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# **Modeling inflation dynamics in a conflict economy**

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## نمذجة التضخم فى إقتصاد حرب

### مستخلص

الهدف من البحث هو تكوين نموذج إقتصادى لنمذجة التضخم فى إقتصاد يواجه صعوبات خارجية وداخلية تحد من قدراته الإنتاجية وتسهم فى عدم إستقرار سياسى يستلزم تزايد نشاط سوق غير رسمى لأسعار الصرف مقابل العملات الأجنبية ونمو الكتلة النقدية نتيجة لصرف أمنى وعسكرى متزايد. نتائج البحث توضح بالرغم أن المحرك الرئيسى لتحويلات التضخم فى السودان خلال الفترة الموضحة هو نمو الكتلة النقدية إلا أن تأثير نشاط السوق غير رسمى للعملات الأجنبية على معدل التضخم أصبح يتزايد بصورة ملحوظة هذا بالإضافة إلى تزايد دور التضخم المستورد نتيجة لتزايد الإعتقاد على السلع الغذائية المستوردة. وتوضح نتائج الدراسة أيضاً حسب تقديرات نتائج النموذج أن معدل التضخم أعلى بحوالى 22% من المعدل الرسمى المعلن من السلطات الرسمية.

# Modeling inflation dynamics in a conflict economy

## Abstract

**Research Problem:** The primary purpose of the paper is to set up a macroeconomic model that depicts domestic inflation dynamics in a conflict economy impeded by parallel market for foreign exchange and internal political conflict.

**Research methodology:** To investigate domestic inflation sensitivity to macro variables time-varying coefficient estimation approach employed on monthly data from Sudan during the period from January 2008 to December 2013.

**Results:** While domestic money growth (government spending) is the main driver of domestic inflation, the increasing role of parallel market for foreign exchange and imported inflation on domestic inflation reveal increasing sensitivity of the economy to external shocks. Also indicated that our model based estimates of domestic inflation rate is about 22% above the officially announced inflation rate.

**Recommendations:** To control domestic inflation it is essential to control growth in domestic money creation and adopt more flexible official foreign exchange rate that enables inflation targeting policy.

**Keywords:** Inflation, parallel market, money growth

## 1- Introduction:

Sudan economy can be depicted as a conflict economy as its growth has been impeded in the past due to economic sanctions, but, prior to 2011, at least remained positive due to oil revenues. However, South Sudan's secession, and subsequent oil production shutdown, drastically altered Sudan's economic growth prospects. The latest International Monetary Fund (IMF) estimates indicate that the economy contracted by 4.4% during 2012, which followed the 2011 contraction of 3.3%. Sudan's economic policy is guided by the Three Year Program (2012-14), which

centers on dealing with the negative consequences of South Sudan's secession. The program focuses on softening the adverse effects on Sudan's economic growth rate, and dealing with problems that arise in public finances. At present, severe austerity measures are in place to aid the government with the aims of the program.

The economic situation in Sudan, already dire, has continued to deteriorate since South Sudan's secession. The shutdown in South Sudanese oil production early last year, severely affected Sudan's economic indicators. To further exacerbate matters, economic sanctions remain imposed on Sudan, while aid and external economic activity is limited. The structural economic shift caused by South Sudan's secession has adversely altered virtually all economic growth prospects.

As a consequence of the secession, and subsequent extended lack of oil, Sudan's attention has shifted towards agriculture and gold mining, two potentially lucrative – and in the agricultural sector's case, almost untapped – sectors of the economy. Gold in particular has been touted as oil's possible replacement. Sudan's services sector is at present driven by the telecommunications industry, whereas the banking sector is also relatively well-developed in regional terms. Both these industries are however expected to feel the impact of the fiscal deficit, which has resulted in severe austerity measures, such as higher tax rates and the removal of fuel subsidies. Soaring food prices, along with the cessation of oil exportation, led to crippling inflation in 2012 and 2013. Although the devaluation of Sudan's national currency was necessary to realign the Sudanese pound to a level resembling its internationally perceived value, this also implied that the cost of imports increased in local currency terms.

Since losing more than half its oil reserves to South Sudan in 2011, Sudan has been struggling to keep consumer price index (CPI) inflation levels

low. The latest IMF forecasts cite CPI inflation to average 28% in 2013 – down from the 35% recorded in 2012. While this forecast seems likely at the moment, there is a risk that CPI inflation could be much higher, despite the likelihood of base effects occurring later in the year.

The remaining parts of the paper structured as follows: section two present literatur review, section three includes a macro model depicting a conflict economy, section four present empirical analysis, the final section concludes the research findings.

## **2-Previous studies:**

In the past two decades a number of studies (Estrella and Mishikin (1997), Anderson and Sj (2000), Chandra and Tallman (1996, Gray and Thoma (1998)) investigated the causal relationship between inflation and financial variables as monetary aggregates and foreign exchange rates in developed economies. The search of the causal relationship of the monetary aggregates and foreign exchange rates on inflation also carried on to the African economies. London (1989) analyzed the experience of 23 African countries and concluded significant effect of exchange rates and money growth on inflation rates. Chhiber et al (1989) indicated exchange rate adjustment and domestic money growth had a significant effect on inflation in Zimbabwe. Tegene (1989) employed Granger and Pierce causality tests to find out that monetary expansion causes domestic inflation in six African countries. Agenor (1989) identified significant role for parallel market rates on

inflation in four African countries. Durevall and Ndung (2001) employed error correction model of inflation for Kenya to find out that money supply affected inflation only in the short-run, and had a significant impact on three month treasury bill rate. Similar results concluded for significance of T-bills by Nachenga (2001) on inflation in Uganda. Sacerdoti and Xiao (2001) indicated money growth had insignificant effect on inflation in Madagascar, but the effect of exchange rate was significant. Durevall and Kadenge (2001) indicated a significant role for exchange rate and foreign price changes after the economic reforms in Zimbabwe. Barnichon and Peiris (2007) used a panel co-integration model to verify the effect of money and output gap on inflation in Sub-Saharan African countries. Balvy (2004) and Nassar (2005) found long-run association between consumer prices and money supply in Guinea and Madagascar respectively. Despite the consensus in emirical research on the impact of money supply and exchange rates on inflation in low income economies, however, studies on inflation dynamics in post-conflict coutnries have been scarce. To fill this void this paper aims to achieve two purposes: first, to structure a macro economic model depicting a conflict economy; second, to assess time-varying effects of explanatory variables on inflation in Sudan using dynamic estimation approach.

### 3- The Macroeconomic Model:

In this economy domestic firms produce for home consumption or export. Exports are exogenously determined, as they depend mainly on international terms of trade. Home goods (y) have a Cobb-Douglas production function with imported producer goods  $I_p$  and domestic labour  $L_y$  as the only inputs, as indicated in equation (1).

$$Y \leq I_p^{(1-\alpha)} L_y^\alpha, \quad 0 \leq \alpha \leq 1 \quad (1)$$

The government stipulate that private firms convert a portion,  $(0 < \phi < 1)$  of their export proceeds at the parallel rate  $b$ , and the remaining part at the official rate,  $e$  which is always lower than  $b$ .

Despite foreign exchange regulations firms can divert additional export proceeds illegally at the parallel rate  $b$ , by under-invoicing export proceeds. As a result, the decision of how much of export proceeds to surrender at the official rate versus the parallel rate depends on the size of  $\phi$ , which will determines the amount of export proceeds to evade foreign exchange regulations.

The income of domestic firms consist of revenue from goods produced for domestic consumption and revenue from export. The expenditure side includes imported capital goods and labour cost for both export and domestic consumption goods. It is also included in the expenditure side the cost of under-invoicing export revenue, which is assumed linear function of  $\phi$ , or more specifically  $(\phi/2)$ . Thus, firms' decision rules for all the choices above are found by maximising their profit function With respect to  $L_y$ ,  $I_p$  and  $\Phi$ , subject to production constraints:

$$\text{Max}[p_y Y + \{\phi b(1 - (\phi/2) + (1 - \phi)e)\}X - bP^*_m I_p - W(L_x + L_y)] \quad (2)$$

Subject to:



$$Y \leq I_p^{(1-\alpha)} L_y^\alpha, \quad 0 \leq \alpha \leq 1$$

The first order conditions for  $I_p$ ,  $L_y$  and  $\Phi$  are:

$$P_y(1-\alpha)I_p^{-\alpha}L_y^\alpha = P_m^* b \quad (3)$$

$$P_y \alpha Y / L_y = W \quad (4)$$

$$\Phi = (1 - 1/\pi) \quad (5)$$

Where  $\pi = b/e$ , refers to the parallel rate premium, and  $P_m^*$  is the dollar value of import price. Concavity of equation (5) implies that, while rising premium induce diversion of foreign currency from the official market to the parallel market by under-invoicing export revenue, but in a decreasing rate due to higher penalty cost when the size of under-invoicing increases.

After a few manipulations and substitutions of equations (3) and (4) we get:

$$P_y = P_m^* b (I_p / L_y)^\alpha + w (I_p / L_y)^{\alpha-1} \quad (6)$$

When the ratio of capital and labour inputs  $(I_p / L_y)$  combined in fixed proportions, equation (6) reduces to:

$$P_y = \beta_1 P_m^* b + \beta_2 w \quad (7)$$

where  $\beta_1 = (I_p / L_y)^\alpha$ ,  $\beta_2 = (I_p / L_y)^{\alpha-1}$

Thus, domestic inflation can be expressed as a function of imported inflation and domestic wage cost and the parallel rate:

$$\begin{aligned} \dot{P}_y &= \beta_1 [P_m^* \dot{b} + b \dot{P}_m^*] + \beta_2 \dot{w} \\ &= \beta_2 \dot{w} + \beta_3 \dot{b} + \beta_4 \dot{P}_m^* \end{aligned} \quad (8)$$

for  $\beta_2 > 0, \beta_3 > 0, \beta_4 > 0$

Where a dot over a variable denotes change over time.

Since change in real exchange rate reflect change in the relative price of tradables to non-tradables, or  $r = (eP_x^*/P_y)$  then change in the parallel exchange rate affect the real exchange through its effect on domestic inflation (equation 8). In this definition of real exchange rate the relation between real exchange rate and export defined as:  $(\partial X/\partial r) > 0.$ , so that appreciation in real exchange rate induce non-oil commodity exports.

#### **4- Empirical analysis**

Equation (8) specify domestic inflation in the conflict economy as a function of domestic money growth (or government spending), the parallel market rate for foreign exchange, and imported inflation (measured by the global food price index)<sup>2</sup>. The effect of growth in money supply on domestic inflation transmit through excess liquidity generated in the economy. The demand for foreign currencies in the black markets mainly stems from three activities: legal and illegal imports, portfolio diversification and capital flight, and residents travel abroad. The portfolio motive is believed to be strong in high inflation economies, where real interest rates are very low, and where considerable uncertainty over economic policies prevails. In these situations foreign currency holdings represent a safeguard against domestic currency depreciation. Portfolio diversification through the black market can also take place as a result of restrictions on private capital outflows through the official market.

To assess long term association between domestic inflation and the explanatory variables mentioned above we employed Autoregressive Distributed Lagged (ARDL) bound test for cointegration analysis.

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<sup>2</sup> Domestic money supply data obtained from the Economic Report of Bank of Sudan and the foreign exchange data from foreign exchange bureaus operating in the country, and the global food price index data obtained from Index Mundi website at: <http://www.indexmundi.com/commodities/>.

To test for unit root in the data we employed the conventional PP (Phillips-Perron) test which test for the null-hypothesis of random walk. The ARDL cointegration test requires each of the variables either integrated of order 0, or 1 (i.e., I(0) or I(1)) but not I(p) for  $p > 1$ , as the test result becomes inconclusive for  $p > 1$ . The results of unit root test included in table (1) indicate all variables are random walk (non-stationary) at levels, but at the first difference they reject the null-hypothesis of random walk which indicates all variables are integrated of order one (I(1)).

**Table (1): Unit root tests**

level	PP test statistics	Critical value
Domestic Inflation	2.79	6.25
FX rate	2.73	6.25
M2	1.62	6.25
Foreign Inflation	2.66	6.25
First difference		
Domestic Inflation	13.68*	6.25
FX rate	20.65*	6.25
M2	43.22*	6.25
Foreign inflation	14.41*	6.25

\*significant at 5% significance level.

Given that all variables are I(1) we can apply ARDL bound test to assess long-run association between the dependent variable and the set of the independent variables . The calculated F-statistic equal 5.67, which is greater than the upper bound critical value ( 3.79) at 5% significance level. This result reject the null-hypothesis of no cointegration between the

variables . Evidence of long-term association of variables in equation (1) justify use of error correction specification. Table ( 2) presents estimation results of time varying coefficients using flexible least square (FLS) method . Results in table (2) indicate during the sample period 2008 – 2013 the effect of the parallel market rate for foreign exchange on domestic inflation rate jumped from 5% to 37%, which is an indication of the increasing role of the parallel market rate for foreign exchange on domestic inflation. During the same period the effect of domestic money growth (growth in government spending) on domestic inflation rate increased from 63% to 67%, which is high , but stable effect as indicated by the relatively low value of coefficient of variation. The impact of imported inflation on domestic inflation rate also increased from 10% to 27%. In general, these results indicate the transmission effect of the two variables , parallel market rate, and imported inflation , on domestic inflation are unstable revealing the high sensitivity of the economy to external shock.

Table (2): Time-varying coefficient estimates

variable	coefficients mean	coefficients (min to max)	coefficient of variation
Parallel Market	0.22	0.05 to 0.37	0.47
Foreign Inflation	0.19	0.10 to 0.27	0.25
Money supply	0.64	0.63 to 0.67	0.01
constant	0.004	-0.001 to 0.18	18.9

Note: All variables transformed to log differences.

Table (3): Inflation rates

year	CPI-based Inflation rate	Model-based Inflation rate	% Change
2013			
Jan	43.6	42.1	-3
Feb	48.8	55.9	14.5
Mar	47.9	60.4	26.1
Apr	41.4	57.6	39.1
May	37.3	48.4	29.7
Jun	27.1	45.7	68.6
Jul	23.8	33.4	40.3
Aug	22.9	28.5	24.4
Sep	29.4	27.6	-6.1
Oct	40.3	35.9	-10.9
Nov	42.8	48.6	13.5
Dec	41.9	51.9	23.8
Mean	37.2	44.7	20.2

## 5. Concluding remarks

The paper investigates dynamics of inflation in a conflict economy enduring political instability and external economic sanctions using time-varying coefficient estimation approach. We set up a macroeconomic model featuring a conflict economy reflecting active parallel market for foreign exchange and excessive government spending on non-productive activities (i.e on military and security spending). Our estimation results indicate:

- a) The effect of the parallel market rate for foreign exchange on domestic inflation rate jumped during the sample period from 5%

to 37%, which is indication of the increasing role of the parallel market rate for foreign exchange on domestic inflation at the post-secession period.

- b) The effect of domestic money growth on domestic inflation increased from 63% to 67%, which is eventhough relatively sizable effect, it is stable as indicated by the low value of coefficient of variation.
- c) The impact of imported inflation on domestic inflation rate at the post-secession period also increased from 10% to 27%.
- d) The increasing role of the parallel market , and imported inflation on domestic inflation is indication of increasing exposure of Sudan economy to external shocks.
- e) Also indicated that the official government figures of domestic inflation rates under estimates actual inflation rate as our model based estimates of domestic inflation rate is about 22% above the officially announced inflation rate.

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