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# Modelling the Effect of the Parallel Exchange Rate on Inflation Dynamic

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## Abstract

The purpose of this study is to examine the relationship between the parallel exchange rate and consumer price inflation in Sudan. The methodological approach taken in this paper is based on Markov-switching model that allows for different regimes to be estimated. The findings reveal that the exchange rate pass-through to inflation is asymmetric across and within regimes. In particular, fluctuations in the parallel market rate have more effect on inflation during high inflation regimes. Moreover, the study finds that a currency depreciation is passed through to price level more than a currency appreciation during the unstable regime. Most importantly, we find partial evidence of complete pass-through in the long- and short-run. Interestingly, the conclusions drawn are quite similar even when the official exchange rate is used. This analysis provides new insights into the consequences of the unofficial market for currency in a high inflationary economy. Therefore, there is, a definite need to maintain and strengthen the efforts to combat all the unofficial exchange rate market activities.



**Keywords:** parallel market exchange rate, exchange rate pass-through, inflation, asymmetry, Markov-switching, Sudan.

**JEL:** F31, E31, C24


## 1. Introduction

The emergence of the parallel foreign exchange market, which mostly takes place in less-developed countries, is considered a clear sign of economic distortion. In such situations, the economy becomes highly unstable at both macro and micro levels. It is known that dual exchange rates[1] is viewed as one of the main causes of resources misallocation, which in turn affects economic growth (Pinto, 1989; Morris, 1995). The serious attempts of exchange rates unification by minimizing the gap between the official rate and the parallel rate, as the case for many countries, may likely worsen the economic conditions and fuel the price levels (Pinto, 1989). Consequently, in many countries the parallel market for foreign exchange is strongly linked to inflation. Also, the

[1] This refers to both official and unofficial dual exchange rates.

monetary expansion in a condition where the compression of import volumes and falling domestic production levels produce shortages of goods and contribute to a higher consumer price index (CPI) and increases the parallel market premium (Ansu, 1997).

Maintaining price stability and controlling inflation rates are major economic policy objectives. Unexpected or high inflation is one of the main elements that lead to economic imbalance and instability. The persistent increase in the price levels creates an uncertain economic environment due to higher inflation expectations and lower economic and investment activities. Consequently, the volatility of prices could be a major source of disturbance to full employment and contraction of economic growth rate.

The tale of exchange rate depreciation and fluctuations in Sudan's parallel market for foreign exchange began quite after the huge loss of oil revenues followed the secession of South Sudan in 2011. Since then, the Sudanese economy began to slowdown, reflecting the deterioration in the core economic indicators of economic sectors, mainly external sector. In particular, due to the shortages in the foreign exchange reserves the epidemic of the parallel market started to grow. The high inflation rates led to an overvaluation of real exchange rate, especially under the fixed exchange rate regime, which resulted in a parallel exchange rate market (International Monetary Fund, 2020). In addition, the domestic price levels and money supply have witnessed gradual upward movement before they skyrocketed. As a result of financing fiscal deficits using seigniorage or quasi-fiscal financing, inflation surpassed 70 percent in December 2018 before it reaches 341.8 percent in March 2021 (Central Bank of Sudan, 2021). Until recently, the government preserved multiple exchange rates, starting with the official exchange rate, the customs exchange rate, the fuel import rate, and the parallel market rate, at which all other transactions take place (International Monetary Fund, 2020). Before the mid of 2019, the currency exchange in the parallel market had two different rates for cash and cheque.

Over the past decade, several attempts to eliminate the difference between the official and parallel market rates failed, and the difference reached around 38 percent at the end of 2017 (Onour, 2018). As a result, the US$ was selling for 100 Sudanese pound (SDG) in cash transactions, and the gap with the official rate reached more than 45 SDG to the dollar and continues to widen (Thomson Reuters, 2020). The failure to control the parallel or the black-market exchange rate had dire effects on the economy, especially the price levels of goods and services. Interestingly, various local

markets have become directly linked to the parallel market, and the prices of products are adjusted to the parallel market exchange rate of SDG to US$ on a daily or sometimes hourly basis, indicating the possibility of a high or a complete exchange rate pass-through (ERPT hereafter). Not only that but the markets were characterized by overwhelming chaos even in the pricing of a certain commodity in the same geographical area.

In the literature, the fluctuations of exchange rates have recorded many adverse economic effects in most countries, especially less-developed countries. In a high inflationary environment, the exchange rate fluctuation is transmitted to the domestic prices much more quickly and with a higher magnitude compared to a low inflationary environment (Taylor, 2000). Moreover, many empirical studies advocate that exchange rate changes affect prices in an asymmetric fashion where inflation responds to the depreciation of the currency more than the appreciation (see Delatte and López-Villavcencio, 2012; Kilic, 2016; Baharumshah et al., 2017a,b). While only few studies attempt to investigate the ERPT in the case of Sudan, Baharumshah et al. (2017a) find that consumer price index reacts asymmetrically to exchange rate changes. Nevertheless, the official exchange rate is used by the majority of the previous literature. In the presence of the parallel market for foreign currencies, the exchange rate is expected to have a dominant effect on domestic inflation (Aron and Elbadawi, 1997). Therefore, using only the official exchange rate to estimate the ERPT in a country such as Sudan, especially under a fixed exchange rate regime, may likely affect the outcomes and thereby the parallel exchange rate should be used as a main indicator.

To the best of our knowledge, this paper is among the few studies that examined the ERPT in the case of Sudan using the parallel exchange rate together with the official rate. In addition, the study uses an econometric technique of a Markov-switching model to determine the extent of ERPT to inflation in Sudan using monthly data from January 2015 to March 2021. An important feature that distinguishes the regime switching model from the other existing ones is that the switching mechanism is governed by an unobservable state factor. Also, the ability of the model to control for different inflationary environments, which reflects the asymmetric/symmetric behaviour of exchange rate.

The organization of the research proceeds as follows. Sections 2 reviews some relevant theoretical and empirical literature, Section 3 illustrates the methodology and data used in the study, Section 4 presents the findings and discussion, and Section 5 concludes the study.

## 2. Literature Review

Several research point to the nexus between parallel exchange rate and inflation. For instance, Kaminsky (1997) discussed that the link between inflation and capital movements may exist under dual exchange rates, since a depreciation of the parallel rate may affect prices through the three following channels. First, the linkage between official and parallel markets exists when a depreciation of the parallel rate above the official rate induces under-invoicing of exports or over-invoicing of imports. In turn, this may influence the market prices of goods and services, suggesting that demand for foreign exchanges has a direct link with domestic prices. Second, the increase in interest rates due to a depreciation in the parallel market exchange rate may lead to changes in investment and consumption decisions. As a simple economic fact, changes in investment and consumption affect demand for goods and services, thus prices change accordingly. Third, the monetary expansion due to the increase in government deficit. Given the difference between the parallel market and official exchange rates, the government transactions in the commercial and the financial market may lead to budget deficit especially if the value of the transactions were higher in the commercial market. As a result, the fiscal deficit may bring an increase in money creation and thus higher domestic prices.

The emergence of parallel markets for foreign exchange trading is a special case in some less-developed countries. For instance, Aron and Elbadawi (1997) found the parallel market exchange rate had a significant effect on domestic inflation in Zambia. In an oil exporting country such as Iran, Bahmani-Oskooee (1999) found that during the depreciation of the parallel market exchange rate higher imports were observed, while less goods were imported during appreciation. It is worth noting that relying on monetization to finance the budget deficits is one of the leading factors for the depreciation of the parallel market exchange rate in Iran (Valadkhani and Nameni, 2011). Although the dollarization is normally viewed as an exit strategy from hyper-inflation that is mainly driven by the parallel market for foreign exchange, some literature found otherwise. For example, Mengesha and Holmes (2015) studied the effect of exchange rate on inflation in a partially dollarized state of Eritrea. A positive effect on inflation was found when the official and the parallel market exchange rate were used. According to Cerra (2019) the domestic price of goods is determined by the demand for the goods and the availability of foreign exchange in the Venezuelan context. Interestingly, the study argued that the parallel market may have the highest

markup for import prices. The large depreciation of the parallel exchange rate mirrors prices in the distorted markets (Cerra, 2016).

Under the dominance of parallel market for foreign exchange such as in Sudan, it is unlikely for economic authorities to control inflation. Few studies have highlighted the issue of parallel market exchange rate and inflation in Sudan. In this regard, Elbadawi (1994) studied the economic implications of the parallel market for foreign exchange for the period of the early 1990s. The author argued that during periods of high premium of exchange rate, greater macroeconomic uncertainties are likely to exist. In addition, the unofficial market for foreign exchange in Sudan is linked to inefficiency (Onour, 2017). Moreover, Ebaidalla (2019) investigated the macroeconomic impact of the parallel exchange rate in Sudan. His findings showed that the parallel market premium had a reverse effect on economic growth and exports; however, it had a positive and significant effect on inflation.

A considerable amount of literature has been published on the issue of exchange rate pass-through to domestic prices (see Pollard and Coughlin, 2004; Delatte and López-Villavcencio, 2012; Bussiere, 2013; Forero and Vega, 2015; Kilic, 2016; Baharumshah et al., 2017a,b,c; Soon and Baharumshah, 2017; Amoah and Aziakpono, 2018; Kurtović et al., 2020). These studies suggested an incomplete pass-through to inflation. Also, they found that inflation reacts differently to changes in exchange rate in the short-run and/or the long-run. Nevertheless, all the previous studies were concerned with the effect of the official exchange rate on inflation and the exchange rate pass-through of the parallel market exchange rate remains unstudied. Although the study aims to fill the gap in the literature by examining the effect the parallel market exchange rate on inflation in Sudan, the official rate is used for robustness and comparison purposes.

# 3. Methodology and Modelling

## 3.1 The Conceptual Framework

In an open economy, the fluctuation in the exchange rate affects the domestic price level. The effects are transmitted through the prices of intermediate goods and higher wages. The growth of money supply results in higher inflation rates. The domestic demand is one of the factors that creates inflation in the short-run. This is normally assessed through the deviation of the actual

output from the potential. Figure (1) shows the conceptual framework that summaries the relationship among the exchange rate, money supply, output, and inflation.

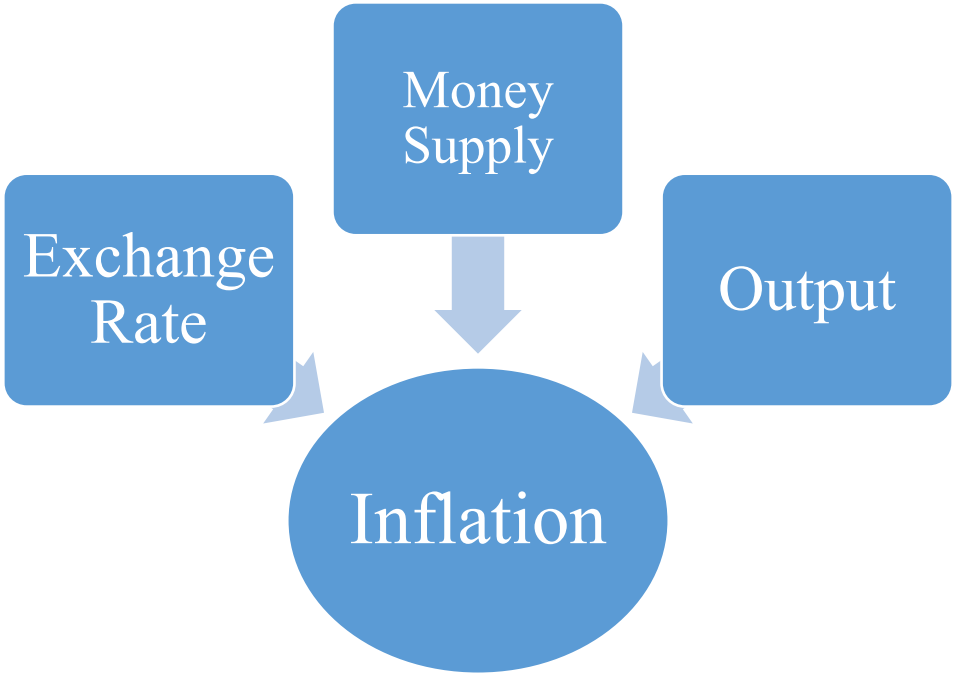


Figure 1. The Conceptual Framework

### 3.2 Markov-Switching Model

To deepen our understanding of the relationship between exchange rate and inflation, we rely on a Markov-switching model similar to Hamilton (1989, 1990). Such regime-switching models are considered alternative methods for introducing asymmetry, for instance; in the exchange rate-inflation nexus. One of the unique features of the Markov-switching model is its ability to produce time-varying parameters that can be evidence of non-linearity and/or asymmetry. These models are very useful to capture highly volatile financial and economic regimes. Moreover, Markov-switching models allow for the estimation of two or more regimes resulting from unobserved components of a Markov chain (Boroumand, 2016; Mills, 2019, p. 185). The switching from a state *i* to another *j*, is subject to transition probabilities.

For modelling the parallel market ERPT to inflation, the Markov-switching model is appropriate since it captures the stability and instability of the inflationary regimes in a country. This seems to

be logical and reasonable, especially with the swings and uncertainties that Sudan's economy is suffering from. Therefore, the following regime-switching model is considered:

$$\Delta INF_t = \alpha_{st} + \lambda_{st}\Delta INF_{t-1} + \beta_{st}\Delta PMER_t + \theta_{st}\Delta MG_t + \rho_{st}outp_t + \varepsilon_t \qquad (1)$$

where, *INF* is the CPI inflation rate, *PMER* is the parallel market exchange rate, *MG* is money growth, *outp* is the output gap constructed using Hodrick-Prescott filtered trend[2], Δ refers to the first-difference of the series, $st$ denotes the state at time *t*, and $\varepsilon_t \sim N(0, \sigma_{st}^2)$. The transition between states is assumed to be governed by a first-order Markov process

$$\left.\begin{array}{l} \Pr[S_t = 1|S_{t-1} = 1] = p, \\ \Pr[S_t = 2|S_{t-1} = 1] = 1 - p, \\ \Pr[S_t = 2|S_{t-1} = 2] = q, \\ \Pr[S_t = 1|S_{t-1} = 2] = 1 - q, \end{array}\right\} \quad \text{where } p + (1-p) = q + (1-q) = 1 \qquad (2)$$

The transition probabilities are shown in Eq. (2), which determine the probability of each state occurrence at each point in time, rather than imposing particular dates in advance. Also, one may assume a constant variance across different states, but allowing for heterogeneity of the variances is more common in the empirical studies (Boroumand et al., 2016; Soon and Baharumshah, 2017; Baharumshah et al., 2017c). In an attempt to find an appropriate model, we estimate Eq. (1) under both scenarios. The short-run ERPT in state *t* is captured by $\beta_{st}$, whereas in the long-run it is calculated as $\beta_{st}/(1-\lambda_{st})$.

The ERPT is expected to be bounded between 0 and 1. In the case where ERPT equals to zero, foreign exporters decide not to fluctuate the prices in the destination country's currency and absorb the fluctuation (Local Currency Pricing). If the ERPT is complete or equal unity, exporters will respond to fluctuation of the exchange rate by setting their prices in foreign currencies (Producer Currency Pricing). The rejection of a certain hypothesis and failure to reject the other indicates the validity of the latter hypothesis. Also, an incomplete ERPT to domestic inflation may exist when the coefficient is greater than zero, and less than one and both hypotheses are rejected. The assumptions of local currency pricing and producer currency pricing in each state are tested in the

[2] Neither GDP nor industrial production index are available in a monthly basis. Therefore, we relied on linear interpolation to construct a proxy for output then use it to calculate the output gap.

short-run as: $H_0: \beta_{st} = 0$, and $H_0: \beta_{st} = 1$, and in the long-run as: $H_0: = \beta_{st}/(1 - \lambda_{st}) = 0$, and $H_0: = \beta_{st}/(1 - \lambda_{st}) = 1$, respectively.

### 3.3 Asymmetric Markov-Switching

Although regime-switching models capture the potential asymmetric effect of exchange rate changes on inflation during different inflationary regimes. Nevertheless, it does not differentiate between the appreciation and depreciation of the currency in a certain state. Within a specific regime, the changes in exchange rate may have asymmetrical effects on consumer price inflation. To incorporate such asymmetric responses, Eq. (1) can be modified as follow:

$$\Delta INF_t = \alpha_{st} + \lambda_{st}\Delta INF_{t-1} + \beta_{st}^{+}\Delta PMER_t^{+} + \beta_{st}^{-}\Delta PMER_t^{-} + \theta_{st}\Delta MG_t + \rho_{st} outp_t + \varepsilon_t \qquad (3)$$

where all the variables are defined below Eq. (1), $PMER^{+}$ refers to the partial sums of the positive changes or exchange rate depreciation in state *s*, and $PMER^{-}$ denotes the negative changes or exchange rate appreciation in state *s*. As shown by Shin et al. (2014), both series $PMER^{+}$ and $PMER^{-}$ are decomposed to their partial sums in $PMER$,

$$PMER^{+} = \sum_{t=1}^{t} \Delta PMER_t^{+} = \sum_{t=0}^{t} \max\left(PMER_i, 0\right)$$

$$PMER^{-} = \sum_{t=1}^{t} \Delta PMER_t^{-} = \sum_{t=0}^{t} \max\left(PMER_i, 0\right)$$

Similar to Eq. (1), we estimate Eq. (3) assuming homogeneity and heterogeneity of the variances, respectively. The assumption of local currency pricing in state *s* is tested using the hypotheses: $H_0: \beta_{st}^{+} = 0$, $H_0: \beta_{st}^{-} = 0$ in the short-run, and $H_0: = \beta_{st}^{+}/(1 - \lambda_{st}) = 0$, $H_0: = \beta_{st}^{-}/(1 - \lambda_{st}) = 0$ in the long-run. Whereas producer currency pricing in each state is tested as: $H_0: \beta_{st}^{+} = 1$, $H_0: \beta_{st}^{-} = 1$ , in the short-run, and $H_0: = \beta_{st}^{+}/(1 - \lambda_{st}) = 1$, $H_0: = \beta_{st}^{-}/(1 - \lambda_{st}) = 1$ in the long-run.

### 3.4 The Data sources

The unavailability of high-frequency data that covers long period of time, especially in less-developed countries, remains a bewildering mystery. Therefore, our study relies on monthly data covering the time period from January 2015 to March 2021. The Sudan's inflation is measured

using the changes in CPI and the data are collected from the Central Bank of Sudan (2021). The monthly CPI is one of the significant economic indicators in the country since other measures, such as producer price index and imports prices index are not reported in Sudan. In the same vein, the parallel market exchange rate data are collected from Alnilin news.[3] Moreover, money growth is obtained from the Central Bank of Sudan (2021). While output gap, which is considered as an essential factor in controlling for domestic demand, is obtained using Hodrick-Prescott filtered trend of the real GDP. We utilize interpolation technique to convert the low frequency series to a high frequency series. Although data interpolation methods are problematic, however; still some studies have used similar approach (see Baharumshah et al., 2017a). Also, the series can be used since it is considered as the best alternative. The real GDP data are obtained from the World Development Indicators of the World Bank (2021). Finally, the official exchange rate data are retrieved from the Central Bank of Sudan (2021).

Figure (2) shows monthly data for inflation, parallel market exchange rate, and money growth from January 2015 to March 2021. It can be seen that the data is relatively more stable during the period January 2015 until September 2017, whereas for the rest of the period the data is characterized by higher instability. Hence, the behavior of our data fits the econometric technique of regime-switching models. Table (1) presents the descriptive statistics of the variables used in this study. As the table show, the *PMEX* has the highest variation among the data with standard deviation about 1.06.

[3] The data for the parallel exchange rate is obtained from Alnilin news: www.alnilin.com.

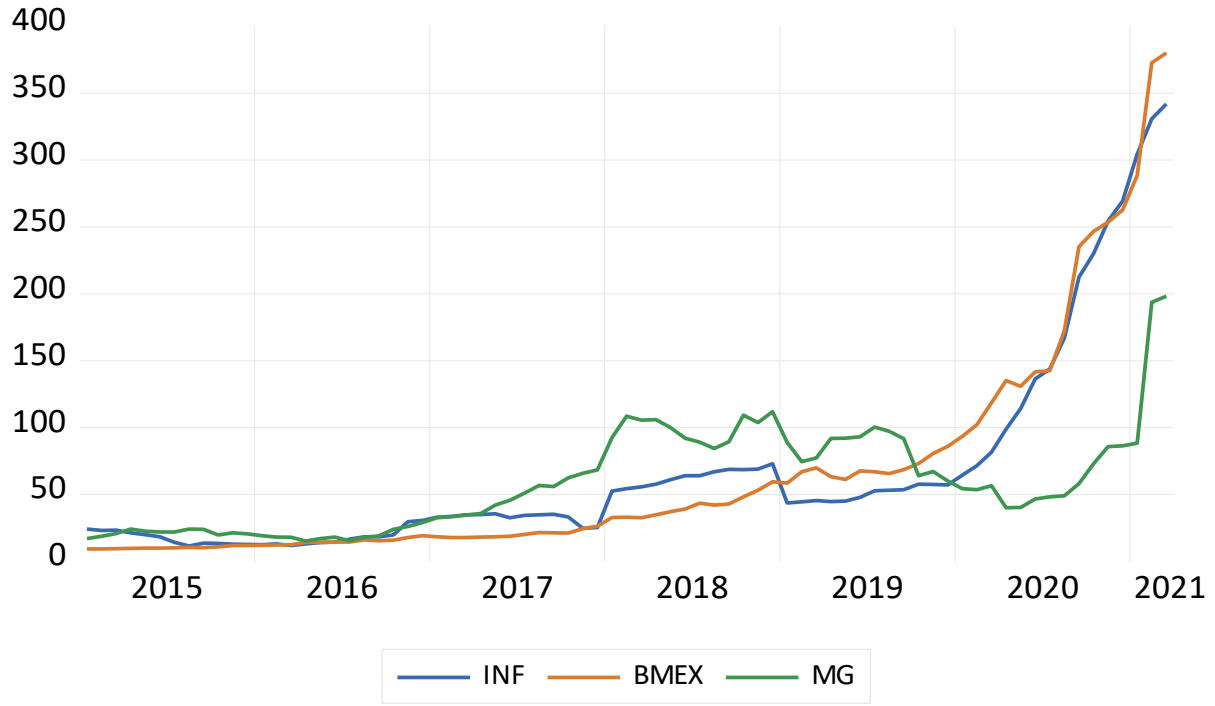


Figure 2. Inflation Rate, parallel Market Exchange Rate, and Money Growth (Jan 2015 – Mar 2021).

Source: Central Bank of Sudan (2021) is the source for INF and MG, while PMEX is obtained from Alnilin (2021).

Table 1. Descriptive Statistics

| Variable | Obs | Mean | Maximum | Minimum | Std. Dev. |
|---|---|---|---|---|---|
| *INF* | 75 | 3.7634 | 5.8342 | 2.4248 | 0.8864 |
| *PMEX* | 75 | 3.5937 | 5.9402 | 2.2235 | 1.0577 |
| *MG* | 75 | 3.8620 | 5.2891 | 2.7185 | 0.6866 |
| *outp* | 75 | -0.0064 | 5.10E+08 | -9.15E+08 | 3.87E+08 |

Note: all the variables are expressed in logarithmic form, except *outp*.

# 4. The Empirical Findings

## 4.1 Markov-Switching Results

Table (2) shows the findings of Markov-switching model with homogeneous variance. State 1 presents the findings of the stable regime (low-volatility), and state 2 demonstrates the results of the instable regime (high-volatility). In state 1, the outcomes reveal that *PMER* has a positive and significant impact on inflation. This finding suggests that higher inflation could be due to currency

depreciation. In addition, the results show that *MG* affects inflation positively in the country. While the *outp* is not statistically different from zero, indicating that it has no influence on inflation rate during the stable regime. The results of the unstable regime (state 2) show that the coefficients of the lagged-dependent variable and *PMER* are statistically not equal to zero, whereas those of *MG* and *outp* are insignificant. These findings indicate that the dynamic term of inflation and *PMER* affect the inflation positively during the unstable regime. The idea that the previous inflation is positively related to the current inflation level suggests that a higher inflation raises the expectations about future prices, and thereby increases inflation. Also, the changes in the *PMER* have positive effect on inflation. However, the findings of state 2 show that *outp* has a negative and insignificant effect on inflation. This would imply that during the highly unstable inflationary regime, the domestic demand has adverse consequences on the economy's overall price levels.

Importantly, our findings highlight the influence of *PMER* on inflation. We find that the fluctuations in *PMER* have positive influence on inflation rates during the stable and unstable regimes. These outcomes indicate that the depreciation/appreciation of the Sudanese currency in the parallel market, during the stable and unstable inflation regimes, will be symmetrically transmitted to the consumer price index. The coefficients' restrictions results show the rejection of the hypotheses $H_0: \beta_{s1} = 1$ and $H_0: \beta_{s2} = 1$ in the short-run for state 1 and state 2, respectively, implying the non-existence of both hypotheses and the presence of an in complete pass-through. While the long-run restrictions results reveal that the producer currency pricing is supported in state 1 since we rejected the local currency pricing. However, the long-run ERPT during state 2 is incomplete since both restrictions are rejected. Regarding the specification of the Markov-switching model, the transition probabilities of being in state 1 and state 2 are about 0.001 and 0.89, respectively. From these probabilities, the model's expected duration is about 1.0 month in state 1, and approximately 9.2 months in state 2. These findings indicate a higher probability of remaining in the state 2 or the high inflationary regime. Also, it is signified that being in state 1 is just a temporary situation and the model quickly goes to state 2. Figure (3) illustrates the findings of the smoothed probabilities. There are few intermediary cases in the data set. But in most situations, the probability is/close to 1 or 0 of being in one of the two states.

Table (3) presents the outcomes of the Markov-switching model after allowing for variance to vary across regimes. The variance equality test provides a support to the heterogeneity for variances in different states since we rejected the $H_0: \sigma_{s1} = \sigma_{s2}$. The findings reveal that all the variables have no impact on inflation in the stable regime. Nonetheless, we find the coefficients of the lagged-dependent variable and *PMER* to be statistically significant during the unstable or high inflationary regime. The results suggest the validity of inflation dynamic during the unstable regime. Also, the positive relationship between *PMER* and inflation, during the unstable regime, indicates that the change in the parallel exchange rate leads to a movement in inflation in the same direction. From the short-run restrictions, we fail to reject either of the two hypotheses during the stable regime (state 1). Whereas the rejection of both hypotheses suggests an incomplete ERPT to inflation during the unstable regime (state 2). Similarly, the long-run restrictions show the inability to reject the null hypothesis of the local currency pricing and producer currency pricing in state 1, indicating the absence of significant association between exchange rate and inflation during stable inflationary periods. During the high inflationary regime, however, the long-run ERPT is incomplete due to the rejection of local currency pricing and producer currency pricing. It is worth mentioning that allowing the variance to vary across regimes has shown an incomplete ERPT to consumer price index inflation, both in the short- and the long-run, only when unstable inflationary environment is present. Importantly, the transition probabilities of being in the stable regime and the unstable regime are roughly 0.32 and 0.88, respectively. Whereas the expected durations are about 1.5 month and 8.6 months, for state 1 and state 2, respectively. Thereby, implying high probability of lasting in the state 2, while the chance to remain in state 1 is low. In addition, state 2 have more expected duration compared to state 1. These results could be attributable to allowing for different variances for each regime. Figure (4) demonstrates the results of the smoothed probabilities. In most cases, the probability is either 1 or close to 1 of being in state 2, but there are few intermediary cases in the data set showing relatively low probability of being in state 1.

Table 2. Markov-Switching Model – Homogeneous Variance

| Variable | State 1 | State 2 |
|---|---|---|
| $\boldsymbol{\alpha}$ | -0.0586 (0.0571) | 0.0019 (0.0138) |
| $\boldsymbol{\lambda}$ | -0.3949 (0.4284) | 0.2140*** (0.0759) |
| $\boldsymbol{\beta}$ | 2.9402*** (0.9497) | 0.4251*** (0.1572) |
| $\boldsymbol{\theta}$ | 0.8579* (0.4755) | -0.0892 (0.0764) |
| $\boldsymbol{\rho}$ | 2.04E-09 (9.47E-10) | -1.07E-10 (1.47E-10) |
| $\boldsymbol{\sigma}$ | -2.5689*** (0.0963) | |
| $\boldsymbol{p11}$ | -7.0781 (0.6635) | |
| $\boldsymbol{p21}$ | -2.1097*** (1.2928) | |
| Transition probabilities | 0.0008 | 0.8918 |
| Expected durations | 1.0 Month | 9.2 Months |
| $\boldsymbol{H_0: \beta_{s1} = 1}$ | 4.1735$^{w}$** | |
| $\boldsymbol{H_0: \beta_{s2} = 1}$ | 13.360$^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s1}/(1-\lambda_{s1}) = 0}$ | 5.2322$^{w}$** | |
| $\boldsymbol{H_0: \beta_{s2}/(1-\lambda_{s2}) = 0}$ | 6.5581$^{w}$** | |
| $\boldsymbol{H_0: \beta_{s1}/(1-\lambda_{s1}) = 1}$ | 1.4454$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}/(1-\lambda_{s2}) = 1}$ | 4.7232$^{w}$** | |

Note: ***, **, * denote 1%, 5%, 10%. This model restricted the variance to be the same across states. The 'w' refers to Wald test F-statistic values. The calculated long-run coefficients of exchange rate are 2.1078 and 0.5409 for regime 1 and regime 2, respectively.

Table 3. Markov-Switching Model – Heterogeneous Variances

| Variable | State 1 | State 2 |
|---|---|---|
| $\boldsymbol{\alpha}$ | -0.0898 (0.1232) | 0.0153 (0.0105) |
| $\boldsymbol{\lambda}$ | 0.9585 (0.9145) | 0.1155** (0.0581) |
| $\boldsymbol{\beta}$ | 0.9086 (1.8193) | 0.4886*** (0.1153) |
| $\boldsymbol{\theta}$ | 1.6062 (1.0418) | -0.0622 (0.0555) |
| $\boldsymbol{\rho}$ | 1.29E-09 (1.59E-09) | -1.14E-10 (1.08E-10) |
| $\boldsymbol{\sigma}$ | -1.5794*** (0.2712) | -2.9326*** (0.1123) |
| $\boldsymbol{p11}$ | -0.7696 (1.0301) | |
| $\boldsymbol{p21}$ | -2.0223*** (0.6151) | |
| Transition probabilities | 0.3167 | 0.8831 |
| Expected durations | 1.5 Month | 8.6 Months |
| The equality of variances | 22.4332$^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s1} = 1}$ | 0.0025$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2} = 1}$ | 19.6435$^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s1}/(1-\lambda_{s1}) = 0}$ | 0.0021$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}/(1-\lambda_{s2}) = 0}$ | 16.0793$^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s1}/(1-\lambda_{s1}) = 1}$ | 0.0019$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}/(1-\lambda_{s2}) = 1}$ | 10.5511$^{w}$*** | |

Note: ***, ** denote 1%, 5%. This model allows for heterogeneous variances across states. The 'w' refers to Wald test F-statistic values. The calculated long-run coefficients of exchange rate are 21.9324 and 0.5525 for regime 1 and regime 2, respectively.

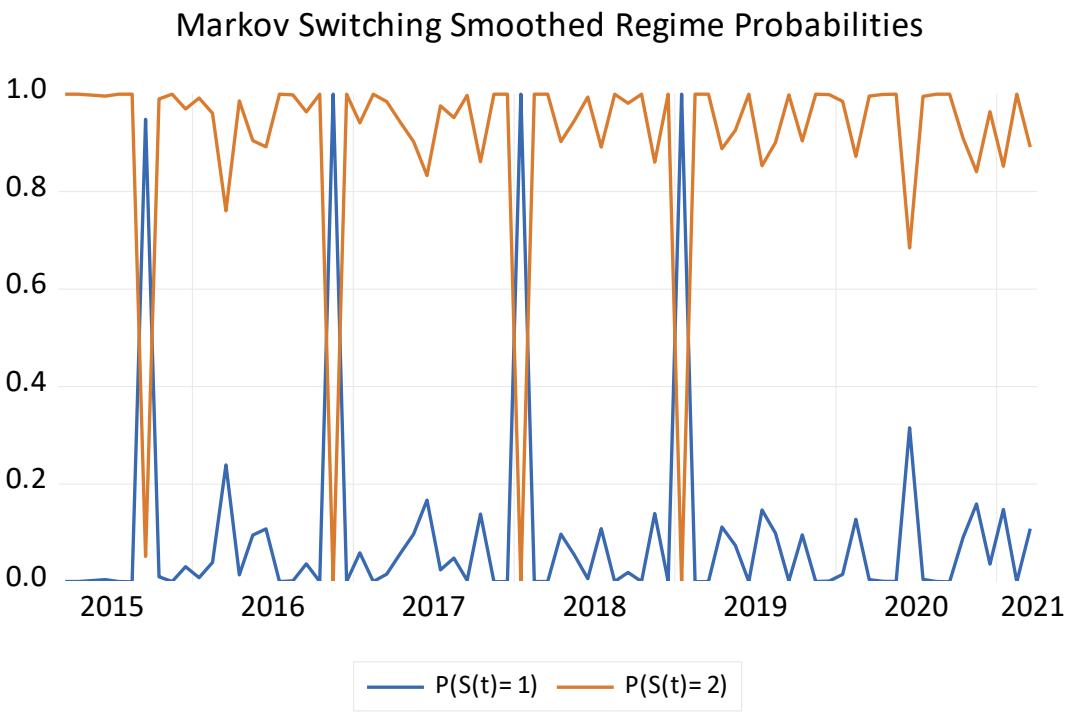


Figure 3. Smoothed States Probabilities (homogeneous variances).

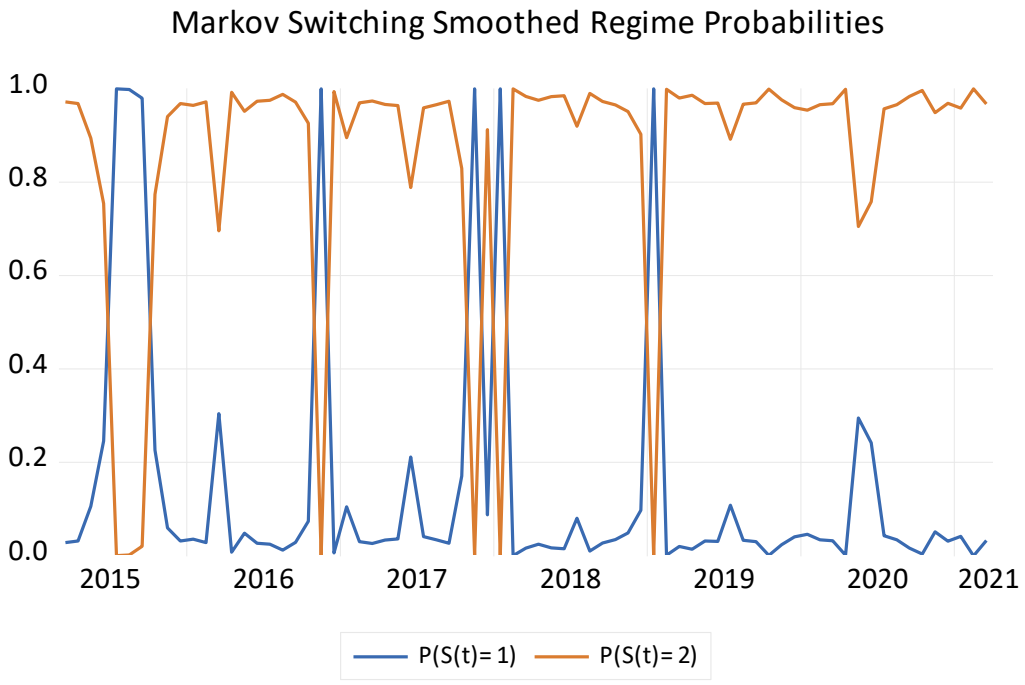


Figure 4. Smoothed States Probabilities (heterogeneous variances).

## 4.2 Asymmetric Markov-Switching Results

Although the above findings represent asymmetrical evidence of the parallel market ERPT to inflation, but the asymmetries are existed only across states. Nevertheless, asymmetries may exist in a particular state as far as exchange rate fluctuation is concerned. In particular, the depreciation of the currency in the parallel market may not necessarily have the same impact on domestic inflation as currency appreciation, which implied by the results in Table (2) and (3). Table (4) presents the results of the asymmetric Markov-switching model with restricted variance in both regimes. In state 1, the results show that only $INF_{t-1}$ and $PMER^{+}$ are positive and statistically meaningful related to price levels. This points out that the $PMER^{-}$, *MG* and *outp* have no impact on inflation in state 1. While the outcomes of state 2 show that $BMER^{+}$ and *MG* are positive and statistically significant determinants of inflation, implying that the depreciation of the currency in the parallel market fuels inflation especially during the unstable regime. Also, the positive and significant influence of money growth on consumer price index could be due to the fact that money supply has dramatically increased over the last years. However, during the high inflationary regime, the appreciation of the currency has no effect on the price levels. It is interesting to note that when the exchange rate depreciates against the US dollar in the unofficial market, the depreciation will quickly be passed through to the inflation rates. But when the Sudanese pound appreciates against the dollar, the prices remain unchanged. The restrictions results show that the producer currency pricing is rejected for both $PMER^{+}$ and $PMER^{-}$, while local currency pricing is rejected only for $PMER^{+}$, indicating the reality of an ERPT to price level in the short-run during the stable regime. For state 2, we are able to reject the local currency pricing and the producer currency pricing hypotheses only for $PMER^{+}$, thus the prices are stimulated by the depreciation of the currency in the parallel market. In the long-run, however, local currency pricing is stablished for appreciation of the currency in state 1, suggesting no adjustment to prices take place as currency appreciates. While the long-run producer currency pricing is established during both inflation regimes for $PMER^{+}$, suggesting that producers pass the depreciation of the currency to the consumers which translated into higher inflation rates. The transition probabilities of state 1 and state 2 are about 0.89 and 0.001, respectively, suggesting high chance of remaining in the stable regime with 9.3 months and 1.0 month expected durations for state 1 and state 2, respectively. Figure (5) demonstrates the smoothed probabilities. In most circumstances, the probability is close to 1 to remain in state 1 and close 0 of being in state 2. This finding is quite

surprising since it is expected to obtain a higher probability for the unstable regime given the data set. One possible explanation could be the restriction of the homogenous variance across regimes.

Table (5) contains the results of the asymmetric Markov-switching with heterogeneous variances in each state. The rejection of variance equality test, $H_0: \sigma_{s1} = \sigma_{s2}$, shows evidence of heterogeneity in both regimes. In state 1, the results reveal that only $PMER^+$ and *MG* variables are directly related to inflation, suggesting that currency depreciation and money supply lead to higher price level. While for regime 2, the findings show that $INF_{t-1}$ $PMER^+$, and *MG* are statistically significant determinants of inflation, except that *MG* shows a negative sign. During the unstable regime, the $PMER^+$ contributes to increased inflation, where the $PMER^-$ has no effect on the price levels, which implies that producers tend to pass the prices to consumers during currency depreciation and make no adjustments to prices during currency appreciation times. For the period of the stable regime, $PMER^+$ has a complete ERPT to the consumer price index since we cannot reject the producer currency pricing in the short-run, whereas we fail to reject both hypotheses in the case of $PMER^-$. Moreover, in state 2, we find an incomplete ERPT to inflation due to the depreciation of the currency. In the long-run, however, the producer currency pricing is verified for the depreciation during the high inflationary regime. Interestingly, the long-run ERPT of $PMER^+$ in state 2 is complete since the producer pricing cannot be rejected. This most certainly supports the intuition that all the fluctuations in the parallel market exchange rate will be fully transmitted to the domestic price level in the long-run. The transition probabilities are 0.67 and 0.91 for state 1 and state 2, respectively. The expected durations are 3.1 months and 11.6 months for state 1 and state 2, respectively. These findings point toward more probability and higher expected duration of remaining the unstable high inflation regime. Figure (6) exhibits the smoothed probabilities. Except for few cases, most of the time the probability is 1 for being in state 2, and somewhat equal between 0.5 to 0.6 for being in state 1.

Table 4. Asymmetric Markov-Switching Model – Homogeneous Variance

| Variable | State 1 | State 2 |
|---|---|---|
| $\boldsymbol{\alpha}$ | -0.0140 (0.0161) | -0.0690 (0.0810) |
| $\boldsymbol{\lambda}$ | 0.2168*** (0.0745) | -0.2899 (0.6291) |
| $\boldsymbol{\beta^+}$ | 0.6047*** (0.1827) | 2.9069*** (1.0941) |
| $\boldsymbol{\beta^-}$ | -0.8306 (0.7031) | 0.7306 (5.1828) |
| $\boldsymbol{\theta}$ | -0.1153 (0.0765) | 0.9311* (0.5516) |
| $\boldsymbol{\rho}$ | -1.31E-10 (1.44E-10) | 2.20E-09 (1.68E-09) |
| | | |
| $\boldsymbol{\sigma}$ | -2.6024*** (0.1120) | |
| $\boldsymbol{p11}$ | 2.1174*** (0.6583) | |
| $\boldsymbol{p21}$ | 7.2648 (22.7578) | |
| | | |
| Transition probabilities | 0.8925 | 0.0007 |
| Expected durations | 9.3 Months | 1.0 Months |
| $\boldsymbol{H_0: \beta_{s1}^+ = 1}$ | 4.6757$^{w}$** | |
| $\boldsymbol{H_0: \beta_{s1}^- = 1}$ | 6.7786$^{w}$** | |
| $\boldsymbol{H_0: \beta_{s2}^+ = 1}$ | 3.0375$^{w}$* | |
| $\boldsymbol{H_0: \beta_{s2}^- = 1}$ | 0.0027$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}^+/(1-\lambda_{s1}) = 0}$ | 9.5457$^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s1}^-/(1-\lambda_{s1}) = 0}$ | 1.3801$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^+/(1-\lambda_{s2}) = 0}$ | 1.9508$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^-/(1-\lambda_{s2}) = 0}$ | 0.0204$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}^+/(1-\lambda_{s1}) = 1}$ | 0.8297$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}^-/(1-\lambda_{s1}) = 1}$ | 5.2090$^{w}$** | |
| $\boldsymbol{H_0: \beta_{s2}^+/(1-\lambda_{s2}) = 1}$ | 0.6035$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^-/(1-\lambda_{s2}) = 1}$ | 0.0119$^{w}$ | |

Note: ***, **, * denote 1%, 5%, 10%. This model restricted the variance to be the same across states. The 'w' refers to Wald test F-statistic values. The calculated long-run coefficients of exchange rate depreciation are 0.7723 and 2.2534 for regime 1 and regime 2, respectively. Whereas the calculated long-run coefficients of exchange rate appreciation are -1.0607 and 0.5663 for regime 1 and regime 2, respectively.

Table 5. Asymmetric Markov-Switching Model – Heterogeneous Variances

| Variable | State 1 | State 2 |
|---|---|---|
| $\boldsymbol{\alpha}$ | -0.2258 (0.1111) | -0.0053 (0.0119) |
| $\boldsymbol{\lambda}$ | 0.1569 (0.2306) | 0.4773*** (0.1398) |
| $\boldsymbol{\beta^+}$ | 2.5054** (1.0836) | 0.5737*** (0.1289) |
| $\boldsymbol{\beta^-}$ | -6.3429 (8.4211) | -0.3541 (0.4827) |
| $\boldsymbol{\theta}$ | 0.9548** (0.4470) | -0.1349** (0.0567) |
| $\boldsymbol{\rho}$ | 1.23E-09 (9.54E-10) | -6.12E-11 (1.05E-10) |
| | | |
| $\boldsymbol{\sigma}$ | -1.7035*** (0.2127) | -3.0551*** (0.1153) |
| $\boldsymbol{p11}$ | 0.7248 (0.6980) | |
| $\boldsymbol{p21}$ | -2.3641*** (0.6377) | |
| | | |
| Transition probabilities | 0.6736 | 0.9141 |
| Expected durations | 3.1 Months | 11.6 Months |
| The equality of variances | 32.5736$^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s1}^+ = 1}$ | 1.9301$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}^- = 1}$ | 0.7603$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^+ = 1}$ | 10.9226$^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s2}^- = 1}$ | 7.8682$^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s1}^+/(1-\lambda_{s1}) = 0}$ | 2.7596$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}^-/(1-\lambda_{s1}) = 0}$ | 0.5017$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^+/(1-\lambda_{s2}) = 0}$ | 10.0822$^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s2}^-/(1-\lambda_{s2}) = 0}$ | 0.5392$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}^+/(1-\lambda_{s1}) = 1}$ | 1.2149$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}^-/(1-\lambda_{s1}) = 1}$ | 0.6439$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^+/(1-\lambda_{s2}) = 1}$ | 0.0799$^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^-/(1-\lambda_{s2}) = 1}$ | 3.3047$^{w}$* | |

Note: ***, **, * denote 1%, 5%, 10%. This model allows for heterogeneous variances across states. The 'w' refers to Wald test F-statistic values. The calculated long-run coefficients of exchange rate depreciation are 2.9718 and 1.0977 for regime 1 and regime 2, respectively. Whereas the calculated long-run coefficients of exchange rate appreciation are -7.5236 and -0.6776 for regime 1 and regime 2, respectively.

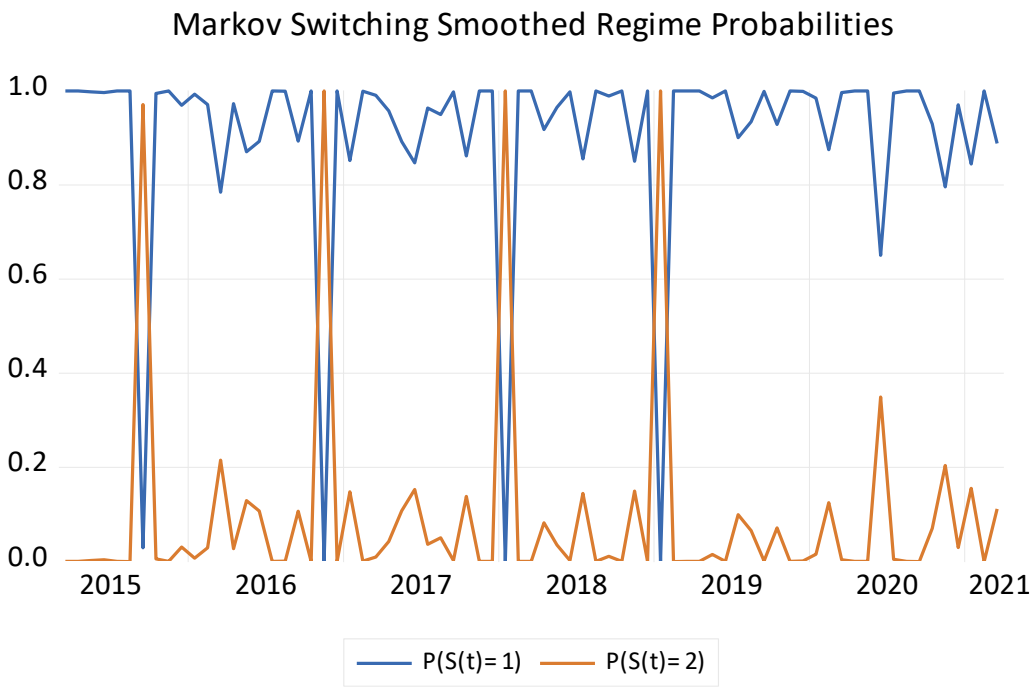


Figure 5. Smoothed States Probabilities (homogeneous variances).

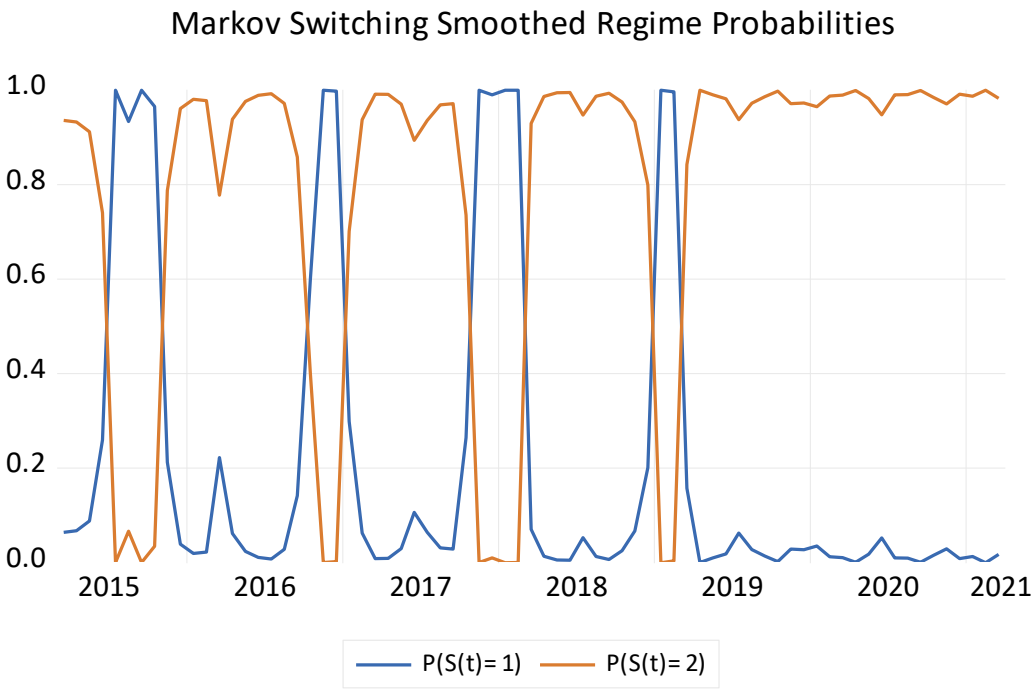


Figure 6. Smoothed States Probabilities (heterogeneous variances).

### 4.3 Markov-Switching Model – Official Exchange Rate Results

Although the official exchange rate in Sudan was fixed during the study period and may have no much influence on the price levels due to the sizeable gap between the official rate and the parallel market rate, we use it to model inflation for the robustness and comparison purposes. Assuming heterogenous variance, we employ Markov-switching in a symmetric and asymmetric fashions. Table (6) illustrates the results of the symmetric Markov-switching model using the official exchange rate. The findings show that all the variables have no significant effect on inflation in state 1. Also, the local currency pricing is established in the short-run indicating that changes in the official exchange rate has no effect on inflation and the ERPT is zero during the stable regime. More importantly, all the variables appear to be positively and significantly related to inflation during the unstable regime. Specifically, the changes in the official exchange rate show a huge influence on the price level in the short-run. The ERPT is equal to unity when the inflation shows high instability. Furthermore, money growth and output gap are stimulating inflation when the economy is unstable. Though the symmetric model signifies higher probability and expected duration in the stable regime. The long-run restrictions indicate the absence of any relationship between the official exchange rate and inflation.

Table (7) presents the results of the official exchange rate using the asymmetric Markov-switching model. Similar to the results shown in Table (6), all the variables are found to have no significant impact on inflation rate during stable regime. Moreover, the local currency pricing is verified in the short-run showing that exchange rate has no effect on price level during the state 1. Nevertheless, during the high inflationary regime, the outcomes reveal that all the variables, except $PMER^{-}$, are positive and statistically significant determinants of CPI inflation. Precisely, the depreciation of the official exchange rate exhibits an enormous impact on the inflation rate since the ERPT is equal to one and the producer currency pricing hypothesis cannot be rejected. While the effect of the exchange rate appreciation on inflation is not detected. The results show higher inflationary impact for the indicators *MG* and *outp* in the unstable state. The model reveals higher probability and expected duration to remaining in the stable regime. The long-run restrictions reveal that the ERPT of currency depreciation is zero during both regimes since the unit hypothesis is rejected, suggesting that positive changes have no influence on inflation.

Table 6. Symmetric Markov-Switching Model (Official exchange rate) – Heterogeneous Variances

| Variable | State 1 | State 2 |
|---|---|---|
| $\boldsymbol{\alpha}$ | 0.0407*** (0.0097) | -0.1261*** (0.0444) |
| $\boldsymbol{\lambda}$ | 0.0434 (0.0619) | 1.5750*** (0.4360) |
| $\boldsymbol{\beta}$ | 0.0511 (0.0441) | 1.0663*** (0.3639) |
| $\boldsymbol{\theta}$ | -0.0961 (0.0786) | 1.3324*** (0.3859) |
| $\boldsymbol{\rho}$ | -9.57E-11 (1.27E-10) | 1.60E-09* (9.16E-10) |
| $\boldsymbol{\sigma}$ | -2.8368*** (0.2712) | -2.1989*** (0.2525) |
| $\boldsymbol{p11}$ | 1.4716*** (0.5583) | |
| $\boldsymbol{p21}$ | 1.5587 (1.1167) | |
| Transition probabilities | 0.8133 | 0.8831 |
| Expected durations | 5.4 Months | 1.2 Months |
| The equality of variances | $5.5948^{w}$** | |
| $\boldsymbol{H_0: \beta_{s1} = 1}$ | $461.9417^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s2} = 1}$ | $0.0332^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}/(1-\lambda_{s1}) = 0}$ | $1.3622^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}/(1-\lambda_{s2}) = 0}$ | $1.6749^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}/(1-\lambda_{s1}) = 1}$ | $426.3986^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}/(1-\lambda_{s2}) = 1}$ | $3.9685^{w}$ | |

Note: ***, **, * denote 1%, 5%, 10%. This model allows for heterogeneous variances across states. The 'w' refers to Wald test F-statistic values. The calculated long-run coefficients of exchange rate are 0.0534 and -1.8542 for regime 1 and regime 2, respectively.

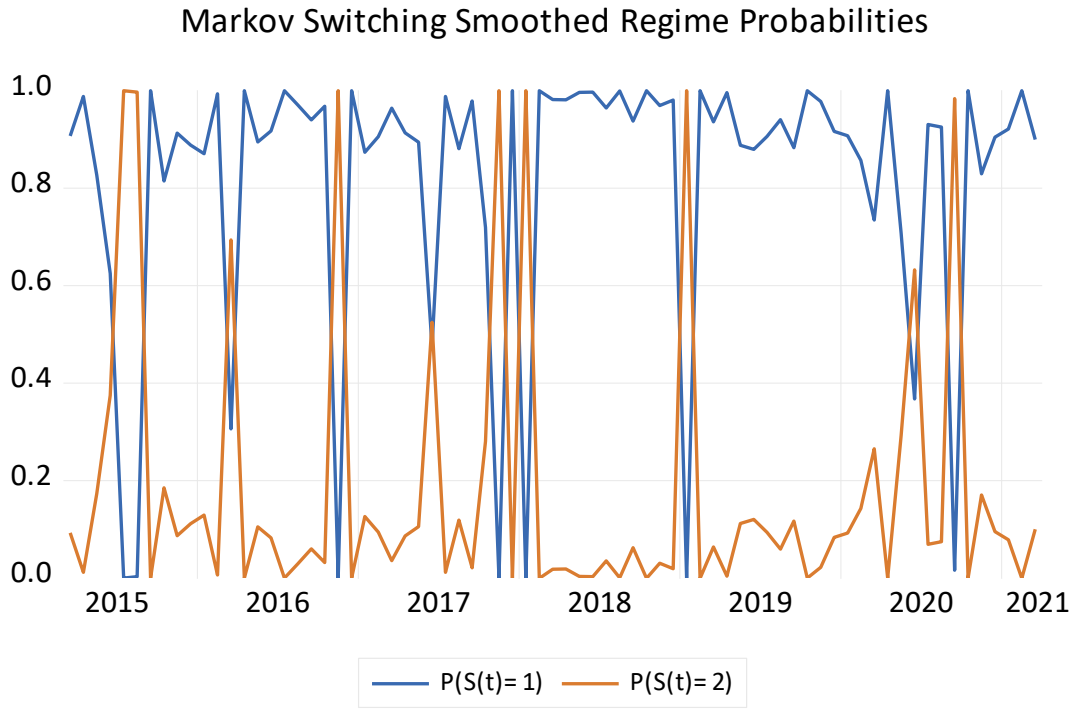


Figure 7. Smoothed States Probabilities (Official exchange rate).

Table 7. Asymmetric Markov-Switching Model (Official exchange rate) – Heterogeneous Variances.

| Variable | State 1 | State 2 |
|---|---|---|
| $\boldsymbol{\alpha}$ | 0.0413*** (0.0100) | -0.1259*** (0.0447) |
| $\boldsymbol{\lambda}$ | 0.0438 (0.0629) | 1.5769*** (0.4389) |
| $\boldsymbol{\beta^+}$ | 0.0451 (0.0463) | 1.0660*** (0.3664) |
| $\boldsymbol{\beta^-}$ | 0.6589 (1.3645) | 6.5251 (7.2675) |
| $\boldsymbol{\theta}$ | -0.0867 (0.0821) | 1.3318*** (0.3878) |
| $\boldsymbol{\rho}$ | -8.15E-11 (1.32E-10) | 1.61E-09* (9.16E-10) |
| $\boldsymbol{\sigma}$ | -2.8395*** (0.1185) | -2.2074*** (0.2548) |
| $\boldsymbol{p11}$ | 0.7248 (0.6980) | |
| $\boldsymbol{p21}$ | -2.3641*** (0.6377) | |
| Transition probabilities | 0.8098 | 0.1753 |
| Expected durations | 5.3 Months | 1.2 Month |
| The equality of variances | $5.3680^{w}$** | |
| $\boldsymbol{H_0: \beta_{s1}^+ = 1}$ | $424.7837^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s1}^- = 1}$ | $0.0624^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^+ = 1}$ | $0.0324^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^- = 1}$ | $0.5779^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}^+/(1-\lambda_{s1}) = 0}$ | $0.9627^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}^-/(1-\lambda_{s1}) = 0}$ | $0.2327^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^+/(1-\lambda_{s2}) = 0}$ | $1.6639^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^-/(1-\lambda_{s2}) = 0}$ | $0.6585^{w}$ | |
| $\boldsymbol{H_0: \beta_{s1}^+/(1-\lambda_{s1}) = 1}$ | $391.4605^{w}$*** | |
| $\boldsymbol{H_0: \beta_{s1}^-/(1-\lambda_{s1}) = 1}$ | $0.0473^{w}$ | |
| $\boldsymbol{H_0: \beta_{s2}^+/(1-\lambda_{s2}) = 1}$ | $3.9525^{w}$* | |
| $\boldsymbol{H_0: \beta_{s2}^-/(1-\lambda_{s2}) = 1}$ | $0.7801^{w}$ | |

Note: ***, **, * denote 1%, 5%, 10%. This model allows for heterogeneous variances across states. The 'w' refers to Wald test F-statistic values. The calculated long-run coefficients of exchange rate depreciation are 0.0472 and -1.8476 for regime 1 and regime 2, respectively. Whereas the calculated long-run coefficients of exchange rate appreciation are 0.6891 and -11.3097 for regime 1 and regime 2, respectively.

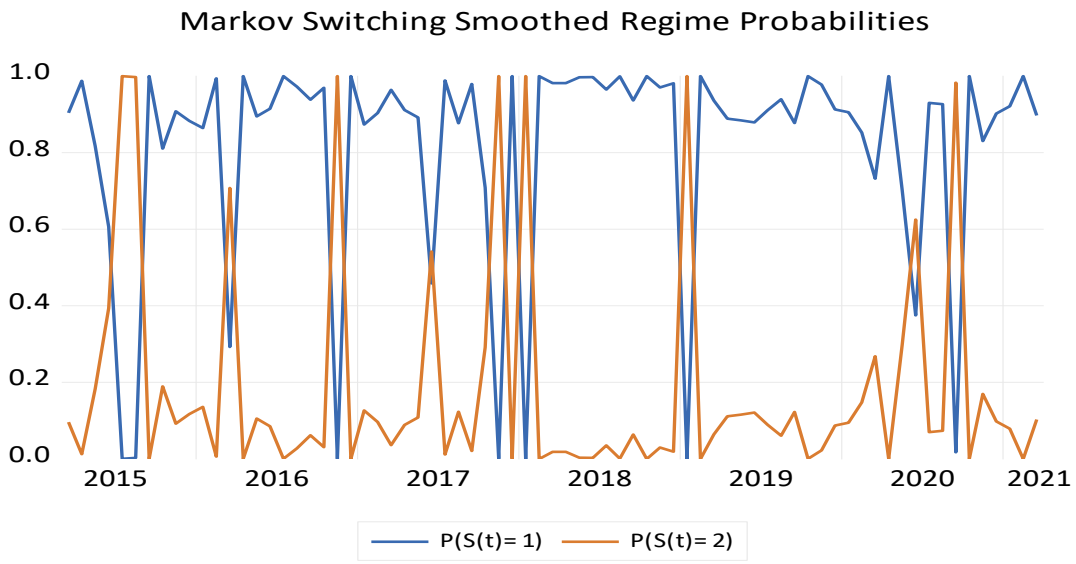


Figure 8. Smoothed States Probabilities (Official exchange rate).[4]

## 4.4 Discussion of the Findings

In reviewing the literature, few studies were found on the parallel market exchange rate pass-through to consumer price inflation. The present study was designed to determine the effect of the parallel market exchange rate on inflation in Sudan. Relying on a regime-switching model, the results of this study show that the exchange rate had a positive and significant effect on inflation especially during the high inflationary environment. Importantly, evidence of a complete pass-through to consumer price index was observed. This finding is in contrary to previous studies which have suggested a low or moderate exchange rate pass-through. As discussed by Taylor (2000), in a high inflationary economy a higher effect of exchange rate on inflation is expected, thereby this may explain the strong and large impact of positive exchange rate changes on consumer price index in Sudan. With respect to the asymmetric model, we found that the depreciation of the currency in the parallel market is largely transmitted to the price levels, notably in the unstable regime both in the long-run and short-run. Where no substantial effect was observed during the appreciation time in both regimes. The results of high or complete pass-through (as shown by some models) of a depreciation may be explained by the link between domestic prices and foreign exchanges. Specifically, the depreciation of the parallel market rate in Sudan over the

[4] Figure (7) and (8) are similar since the transition probabilities, as shown in Table (6) and (7), are almost equal.

last few years has led to an over-invoicing of imports, which contributed to the increase in trade deficit and the raise in the prices of intermediate and final goods. A possible explanation for our results may be the effects of depreciation on investment and consumption. Many large investors were forced to shut down their production activities due to the continuous drop in the parallel market exchange rate. Also, the economy is characterized by macroeconomic uncertainties (Elbadawi, 1994) and inefficiency (Onour, 2017) due to the dominance of the parallel market. It seems possible that these results are due to the reliance of the government on monetization to finance the huge budget deficit as a result of its transactions in the commercial market which was done through the parallel market rate.

Using the official exchange rate, surprisingly we found somewhat similar results to the one obtained when the parallel rate was employed in the main analysis. The asymmetries evidence in the ERPT to inflation corroborates these earlier findings of (Delatte and López-Villavcencio, 2012; Ibrahim, 2015; Kilic, 2016; Baharumshah et al., 2017b,c; Soon and Baharumshah, 2017; Amoah and Aziakpono, 2018; Kurtović et al., 2020); however, all these studies have utilized the official exchange rate since the size and effect of the unofficial market for foreign exchange in these countries were negligible. Although Baharumshah et al. (2017a) found asymmetric but incomplete ERPT in the case of Sudan using official exchange rate for the period from 1992:Q1–2015:Q2, they acknowledged the possibility of a complete ERPT in a country like Sudan. The extreme and continuous expansion of the parallel market and its control over the prices in the country made it very odd to rely merely on the official exchange rate. In fact, almost all producers, investors, large or small sellers in every sector in the economy are adjusting their prices on a daily or even an hourly basis based on the parallel market rate rather than the fixed official exchange rate. In such circumstances, therefore, using the parallel market rate is inevitable for better understanding of the relationship between exchange rate and inflation. The results that the exchange rate depreciation is passed to price levels more than the appreciation can be further explained by the idea that suppliers pass the currency depreciation to consumers to lessen their losses, while they turn a blind eye for adjusting the prices when the currency appreciates. The nature of the economy and the asymmetric evidence obtained earlier advocate the existence of strong market power within the Sudanese economy (see Delatte and López-Villavcencio, 2012).

## 5. Conclusion and Policy Implications

The emergence of the parallel market for foreign exchange in any economy is considered a sign of severe economic crises. The main aim of this study was to investigate the effects of the parallel market exchange rate on price in a high inflationary economy of Sudan. In particular, we examined the ERPT to domestic prices using a Regime-Switching Model. In this study, we identified two regimes namely, state 1 that refers to the low/stable inflationary regime, and state 2 which refers to the high/unstable inflationary regime. This indicated that accounting for such regime variation is an important requirement for the estimation of the ERPT. One of the most significant findings emerged from this study was that the parallel market exchange rate affects inflation rate asymmetrically considering the inflationary regimes. Unambiguously, changes in the exchange rate influenced the price levels more during the high inflation state than low inflation regime. In addition, depreciation of the currency in the parallel and official markets affects the consumer price index more compared to a currency appreciation during the unstable inflationary state.

The findings from this study made several contributions to the current literature. First, this study is among the few that examined the associations between the exchange rate and consumer price inflation considering the parallel market rate for a country like Sudan. Second, the use of an appropriate econometric technique of Markov-switching model enabled the estimation of two regimes based on unobservable factor, which allowed us to obtain the effect of exchange rate changes on inflation across regimes. Third, partial evidence of a complete pass-through to inflation was found by our study even when the official exchange rate was used. Lastly, we found evidence of asymmetries between exchange rate and inflation across and within each regime.

The findings of this study have several important implications for future practice. The results may assist policymakers in formulating the monetary and exchange rate policies in Sudan since the effects of inflation determining factors varies with respect to the inflationary regime. The effect of parallel market exchange rate fluctuations on macroeconomic indicator such as inflation was considerably low during stable inflation periods. Therefore, new strategies to improve the economic circumstances and stabilizing price level are needed. Although the authorities have recently implemented managed floating regime, an ultimate cautious and close monitoring are required, given that the previous attempts to unifying the exchange rates have worsen the situations. In fact, the government should be very careful in its current efforts towards adopting a

floating exchange rate regime, especially it may only be a temporary solution with the inadequacy of foreign reserve. Moreover, before carrying on with the recent policy changes, it is vital for the economy to undergo through a comprehensive reform. The Central Bank must be transparent in the application of foreign exchange policy to make the policy more effective and credible. Enabling monetary policy authority to achieve high degree of independence is critical to improve the prices stability. In this regards, economic policymakers are advised to work closely toward reducing or ending the fiscal dominance. Besides, the efforts to build strong banking sector and the financial markets are necessary and desperately needed to free the economy from the fiscal dominance. Overall, it is strongly recommended that the authorities must put an end to the continuous reliance on the revenues from Seigniorage. Most importantly, using an unorthodox and direct approach to control the fluctuations of inflation rates could be a step in the right direction. This would dictate that the monetary policy should reprioritize its objectives and move gradually toward making prices stability as its main goal. In the end, there is a critical need for developing and improving the right technical infrastructure that assist the Central Bank to produce rational forecasting and modelling of core inflation, which is vital in controlling the public's expectations and price level. Finally, future investigations should concentrate on using core instead of headline inflation to provide the monetary policy with richer analysis.

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