.407\ LnY} + \underset{(0.339)}{4.109 LnP^{\bullet}} \qquad (18)$$

The cointegrating equation shown in equation (18) defines the long-run equilibrium relationship between domestic price index and its determinants. All the variables carry correct signs and significant at least at the 5% level except the elasticity of domestic inflation with respect to nominal exchange rate. For example, keeping other things the same, a 1% growth of real money supply and foreign price respectively could produce domestic inflation rates of approximately 1.3% and 4.1% over the period 1970-2008. In contrast, a 1% growth in real output could cause domestic price to fall by about 3.4% between 1970 and 2008. This implies that foreign inflation and real output were the most influential determinants of domestic inflation in the Sudan between 1977 and 2008, reinforcing the growing fear that inflation in Sudan is both cost-push and demand-pull phenomenon in the long run. Foreign inflation effects could pass to domestic inflation through the costs of imported material inputs via exchange rate, forcing firms to raise prices to pay for the higher raw material costs.

Figure 3: Reponses of Inflation to Nominal Exchange Rate, M2 Growth, Real Output and Foreign Inflation

Response to Cholesky One S.D. Innovations ± 2 S.E.

Response of Inflation to Nominal Eexcahnge Rate

Response of Inflation to M2 Growth

Response ofInflation to Real Output

Response of Inflation to Foreign Inflation

The 10-year impulse response functions presented in Figure 3 describes the response of domestic inflation to an initial shock of one standard deviation (S.D) to other variables. As the IRFs are generated from a cointegrated system, a shock in any variable is expected to exert a permanent and long-lasting effect on the system, which gradually adjusts to a new equilibrium. In this respect, the Figure traces out the impact effect of a one-percentage increase in nominal exchange rate, M2, real output and foreign price on domestic price. For example, a one-percentage appreciation of nominal exchange rate causes inflation to fall while a similar increase in M2 causes inflation to rise. A one-percentage increase in foreign price could cause domestic price to rise whereas a similar rise in real output could reduce it. These findings are consistent with those reported by Moriyama (2008).

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To check whether the estimation regression equations were stable throughout the sample period, we plot the CUSUM and CUSUM (cumulative sum) of squares tests (Brown et al; 1975) as shown in Figures 4. The importance of these tests is that a movement of the CUSUM and CUSUM squared residuals outside the critical lines is suggestive of the instability of the estimated coefficients and parameter variance over the sample period. In this study, the statistics fall inside 5% critical lines, implying that the tests could not reject the null hypothesis that the regression equations are correctly specified at 5% level of significance. This suggests that there have not been systematic changes in the regression coefficients.

Figure 4: Plot of Cumulative Sum of Recursive Residuals (CUSUM)
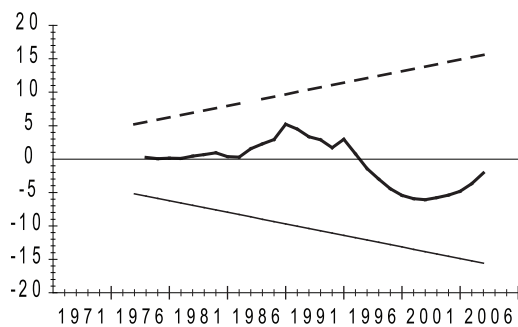
The straight lines represent critical bounds at 5% significance level
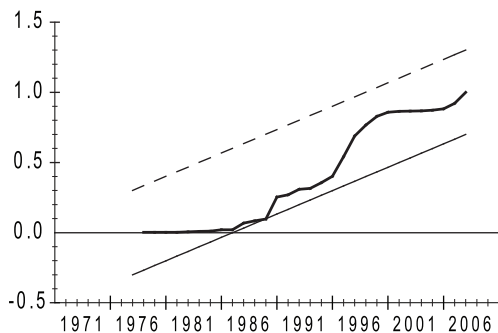
The straight lines represent critical bounds at 5% significance level

5.3. ESTIMATES OF ERROR-CORRECTION MODEL

Since tests involving differenced variables can be mis-specified and some important information lost if the variables are cointegrated, error-correction term (ECT), which is derived from long-run relationships using Johansen procedure, is included as an independent variable. Since all the variables are stationary in the system, the short-run adjustment mechanism can be modeled as an ECM. This ECT, lagged by one year, is used in the ECM, together with current and past differenced fundamentals and other variables that affect the domestic price in the short run.

The results of the error-correction model associated with these long-run estimates are reported in Table 3 in which only the elasticity of domestic inflation with respect to second lag of nominal exchange rate depreciation, first lag of real output growth and first lag of foreign inflation carry the correct signs and significant at the 5% level. In other words, keeping other things the same, a 1% increase in nominal exchange rate and foreign price level would produce inflation rates of about 0.17% and 1.9% respectively per annum whereas a 1% increase in real output would reduce domestic price by 0.26%.

This finding implies that foreign inflation was the most important determinant of domestic inflation. In other words, domestic inflation was significantly determined by foreign inflation in both short-and-long runs. Both dummy variables are statistically significantly different from zero, at least at the 10% level and carry negative signs. The oil dummy variable is highly significant at the 1% level, suggesting that a rise in exports of oil would tend to reduce domestic inflation. These results indicate how important the short-run dynamics between inflation and the specified regressors, although Masih and Masih (2004, p.597) cautioned against attaching too much importance to such short-run relationships as they are simply derived from reduced-form model.

Table 3: Results of the Error-Correction Model

Results of the selected error-correction model		
Regressor	(.Coefficient (S.D	t-statistics
Intercept	***0.808 (0.175)	4.622
(Ln P(-1 Δ	0.036 (0.227)	0.159
(Ln P(-2 Δ	***-0.810 (0.256)	-3.154
(Ln E(-1 Δ	0.044 (0.066)	0.662
(Ln E(-2 Δ	**0.168 (0.069)	2.445
(Ln M2(-1 Δ	-0.027 (0.211)	-0.130
(Ln M2(-2 Δ	**0.639 (0.229)	-2.791
(Ln Y(-1 Δ	**0.255 (0.119)	2.166
(Ln Y(-2 Δ	-0.034 (0.101)	-0.334
(Ln P*(-1 Δ	***1.889 (0.486)	3.885
(Ln P*(-2 Δ	**-1.309 (0.601)	-2.179
Oil Dummy	**-0.195 (0.085)	-2.281
Exchange rate Dummy	ᵒ-0.426 (0.100)	-1.784
(ECT(-1	***-0.2068 (0.083)	-6.130
R-square	0.9293	
SSR	0.153	
Durbin-Watson test	1.818	
Akaike Info. Criteria	-1.846	
Schwarz Criteria	-1.230	
.F-Stat	22.257	
Prob(F − Statistic	0.000	

.Note: (***), (**) and (*) refer to 1%, 5% and 10% level of significance respectively

The coefficient of error-correction term that represents the proportion by which a long-run disequilibrium in inflation can be corrected in each year, estimated as –0.2068, is statistically significant at 1% level and correctly negatively signed. This suggests that approximately 21% of total disequilibrium in domestic price level was being corrected in each year in the country across the study period over period 1970-2008. The Durbin-Watson statistic being around 2 indicates that the residuals are uncorrelated with their lagged values, that is, there is no first-order serial correlation among the residuals. Figure 5, which plots the residuals of the error-correction model, does not indicate any problem with the residuals. In other terms, the plot provides important supportive visual evidence that the residuals for the ECM equation are stationary.

Figure 5: Plots the Residuals of the Error-correction Model
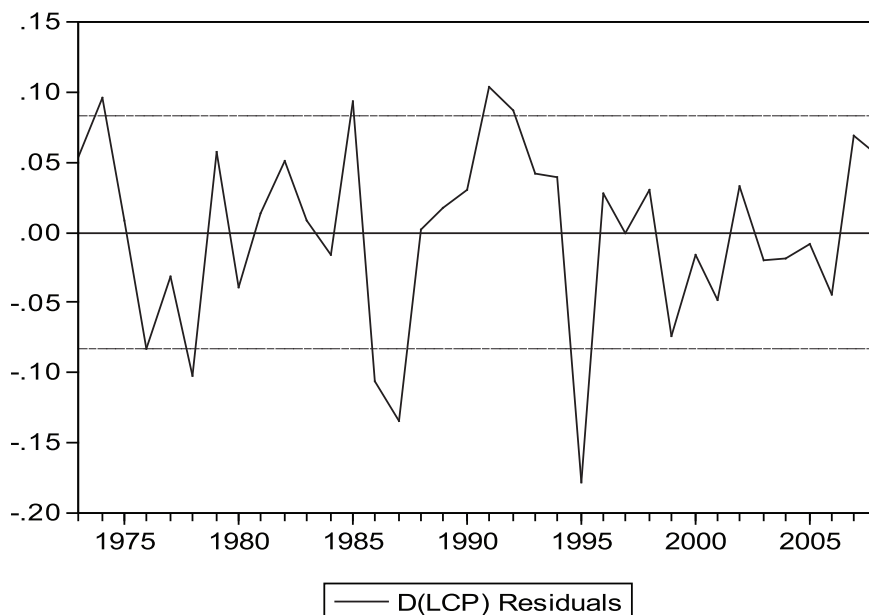
5.2 Causality Among the Variables

Although we may understand that real money supply, nominal exchange rate, real output and foreign price affect domestic price, the direction of causality among the variables is not clear. Correlation and causation among the variables may be confused. The Granger (1969) approach to the question of causation among the variables, say x and y, analyzes how much of the current y can be explained by past values of x and to examine whether adding lagged values of x can improve the explanation. In this case, y is said to be Granger caused by x if x helps in the prediction of y, or equivalently if the coefficients on the lagged x's are statistically significant.

The Granger causality test results reported in Table 4 indicate that there is a bi-directional causal effect between money supply and nominal exchange rate in addition to unidirectional causal effects running from domestic price to nominal exchange rate and real money supply, from real money supply to real output, from real output to domestic price and nominal exchange rate, from foreign price to domestic price, nominal exchange rate, real money supply and real output. These causal links show that foreign price is the most exogenous variable in the system whereas nominal exchange rate is the most endogenous variable being influenced by domestic price, real money supply, real output and foreign price.

The impact of foreign price is transmitted to domestic price either via nominal exchange rate depreciation, real output through imported input costs or directly through imported consumer goods. If the government increases money supply in response to money demand triggered by exchange rate depreciation and deficit financing, interest rates fall. This, in turn, initiates capital outflows and a subsequent depreciation of domestic currency. Consequently, domestic price rises via the prices of imported goods, which may result in subsequent fall of domestic real money balances. If the monetary authorities persistently accommodate this demand for money arising from currency depreciation and deficit financing by

expanding domestic money supply, a new round of exchange rate depreciation is set in motion, resulting in a rise in price level and a subsequent fall in real money balances. This exchange rate-inflation spiral can generate and sustain a notorious vicious dynamic causal process of rising prices and depreciating exchange rate, which can destabilize the economy for a long time.

5.3 Variance Decomposition

Further insights about the relationships between domestic inflation and other macroeconomic variables can be obtained from analyzing variance decompositions. Variance decomposition practically decomposes or breaks down variation in each endogenous variable into the component shocks that can be attributed to individual endogenous variables in the VAR system and gives information about the relative importance of each random innovation to the variables in the VAR system. The ordering of VD is mainly based on theoretical speculation and/or some statistical properties of the system such as the correlation among the residuals and the extent of exogeneity among the variables with weakly exogenous variable coming first in the ordering. In this study, our ordering is as follows: domestic inflation (Δp), real output (Δy), foreign inflation (Δp^*), real money supply $(\Delta m2)$ and nominal exchange rate (Δe). Table 5A reports the VDCs of 10-year forecast errors.

Whereas about 25.72% of forecast error variance in domestic inflation is explained by its own innovation, about 20.1%, 49.0%, 4.2% and 0.9% of the remaining forecast error variance is explained by real output growth, foreign inflation, real money supply growth and changes in nominal exchange respectively at the end of a 10-year period. The finding is consistent with those of the long-run model given in equation (11) and the Granger causality test results. Whereas about 49.9% of the forecast error variance in real output growth is explained by its own innovation, about 4.4%, 33.8%, 6.3% and 4.5% of the remaining forecast error variance is explained by domestic inflation, foreign inflation, real money supply growth and changes in nominal exchange rate respectively.

Furthermore, while about 75.6% of forecast error variance in foreign price is explained by its own innovation, about 2.0%, 14.9%, 4.3% and 3.1% of the remaining forecast error variance in foreign price is explained by domestic inflation, real output growth, real money supply growth and changes in nominal exchange rate growth respectively. This is an indication that foreign price is an exogenously determined variable. For real money supply, although 35.3% is explained by its own innovation, the bulk of forecast error variance is explained by other variables. For example, of the remaining forecast error variance, domestic inflation, real output growth, foreign inflation and nominal exchange rate explain about 23.4%, 8.9%, 26.3% and 6.1% at the end of ten years. Finally, while 20.4% of forecast error variance in nominal exchange rate is explained by its own innovation, domestic inflation, real output growth, foreign inflation and real money supply growth respectively explain about 7.1%, 10.1%, 36.5% and 25.8% of the remaining forecast error variance.

Most of these findings are consistent with Granger-causality tests presented in Table 4. For example, apart from its own innovation, changes in domestic price are overwhelmingly Ganger-caused by changes in nominal exchange rate and real money supply growth. Similarly, changes in real output are Granger-caused by changes in domestic real money supply and foreign inflation. Furthermore, foreign inflation Granger-cause domestic inflation, changes in nominal exchange rate, real money supply growth and real output growth.

6. SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

The objective of this study is to identify the fundamental determinants of inflation and examine the direction of causality among the variables. The study applies the cointegration and error-correction model on annual data from Sudan over period 1970-2008. These results can be summarized as follows: first, the series were found to be stationary at the first difference and bound by at least two cointegrating relations. Second, the results of the long-run model indicate that all the included variables carry correct

signs and significant at least at the 5% level except the coefficient of nominal exchange rate. The elasticity of domestic inflation with respect to foreign inflation and real output growth are the largest, respectively, implying that these are the most influential determinants of domestic inflation in the Sudan, reinforcing the growing fear that inflation in Sudan is both cost-push and demand-pull phenomenon in the long run.

Third, in the error-correction model, only the elasticity of domestic inflation with respect to second lag of nominal exchange rate growth, first lag of real output growth and first lag of foreign inflation carry the correct signs. This implies that, keeping other things the same, a 1% rate of depreciation of nominal exchange rate and foreign inflation respectively produce 0.2% and 1.9% rates of domestic inflation per annum, again, reaffirming the importance of foreign inflation in determining inflation in the Sudan in both the short-and-long runs. In contrast, a 1% growth in real output reduces domestic price by 0.3% per annum in the long run. Fourth, the coefficient of error-correction term is significant at the 1% level and correctly negatively signed, which suggests that approximately 21% of total disequilibrium in domestic price level was being corrected in each year in Sudan.

Fifth, the pairwise Granger causality test indicates a bi-directional causal effect between nominal exchange rate and money supply in addition to unidirectional causal effects running from domestic price to nominal exchange rate and real money supply, from real output to domestic price and nominal exchange rate, and from foreign price to domestic price, nominal exchange rate, real money supply and real output. Sixth, although about 25.7% of forecast error variance in domestic price is explained by its own innovation, foreign price alone explains approximately half (49%) of total forecast error variance, followed by real output in domestic price. The fact that approximately 76% of forecast error variance in foreign price is explained by its own innovation underlines the exogenous nature of this variable. In contrast, the fact that the bulk of forecast error variance in real money supply and nominal exchange rate variables

is explained by other variables other than their own innovations confirms the endogenous nature of the variables.

The important lesson to learn from this study is that domestic inflation is influenced by growth in money in the long run and predominantly caused by foreign inflation in both long-and-short runs. Since foreign inflation is an exogenous variable over which the policy makers have no influence, they may employ an exchange rate policy to offset the impact arising from inflation. Besides, as domestic inflation affects nominal exchange rate via money supply, contractionary monetary policy is a feasible option.

The inertia is initiated by both exchange rate depreciation and deficit financing by the government. As money supply increases in response to money demand triggered by exchange rate depreciation or deficit financing, domestic interest rates fall which may, in turn, trigger capital outflows and a subsequent depreciation of domestic currency. This process, in turn, raises domestic prices via the prices of imported goods, which may result in subsequent fall of domestic real money balances. It is, therefore, important that the link between money supply growth on the one hand and exchange rate depreciation and deficit financing on the other be severed. Importantly, policy makers should avoid deficit monetization which may trigger the growth of money supply in the first place.

The findings of this study strongly support the argument by Bilson (1979) that although exchange rates appears to cause movements in prices and wages, the ultimate cause of both the exchange rate depreciation and domestic inflation is an expansionary monetary policy. An exogenous monetary expansion in response to exchange rate depreciation and the government deficit financing efforts can exert a downward pressure on domestic interest rates which initiates capital outflows. As the demand for foreign exchange by investors who want to reshuffle their portfolios of various currencies increase, a further round of depreciating exchange rate will be set in motion. This exchange rate-inflation spiral can generate and sustain a notorious vicious dynamic causal process of

rising prices and depreciating exchange rate, which can destabilize the economy for a long time.

The important lesson to learn from this study is that domestic inflation is predominantly caused by foreign inflation in both long-and-short runs in addition to changes in money growth and real output. The study makes the following policy recommendations:

1- Since money growth is found to be a key determinant of domestic inflation, it is necessary to reduce the growth of money. The Granger causality test indicates a bi-directional causal link between nominal exchange rate and money supply in addition to unidirectional causal effects running from domestic inflation to nominal exchange rate and real money supply.

2- As budget deficit financing is an important factor that accelerates the monetary growth in many economies, curbing inflation requires cutting budget deficit financing via money printing. Immediate review of the current monetary policy should be undertaken with view to targeting lower money growth in order to prevent the current inflation surge.

3- Since inflation is a major source of economic instability, the Central Bank of Sudan should have to adopt a monetary policy that targets inflation. It is critically important to adopt further measures that may strengthen and stabilize the exchange rate regime that can shield the domestic economy from foreign and domestic shocks.

4- Since foreign inflation is an exogenous variable that the authorities have no control over, the authorities may employ an exchange rate policy that could offset the impact of foreign inflation. Enhancing and building strong reservoir of foreign reserves, frequent review of the current exchange rate system with possibility of gradually widening the current band to allow more flexibility of the system should be among the core goals of the Central Bank's monetary

policy. Revising channels of injection and management of the exchange rate are important measures in reducing inflation.

5- Since financial crisis usually gives rise to debt buildup, it is important that the authorities design an appropriate debt relief strategy.

6- Policy measures that aim at reforming the banking sector are needed. The Central Bank of Sudan should strictly enforce regulations that prevent banks from financing investment activities that encourage speculative activities in the economy.

7- To reduce inflation, other policy measures that aim at reducing the cost of finance in the economy should be urgently undertaken. The composition and structure of the returns on Government Musharakat Certificates (GMCs), Government Investment Certificates (GICs) and the Central Bank of Sudan Ijarah Certificates (Shihab) should be immediately reviewed with view to bringing them in line with returns on commercial bank deposits.

8- It is critically important to activate the open market operations to strengthen the Central Bank of Sudan effectiveness in liquidity management in the short run. Strict and continuous monitoring of monetary policy tools such as legal reserve requirement is critically important in liquidity management so that commercial banks do not exceed the stipulated financing limits.

9- The Central Bank should consider reviewing the current exchange rate regime. The current managed-floating exchange rate regime requires active intervention of the Central Bank of Sudan in foreign exchange market without specifying or pre-committing itself to a pre-announced exchange rate path. This discretion in monetary policy dictated by frequent intervention in foreign exchange market, which leads to uncertainty and lack of credibility, can be a potential source of inflation.

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APPENDEXES

Table 4A. Results of the Pairwise Granger Causality Test

Results of the Pairwise Granger Causality Test		
Hypothesis	(t-stat. (p-values	Direction of Causality
Exchange Rate does not Granger cause Domestic price	(0.686) 0.166	Not rejected
Domestic price does not Granger cause Exchange Rate	(0.001)***15.579	Rejected
Money Supply does not Granger cause Domestic price	(0.255) 1.341	Not rejected
Domestic price does not Granger cause Money Supply	(0.007)***8.203	Rejected
Real Output does not Granger cause Domestic Price	(0.049) **4.156	Rejected
Domestic price does not Granger cause Real Output	(0.256) 1.336	Not rejected
Foreign Price does not Granger cause Domestic price	(0.002)***11.081	:Rejected
Domestic price does not Granger cause Foreign price	(0.741) 0.110	Not rejected
Money Supply does not Granger cause Exchange Rate	(0.045) **4.849	Rejected
Exchange Rate does not Granger causes money Supply	(0.082) *3.224	Rejected
Real Output does not Granger cause Exchange Rate	(0.052) **4·061	Rejected
Exchange Rate does not Granger cause Real Output	(0.796) 0.067	Not rejected
Foreign price does not Granger cause Exchange Rate	(0.016)**6.418	Rejected
Exchange Rate does not Granger cause foreign price	(0.907) 0.014	Not rejected
Real Output does not Granger cause Money Supply	(0.863) 0.030	Not rejected
Money Supply does not Granger cause Real Output	(0.137) *3.114	Rejected
Foreign price does not Granger cause Money Supply	(0.115) ***7.124	Not rejected
Money Supply does not Granger cause Foreign price	(0.403) 0.717	Not rejected
Foreign price does not Granger cause Real Output	(0.003)***10.301	Rejected
Real Output does not Granger cause Foreign Price	0.377 (0.543)	Not rejected

Table 5A: Variance Decomposition

Variables	Δp	Δy	Δp^*	$\Delta m2$	Δe
	Percentage of forecast error variance explained by shocks in:				

Variance Decompositions of Δp:

Year 1	100.00	0.00	0.000	0.000	0.000
Year 2	76.81	9.82	9.86	2.61	0.89
Year 3	56.16	14.67	26.07	2.47	0.63
Year 4	43.76	15.91	36.58	3.09	0.65
Year 5	36.66	19.06	39.09	3.51	0.87
Year 6	32.55	19.33	43.14	4.19	0.78
Year 7	29.88	19.81	45.41	4.05	0.85
Year 8	27.97	19.96	47.03	4.19	0.84
Year 9	26.62	20.09	48.18	4.18	0.94
Year 10	25.72	20.09	49.00	4.24	0.95

Variance Decompositions of Δy:

Year 1	1.92	98.08	0.00	0.00	0.00
Year 2	3.05	55.38	39.54	0.35	1.69
Year 3	3.85	53.50	38.43	2.40	1.81
Year 4	3.59	50.94	34.84	6.66	3.99
Year 5	4.12	50.53	34.05	6.64	4.55
Year 6	4.41	50.45	33.63	6.96	4.56
Year 7	4.38	50.05	33.68	6.37	4.52
Year 8	4.38	49.99	33.71	6.37	4.54
Year 9	4.38	49.98	33.71	6.38	4.54
Year 10	4.38	49.91	33.80	6.37	4.54

Variance Decompositions of Δp^*:

Year 1	2.39	6.24	91.36	0.00	0.00
Year 2	2.75	7.05	89.09	0.65	0.46
Year 3	2.51	14.12	77.16	2.94	3.27
Year 4	2.18	13.94	76.44	4.56	2.87
Year 5	2.08	14.50	76.26	4.12	3.01
Year 6	2.10	14.61	76.10	4.33	2.84
Year 7	2.04	14.84	75.74	4.27	3.11
Year 8	2.05	14.85	75.70	4.36	3.04
Year 9	2.03	14.96	75.56	4.30	3.15
Year 10	2.04	14.92	75.59	4.32	3.11

Variance Decompositions of Δm2:

Year 1	36.96	0.01	2.82	60.21	0.00
Year 2	34.60	0.10	10.26	54.94	0.10
Year 3	33.13	4.94	8.92	46.92	6.09
Year 4	31.24	4.73	12.52	45.10	6.41
Year 5	28.81	6.31	17.10	41.60	6.18
Year 6	26.87	6.93	20.54	39.80	5.86
Year 7	25.44	8.15	22.52	37.67	6.22
Year 8	24.64	8.33	24.05	36.91	6.07
Year 9	23.84	8.91	25.36	35.72	6.17
Year 10	23.39	8.97	26.32	35.25	6.06

Variance Decompositions of Δe

Year 1	3.36	1.03	3.62	55.34	36.64
Year 2	13.81	1.04	3.82	45.82	35.51
Year 3	10.28	2.97	25.83	34.63	26.28
Year 4	9.03	4.27	31.86	31.00	23.85
Year 5	8.04	8.71	31.40	28.65	23.19
Year 6	7.95	8.71	31.78	28.30	22.27
Year 7	7.61	9.46	34.34	27.07	21.52
Year 8	7.39	9.63	35.46	26.63	20.89
Year 9	7.20	10.04	36.06	26.00	20.70
Year 10	7.11	10.09	36.54	25.82	20.43

(Footnotes)

[7] Figures in parentheses are standard errors.