

Exchange Rate Pass-Through to Domestic Inflation in Ghana

David Effah-Mensah¹, Ebenezer Essiam^{2*}

¹Department of Research, Bank of Ghana, Republic of Ghana,

²Department of Economics, Management and Statistics,
University of Milano-Bicocca,
Milano, Italy 20126

david.effah-mensah@bog.gov.gh; e.essiam@campus.unimib.it

*Correspondence: e.essiam@campus.unimib.it

ABSTRACT

The current study estimates the exchange rate pass-through on domestic prices from January 2013 to December 2018, using a recursive vector autoregressive model (VAR). Applying Cholesky decomposition to the model, six variables were ordered as follows: oil prices, output gap, exchange rate, import prices, overall inflation and Treasury bill rate with an assumption that the identified shocks contemporaneously impact variables which are ordered after the shock without any contemporaneous feedback. We find evidence of incomplete exchange rate pass-through to domestic prices. Thus, domestic price changes by 9.6 percent in the first three months following an exchange rate shock and the shock dies out after a year with a total pass-through effect of 10.7 percent. We also find that, exchange rate effect is more pronounced for the imported prices than the overall inflation, suggesting some moderation of pass-through effect in domestic price dynamics.

Keywords: Impulse Response; Variance Decomposition; Recursive VAR; Exchange Rate Pass-Through

INTRODUCTION

Central Banks across the globe have price stability as their primary goal for implementing monetary policy irrespective of the policy regime they find themselves. However, there are various macroeconomic variables which could distort this policy goal by threatening the stability of domestic prices. Therefore, it is paramount to know and analyze the dynamics of such variables for effective policy decision. Shocks to these macroeconomic variables affect prices of household consumption basket which leads to an increase or decrease in general level of prices. The items chosen in the consumer basket are based on the expenditure pattern of domestic citizens. The consumer basket is made up of domestic and imported items of which changes in their prices have a direct effect on the consumer price index. Prices of imported items are determined from abroad in foreign currencies hence exogenous, and it is therefore important to understand how sudden external shocks affect our real economy and price stability goal of the central Bank.

From monetary policy perspective, exchange rate is one of the several macroeconomic variables that explains the behavior of domestic prices. On this backdrop, it is necessary to understand the behavior of exchange rate movement on domestic prices and the speed of the pass-through for appropriate policy decision. More so, some empirical studies found that the response of inflation to exchange rate is very low in Sub-Saharan Africa with some having no pass through at all (Frimpong and Adam, 2010).

Ghana has witnessed a disinflation path since 2016 but its currency has witnessed consistent weakness over the past few years. To what extent does exchange rate influence domestic prices? There has been a myriad of studies on exchange rate pass through in the sub-region though the pass-through was not complete. For instance, Chaoudhri and Hakura (2001) did a study to find out the pass through of exchange rate shocks on domestic prices. They found an incomplete pass-through in most African countries. Their finding corresponds with Acheampong (2004) and Loloh (2014) who also found an incomplete exchange rate pass through to domestic inflation of the Ghanaian economy.

On the domestic level, exchange rate movement affects the cost of production which makes the cost of tradable goods very expensive. A depreciating exchange rate makes our export cheaper, making us competitive, though it deters importation of foreign goods and services. On that note, the use of non-food by Acheampong (2004) and Loloh (2014) as a proxy for imported prices was misleading. The current study reestimates their model by using actual imported price index in a VAR Model. Also, the base drift effect in the year-on-year inflation might not give us a good picture of the pass-through effect of exchange rate shock. For instance, two different months can have the same consumer confidence index but different inflation rate. This is due to the different corresponding consumer price indices of the two months. The month with the smaller consumer price index in the corresponding period last year will have higher inflation and the month with a higher consumer confidence index in the corresponding period last year will report a smaller inflation rate. Therefore, the difference in the inflation rate between the two months is not mainly due to current price development but solely due to different consumer prices indices in the previous year. This phenomenon is what is termed as base drift effect. Therefore, the presence of this issue might affect the actual exchange rate pass-through to domestic prices. The current study deals with this issue by adopting a month-on-month measure of inflation.

There have been several deliberations about the major drivers of inflation in Ghana. An empirical study by Bawumia and Abradu-Otoo (2003) points to the fact that, weakening domestic currency is a major source of the inflationary pressures Ghana has experienced over the years. From their point of view, this has been the reason why Ghana has not been able to achieve low and stable inflation ever since Ghana adopted the flexible exchange rate. Their finding shows that, the pass-through effect of exchange rate to domestic prices is paramount.

On the contrary, findings by other researchers point to the fact that, exchange rate cannot be one of the causes of high inflation in Ghana. For instance, a paper by Deureux and Engel (2003) found that the pass through of exchange rate to domestic prices has elasticity of 0.05% for Ghana and also found out a zero pass through for other Sub-Saharan Africa countries.

By convention, exchange rate has a role to play in the behavior of prices which has a long run adverse effect on other macroeconomic variables. A depreciating currency will cause investors to desire foreign asset as against domestic asset which will put pressure on the demand for US dollars creating foreign exchange shortages fueled by demand pressures for forex. The long run effect is reducing consumer welfare through reduction in purchasing power.

The debate is still on, does exchange rate play a role in the inflation path in Ghana and to what extent? The literature is inconclusive which actually put policy makers in a vague. It is however important for the current study to be undertaken to further clear doubts by adding more light to existing empirical findings.

The main aim for this study is to reestimate the model used by Loloh (2014), by using import price index rather than non-food price index of the GSS consumer basket. The specific objectives are:

- To analyze the pass-through behavior of exchange rate to general price using impulse response functions, and variance decomposition from a recursive VAR model
- To analyze the pass-through behavior of exchange rate to import prices using impulse response functions and variance decomposition from a recursive VAR model

The central bank assesses development in the domestic economy and external sector before making any policy decision. It does that by assessing the risk to growth and inflation that helps in setting a monetary policy rate for the country. On that note, exchange rate is a key variable considered in setting the monetary policy rate. Knowledge of exchange rate movements can assist policy makers to take appropriate policy decision. Several empirical studies have looked at how long it takes a change in exchange rate to affect year-on-year inflation. Their findings resulted in mixed conclusions which this study seeks to shed more light on. Also, their use of year-on-year inflation suffers from base drift effect problem which in a way could understate or overstate the pass-through effect. Hence, the current study rectifies this shortfall by adopting month-on-month inflation measures to assist the central bank to understand the monthly dynamics of exchange rate movement on prices.

Godberg and Knetter (1997) explain exchange rate pass-through as the percentage change in home currency prices resulting from a one (1) percentage change in the exchange rate between the exporting and the importing countries. A paper from Menon (1996) explains that the extent of pass-through from the exchange rate to imported prices is the percentage by which import prices, measured by domestic currency rise when the domestic currency depreciates. Classic exchange rate pass-through usually has two stages. In the first stage, changes in the nominal exchange rate are seen in the prices of imports in local currency terms. In the other stage, these changes are then passed on fully or partially to consumers.

In the context of the current paper, we define exchange rate pass-through as the impact of exchange rate movements on import and consumer prices over time. The concept of exchange rate pass-through has its foundation from the Purchasing Power Parity (PPP) theory which establishes a connection between exchange rate, domestic prices and foreign prices. This is because when prices are expressed in one currency, identical goods in different markets will have the same price in the absence of other costs such as transportation and official trade barrier. This is because of the law of one price.

Drawing inspiration from international economics, there has been a prolonged discourse on whether fixed or floating exchange rates are preferable. Friedman (1953) and Johnson (1969) championed the case for flexible exchange rates, contending that a flexible system would offer a more effective means of international adjustment, particularly during periods when fixed exchange rates and exchange rate targeting are the prevailing tools used to control economic fluctuations. The incapacity of flexible exchange rates to mitigate fluctuations in consumer prices has prompted extensive empirical research to clarify the adjustment paradox. Consequently, this has spurred an inquiry into the underlying correlation between the exchange rate and the prices of internationally traded goods and services, which is now commonly referred to as exchange rate pass-through. A primary cause of inflation in countries that depend on imports is the depreciation of the exchange rate. Sanusi (2010) suggests that the effects of exchange rate movements are transmitted to consumer prices through three principal channels, namely: prices of imported consumption goods, locally produced goods priced in foreign currency, and prices of intermediate goods.

Several monetary models of exchange rates presume a direct relationship between the exchange rate and domestic prices, supported by the law of purchasing power parity. However, the majority of empirical research on exchange rate pass-through has found that the pass-through is incomplete. Therefore, the pass-through from the exchange rate to import prices tends to be greater, though still incomplete, than the pass-through to consumer prices. In response, several theoretical models have been developed to elucidate the incomplete nature of exchange rate pass-through.

The literature identifies a multitude of factors that contribute to the incomplete nature of exchange rate pass-through. Acheampong (2004) posits that international market segmentation is a key factor that accounts for the incompleteness of pass-through, particularly concerning the pricing behavior of exporting firms. According to Krugman (1986), in fear of losing market share, a large supplier may not immediately adjust its foreign prices by the same proportion as the exchange rate change. Third-degree price discrimination and import substitution by consumers are identified as significant factors that account for the incompleteness of the pass-through to domestic prices in destination countries. Another reason for price rigidity following an exchange rate movement is menu costs. Firms are often reluctant to adjust prices due to the costs associated with shifting prices, except in cases where the change is substantial. Conversely, Mankiw (1985) contends that even small menu costs can have significant impacts on the economy.

Furthermore, Dornbusch (1976) posits that incomplete pass-through arises due to firms operating in markets with imperfect conditions who adjust their mark-up in response to exchange rate shocks. Dornbusch (1976) highlights the role of less competitive markets in explaining the behavior of prices in response to exchange rate effects.

Burstein et al. (2002) emphasize the importance of non-tradable inputs in the supply chain of tradable goods. The study highlights measurement issues inherent in consumer price indices, which do not account for quality adjustments of tradable goods following an exchange rate adjustment.

Gagnon and Ihrig (2004) suggest that fiscal and monetary authorities may play a role in influencing deviations in the exchange rate on domestic prices. Additionally, the practice of pricing in local currency may be a contributing factor to incomplete pass-through, as noted by Deureux and Engel (2003) and Bacchetta and van Wincoop (2003). Krugman (1986) suggests that “pricing to market” by foreign suppliers may explain why US import prices do not fully reflect exchange rate movements.

Theoretical literature suggests that the degree of exchange rate pass-through to consumer prices is dependent on the inflation environment and the volatility of the exchange rate itself (Taylor, 2000). It is argued that firms tend to pass on increased production costs to consumers in regions of high inflation more readily than in low inflation environments when the exchange rate is depreciated, due to higher inflation expectations. Similarly, when the exchange rate is more volatile, pass-through tends to be higher, largely because firms anticipate a permanent rise in production costs.

Various studies have examined the relationship between exchange rates and inflation across different countries. While some studies have found a positive relationship between the two variables, others have reported mixed results. For example, Goldfajn and Werlang (2000) analyzed a panel of 71 countries and found that the exchange rate pass-through to inflation was influenced by factors such as the business cycle movement, real exchange rate, level of inflation, and the extent of openness of the economy. They also reported that the impact of exchange rate movements on inflation was most significant after a period of twelve months. However, Rabanal and Schwartz (2001) found that the effects of exchange rate movements on inflation can persist for up to 20 months. Similarly, Loloh (2014) used a recursive vector autoregressive model to study the effect of exchange rate movements on domestic prices from 1994 to 2012. The study found that the impact of exchange rate movements on prices was felt after a period of 12 months and disappeared completely between 18-24 months. Also, Frimpong and Adam (2010) assessed the exchange rate pass-through to inflation for Ghana. They used monthly data for the period 1990- 2009 and posited that the pass through of exchange rate to inflation is low and not complete.

Despite the extensive research on the relationship between exchange rate pass-through and inflation, some studies have produced mixed results. For example, McCarthy's (1999) investigation in six industrialized OECD nations found that the impact of exchange rate changes and import prices on producer and consumer prices using a recursive vector autoregressive (VAR) model was uncertain. Likewise, Chaoudhri and Hakura's (2001) study on Ethiopia and other African countries from 1997 to 2000 found incomplete pass-through to inflation.

In a study conducted by Zorzi et al (2007), the pass-through of exchange rates to inflation was examined across twelve emerging markets in Asia, Latin America, Central and Eastern Europe. The findings of the study suggest that the level of inflation in a particular country can influence the relationship between exchange rate movements and domestic prices. The authors found that there is a low pass-through effect in countries with single-digit inflation compared to those with higher inflation rates. The study thus concludes that the degree of exchange rate pass-through to inflation is dependent on the level of inflation in a particular country.

Ghana has been identified in recent empirical research as a small open economy with modest capital mobility because of its low level of financial integration, as Effah-Mensah and Essiam (2024) point out. In this context, investigations on the dynamics of Ghana's economy were carried out by Musah et al. (2017). Exchange rate fluctuations and their associated volatility continue to be major problems in such contexts. They are crucial in the management of international finances and the creation of macroeconomic policies. The need for this has led to a great deal of study on the pass-through effects of exchange rates. This study, which covers the period from January 2000 to March 2016, uses co-integration and error correction models to examine the pass-through effects of exchange rate fluctuations on the consumer price index in Ghana. Asymmetry effects, the degree of exchange rate pass-through (ERPT) to consumer prices, the applicability of purchasing power parity, and exchange rate models are some of the problems that the investigation aims to answer. The low ERPT to consumer prices, however, suggests that variables other than the exchange rate are probably influencing inflation. Variables that react strongly to shocks in external pricing, such as inflation and consumer price interest rate, are included in the model. Ghana is susceptible to worldwide price shocks (imported inflation), as seen by the substantial increase in local prices that follows a positive shock in the foreign price variable. This study emphasizes the significance of shocks within consumer prices and imports as opposed to shocks from the exchange rate and other economic factors using variance decomposition tests.

Also, Asafo (2019) utilized quarterly data from 2006q3 to 2017q4. The study examines how the exchange rate pass-through affects domestic pricing in Ghana. Employing sign limitations in a Vector Autoregression, the study indicates that exchange rate depreciation boosts prices, however the influence is partial. Interestingly, monetary growth turns out to be the main cause of Ghana's inflationary pressures. The results highlight how crucial it is to keep interest rates steady and exchange rates constant to manage inflation.

In West African Commonwealth Countries (WACCs), Danlami et al. (2020) looked at the exchange rate pass-through to inflation (ERPT) and its asymmetry. Employing Autoregressive Distributed Lag (ARDL) and Non-linear ARDL (NARDL) techniques on data from 1980 to 2016, the study produced significant findings.

The results of the symmetry analysis (ARDL) indicate that while ERPT does not show any signs of occurring in Nigeria in the short term, it does show signs of having a disinflationary effect after a year. On the other hand, Ghana, the Gambia, and Sierra Leone a complete ERPT is observed. In the long run, total ERPT is seen in every nation; the Gambia has the greatest ERPT, followed by Nigeria and Sierra Leone; Ghana has the lowest ERPT. In the near term, Nigeria shows positive ERPT with negative shocks but no evidence of ERPT based on positive shocks, according to asymmetry analysis (NARDL). On the other hand, the other nations have evidence of positive ERPT, based on both positive and negative shocks. Over time, nevertheless, positive ERPT to inflation is produced in all nations by both positive and negative shocks.

Using a different approach, Danlami (2020) reexamined the analysis of Exchange Rate Pass-Through (ERPT) to inflation in West African Commonwealth Countries (WACCs). The study examined ERPT dynamics using a Dynamic Panel Data Model–Pool Mean Group (PMG), chosen by the Hausman test over the Mean Group (MG) and Dynamic Fixed Effect Model (DFE). The study employed data from 1980 to 2016 and found that, in the short run, there was no ERPT to inflation in WACCs. The economy self-corrected towards the long run in around two short-run periods. In the long term, WACCs demonstrated full ERPT to inflation, nonetheless. To stabilize their exchange rates, the research advised policymakers in WACCs to strengthen their import substitution and export promotion initiatives. Inflationary pressures are expected to continue in their economies in the absence of such stability. For WACC economies to achieve some degree of durable price stability, exchange rate stability is considered essential.

Using an empirical mode decomposition-based nonlinear autoregressive distributed lags model (EMD-NARDL), this research investigates the pass-through of the US dollar exchange rate to consumer prices in Ghana from January 1990 to January 2020. Both short- and long-run nonlinearities are captured by this model, which also removes the noise component from the underlying data. Asymmetric pass-through effects are discovered in the short and long term, coupled with evidence of cointegration between denoised consumer price and exchange rate series. During periods of depreciation, exchange rate pass-through is statistically zero and incomplete over the long term. When comparing depreciation durations to appreciation periods, currency rate pass-through is almost entirely accomplished in the short run (Obeng et al. 2022).

Valogo et al. (2023) concerns have been expressed regarding Ghana's exchange rate's influence on inflation and the economy due to its persistent decline. The influence of exchange rate pass-through (ERPT) on inflation is examined in this research by utilizing monthly data from January 2002 to December 2018. It also looks at the Taylor rule's exchange rate threshold's applicability. The results, which highlight the significance of this threshold level, show that exchange rate depreciation over a specific threshold has a considerable positive pass-through effect on inflation using the threshold autoregressive (TAR) approach. Furthermore, irrespective of the threshold that is used, the results indicate that the exchange rate has a substantial impact on the monetary policy rate. Consequently, to avoid excessive depreciation and the inflationary effects that follow, monetary authorities must carefully analyze the exchange rate while making policy decisions. These results highlight that, regardless of precise threshold settings, proactive policy rate adjustments in response to exchange rate fluctuations are necessary.

METHODS

The study hinges on the work of Acheampong (2004) and Loloh (2014). The study uses six-variables in a recursive Vector Autoregressive (VAR) model to analyse the pass-through effect. The model is recursive because the error term or the shocks are used as independent variables in the VAR model. The variable used in this study followed the following ordering: oil price index (OPI), output gap (OGAP), nominal exchange rate of the Ghana Cedi to the US dollar (EXR), import price index (IMPI), consumer price index (CPI) and 3-month Treasury bill rate (INT).

The key variables of interest in the study are IMP, CPI and EXR. In order to control for the impact of the real side of the economy, OPI was included to control for supply-side shocks. OGAP was used to control for demand shocks whereas INT was used to control for the money market and monetary policy impact.

$$\Delta OPI_t = E_{t-1} [\Delta OPI_t] + \varepsilon_t^{\Delta OPI} \dots\dots\dots(1)$$

$$\Delta OGAP_t = E_{t-1} [\Delta OGAP_t] + \alpha_1 \varepsilon_t^{\Delta OPI} + \varepsilon_t^{\Delta OGAP} \dots\dots\dots(2)$$

$$\Delta EXR_t = E_{t-1} [\Delta EXR_t] + \beta_1 \varepsilon_t^{\Delta OPI} + \beta_2 \varepsilon_t^{\Delta OGAP} + \varepsilon_t^{\Delta EXR} \dots\dots\dots(3)$$

$$\Delta IMP_t = E_{t-1} [\Delta IMP_t] + \gamma_1 \varepsilon_t^{\Delta OPI} + \gamma_2 \varepsilon_t^{\Delta OGAP} + \gamma_3 \varepsilon_t^{\Delta EXR} + \varepsilon_t^{\Delta IMP} \dots\dots\dots(4)$$

$$\begin{aligned} \Delta CPI_t &= E_{t-1}[\Delta CPI_t] + \delta_1 \varepsilon_t^{\Delta OPI} + \delta_2 \varepsilon_t^{\Delta OGAP} + \delta_3 \varepsilon_t^{\Delta EXR} + \delta_4 \varepsilon_t^{\Delta IMP} + \varepsilon_t^{\Delta CPI} \dots\dots\dots(5) \\ \Delta INT_t &= E_{t-1}[\Delta INT_t] + \tau_1 \varepsilon_t^{\Delta OPI} + \tau_2 \varepsilon_t^{\Delta OGAP} + \tau_3 \varepsilon_t^{\Delta EXR} + \tau_4 \varepsilon_t^{\Delta IMP} + \tau_5 \varepsilon_t^{\Delta CPI} + \varepsilon_t^{\Delta INT} \dots\dots\dots(6) \end{aligned}$$

In the above model, all the variables are expressed in natural log, Δ denotes difference of a variable, and E_{t-1} stands for expectation about a variable subject to information available in period $t-1$. Thus, ΔOPI_t is oil price inflation in period t , $\Delta OGAP_t$ is growth rate of output gap in period t , ΔEXR_t is growth of exchange rate in period t , ΔIMP_t import price inflation in period t , ΔCPI_t is overall inflation in period t noted as *INF*, and ΔINT_t is growth in interest rate in period t . Respectively, demand, supply and exchange rate shocks are captured by $\varepsilon_t^{\Delta OPI}$, $\varepsilon_t^{\Delta OGAP}$, and $\varepsilon_t^{\Delta EXR}$. Also, shocks to inflation, import inflation, the money market are respectively $\varepsilon_t^{\Delta IMP}$, $\varepsilon_t^{\Delta CPI}$, and $\varepsilon_t^{\Delta INT}$. A core assumption underlying the behaviour of model is that the conditional expectations in equations one to six can be incorporated by linear projections based on the appropriate lags of the six variables.

By use of recursive identification design for the model, contemporaneous feedback is not allowed in the model. This means that for a particular variable, it has no contemporaneous feedback to variables ordered after it. However, all variables in subsequent equations after the equation of the variable with the shock are affected by the shock. Therefore shock to oil price inflation which is ordered first affects all other variables contemporaneously and so on. The order used in this study is as follows: ΔOPI , $\Delta OGAP$, ΔEXR , ΔIMP , ΔCPI , ΔINT . This model was estimated by VAR which employs Cholesky decomposition to identify the structural shocks from the VAR residuals.

The study used monthly data from 2013 to 2018. Bilateral exchange rate between the Ghana Cedi and the US Dollar was used for this study since it is the major trading currency in the country. 3-Month Treasury bill rate was used as a proxy for interest rate. Import price index was used to improve on the model adopted by Loloh (2014). Consumer price index was used as a measure for general price. Oil price index was used to capture supply shocks while the output gap was derived from gross domestic product (GDP) by using the Hodrick-Prescott filter tool in Eviews to capture business cycle effects. Data for the study was taken from World Development Indicators (WDI) and Federal Reserve Bank of St. Louis economic data series for international oil prices.

RESULTS AND DISCUSSION

Stationarity test: Philips-Perron

In order to avoid spurious regression, a stationarity test was run on all the variables using the Philips-Perron test. This test is based on the equation specified below.

$$y_t = \alpha + \rho y_{t-1} + \varepsilon_t$$

$H_0: \rho = 1$
 $H_1: \rho < 0$

Table 1. Stationarity test: Philips-Perron Test

		CPI	EXR	IMP	INT	OPI	OGAP
Level	None	8.770 (1.000)	2.340 (0.995)	9.7410 (1.000)	-1.0114 (0.277)	-0.946 (0.304)	-0.438 (0.521)
	Intercept	-10406 (0.575)	-2.142 (0.203)	-1.759 (0.398)	-0.678 (0.845)	-1.573 (0.491)	-3.939 (0.003)***
	Intercept with Trend	-0.652 (0.972)	-1.348 (0.867)	-0.437 (0.984)	-1.604 (0.782)	-1.415 (0.848)	-3.907 (0.017)***
	1 st	-4.724 (0.000)***	-8.252 (0.000)***	-4.136 (0.000)***	-4.381 (0.000)***	-5.615 (0.000)***	-15.839 (0.000)***
	Intercept	-8.059 (0.000)***	-9.075 (0.000)***	-7.995 (0.000)***	-4.266 (0.001)***	-5.561 (0.000)***	-15.610 (0.000)***
	Difference	Intercept with Trend	-8.262 (0.000)***	-9.413 (0.000)***	-8.328 (0.000)***	-4.172 (0.008)***	-5.503 (0.000)***
Conclusion		I(1)	I(1)	I(1)	I(1)	I(0)	

The findings from the Philips-Perron unit root test shows no variable is I(2) and as a result, the model specified for the study would produce reliable, non-spurious results as all the variables used are required to be in their first difference by the model.

Table 2. Lag Length Selection Criteria

Lag length	LogL	LR	FPE	AIC	SC	HQ
0	1072.103	NA	1.37e-22	-33.316	-33.113*	-33.236
1	1112.768	72.433	1.19e-22	-33.461	-32.045	-32.903
2	1151.632	61.940	1.12e-22*	-33.551	-30.920	-32.514
3	1188.004	51.148	1.19e-22	-33.562*	-29.717	-32.048
4	1223.441	43.189	1.42e-22	-33.545	-28.485	-31.552
5	1253.394	30.889	2.24e-22	-33.356	-27.082	-30.884
6	1291.997	32.571	3.22e-22	-33.437	-25.949	-30.487

*indicates lag order selected by the criterion

The lag selection criteria in Table 2 above shows that a lag length of 2 or 3 is appropriate the VAR model. However, the VAR residual serial correlation LM test in Table 3 below shows that a lag length of 2 is does not suffer from serial correlation. Based on this a FPE lag selection criteria is adopted, and a lag length of 2 is used for the Recursive VAR model in this study.

Table 3. VAR Residual Serial Correlation LM Test

Lags	LM- Stat	Probability
1	50.899	0.051
2	39.598	0.313
3	47.655	0.093

In Figure 1 above, all the roots lie within the unit circle. This means that the stability condition is met which complements the Philip-Perron Unit root test of stationarity.

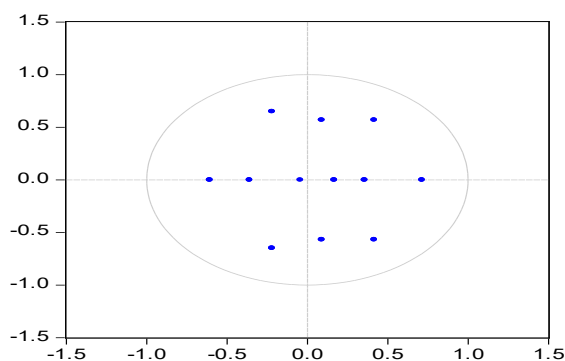


Figure 1. Stability condition

Impulse Response: Cholesky Degrees of Freedom Adjusted

The study used the impulse responses from the estimated VAR to investigate the effects of changes in the prices in the domestic economy. The orthogonalized impulse responses of general price and import price to shocks in the exchange rate are presented in figures 2 and 3 below. The Cholesky ordering is the same as the one in the model specification.

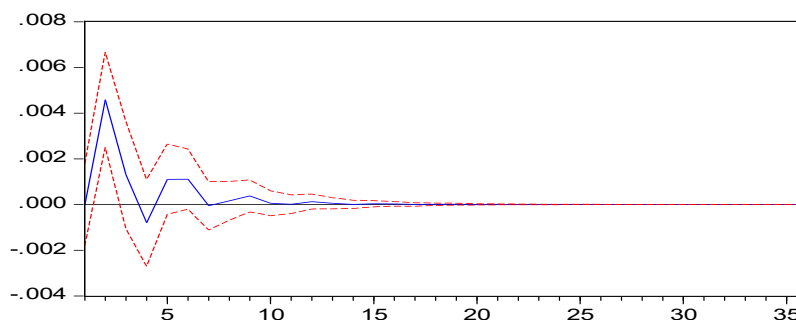


Figure 2. Response of Import Price to Cholesky One Standard Deviation Innovation in Exchange Rate

In figure 2 above, one standard deviation shock to exchange rate leads to a rise in import price and this effect is stronger within the first ten months where it decays quickly. By the end of the tenth month the effect becomes minimal but decays slowly and persists up to the twenty-first month. This means that once the other endogenous variables are accounted for, there is exchange rate pass-through to import price and this effect lingers beyond a period of one year.

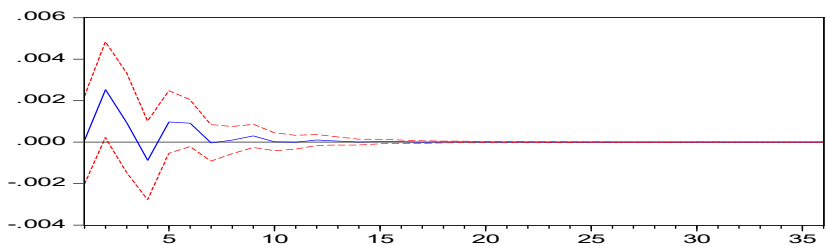


Figure 3. Response of General Price to Cholesky One Standard Deviation Innovation in Exchange Rate

Similar to what was observed in the Figure 2, one standard deviation shock to exchange rate leads to a rise in general price and the effect stronger within the first ten months where it dissipates quickly and then becomes minimal. This minimal rise in general price gradually decays until the twenty-fourth month after which it completely dies out. Thus, after accounting for the other endogenous variables, general price positively responds to shocks in the exchange rate and the effect last for about twenty-four months.

Cumulative Impulse Response

In order to ascertain the cumulative pass-through from exchange rate to domestic prices, the accumulated impulse responses of each price variable after t months was divided by the corresponding accumulated impulse response of exchange rate.

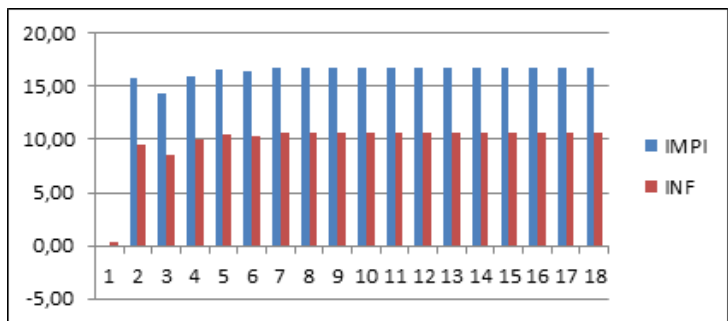


Figure 4. Estimated Cumulative Pass-Through

Figure 4 shows the cumulative responses of import price (in blue) and general price (in red) to shocks in the exchange rate. The exchange rate pass-through is incomplete and the impact on import price is generally higher than that of general price, and this is especially perceptible in the first eleven months. However, the impact on import price lasts shorter than that of general price.

Table 4. Estimated Cumulative Pass-Through Coefficients

Month	IMPI	INF
3	15.813	9.570
5	14.420	8.533
7	16.011	10.032
9	16.613	10.053
11	16.510	10.390
13	16.772	10.651
15	16.750	10.650
17	16.781	10.662
19	16.844	10.680
21	16.800	10.681
23	16.817	10.681
25	16.819	10.690

27	16.819	10.691
29	16.822	10.700
31	16.825	10.700
33	16.828	10.710
35	16.828	10.727

As seen from table 4, effect of exchange rate shock on domestic prices is stronger in the first three months, 15.8% and 9.57% respectively for import price and general price. This however becomes modest and lingers up to the nineteenth month where it terminates at 16.8% in the case of import price; and up to the twenty-fifth month at 10.69% for general price.

Variance Decomposition of Import (Non-Food) Inflation and Overall Inflation

Variance decomposition helps us to investigate whether shocks in exchange rate account for the behavior of import price inflation and overall inflation. This means that if exchange rate accounts for a significant proportion of the forecast error variance of import price inflation and overall inflation, then exchange rate is considered to be an important explanatory factor for fluctuation in these variables. The study therefore decomposed the variations in import price inflation and overall inflation into the shocks to the endogenous variables.

Table 5. Variance decomposition of import inflation

Forecast period	OPI	OGAP	EXR	IMPI	INF	INT
3	4.057	6.470	22.617	60.165	2.712	3.978
6	4.850	8.971	22.746	55.380	4.336	3.716
9	4.867	9.347	22.643	54.937	4.450	3.757
12	4.867	9.378	22.638	54.897	4.466	3.754
15	4.867	9.378	22.640	54.894	4.466	3.754
18	4.867	9.378	22.640	54.893	4.466	3.754
21	4.867	9.378	22.640	54.893	4.466	3.754
24	4.867	9.378	22.640	54.893	4.466	3.754
27	4.867	9.378	22.640	54.893	4.466	3.754
30	4.867	9.378	22.640	54.893	4.466	3.754
33	4.867	9.378	22.640	54.893	4.466	3.754
36	4.867	9.378	22.640	54.893	4.466	3.754

In Table 5, the variance decomposition shows that exchange rate movements account for a large proportion of the fluctuations in import inflation. Though the variation in this variable is greatly explained by its own innovations which account for about 55% of the variations, exchange rate also plays key role in explaining these variations because it accounts for about 23% of the variations. This shows that exchange rate shocks have a great impact on import inflation and as such a critical policy action is needed.

Table 6. variance decomposition of overall inflation

Forecast period	OPI	OGAP	EXR	IMPI	INF	INT
3	4.786	4.140	6.920	52.288	24.656	7.209
6	5.031	6.626	8.567	49.008	24.010	6.759
9	5.038	6.796	8.591	48.826	23.920	6.830
12	5.038	6.832	8.594	48.792	23.919	6.826
15	5.038	6.832	8.596	48.490	23.918	6.826
18	5.038	6.832	8.596	48.490	23.917	6.826
21	5.038	6.832	8.596	48.490	23.917	6.826
24	5.038	6.832	8.596	48.490	23.917	6.826
27	5.038	6.832	8.596	48.490	23.917	6.826
30	5.038	6.832	8.596	48.490	23.917	6.826
33	5.038	6.832	8.596	48.490	23.917	6.826
36	5.038	6.832	8.596	48.490	23.917	6.826

On the other hand, after accounting for all the other endogenous variables, the variance decomposition in Table 6 shows that the exchange rate does not play a major role in the fluctuations in overall inflation. This is because whereas about 23% of the variations in overall inflation are explained by its own innovations, exchange rate accounts for only about 9% of these variations. However, a deeper look at the results could be more revealing. It is seen that import inflation accounts for about 49% of the variations in overall inflation and because it is already established that exchange rate has greater impact on import inflation, exchange rate could be seen to have a great indirect impact on overall inflation although the direct impact is minimal.

CONCLUSION

The study found that the exchange rate pass through to import price and the general price is incomplete similar to the findings in Ghana made by Loloh (2014), Frimpong and Adam (2010), and in some African countries by Chaoudhri and Hakura (2001). This is good in the sense that when the exchange rate depreciates the pass-through to import price and the general price is not 100%. Specifically, the exchange rate pass-through to import price is 16.8% and that of the general price is 10.9%. This is new findings contradict the findings by Frimpong and Adam (2010) in Ghana, and Zorzi *et al* (2007) in other developing countries that exchange rate pass-through was low whereas confirming a high exchange rate pass through found by Adu *et al* (2015) in Ghana. The high exchange rate pass-through is confirmed by results from the variance decomposition which shows that 23% of the variations in import price, and 9% of the variations in general price is due to shocks in the exchange rate. The indirect influence is also considerable as 49% of the variations in general price is due to shocks in import price. The impact of exchange rate on domestic prices is felt around the tenth month which is marginally below the twelve months found by Loloh (2014). It was also observed that exchange rate effect on prices peaks at nineteen months in the case of import price and twenty-five months in the case of overall inflation which confirms what was found by Acheampong (2004) and Loloh (2014).

The findings reveal that exchange rate movement affects prices faster than predicted by empirical literature which studied similar issue in the sub-region. The current study has policy implication for the central bank monetary policy decision making committee. The monetary authorities must recalibrate their model to take into account the short term implication of exchange rate effect on domestic prices. In the long run, the paper concludes that, it takes about two (2) years for a shock to inflation from exchange rate to return to equilibrium. Hence, the central bank should not only be interested in the current movement of exchange rate for their decision making, but also take into consideration persistence effect on prices.

The analysis discovers evidence of incomplete exchange rate pass-through to domestic prices, with the effect decreasing with time. Further study should look at the dynamic impacts of exchange rate shocks on domestic prices, as well as variables influencing the longevity of pass-through effects over longer time horizons.

The analysis discovers that the exchange rate effect is stronger for imported prices than for total inflation, implying variability in the pass-through effects across different sectors of the economy. Further study might investigate the origins of variation in exchange rate pass-through and how factors such as industry characteristics, trade openness, and exchange rate volatility impact the transmission of exchange rate shocks to domestic pricing.

Similarly, historical price development in the Ghana points to the fact that, some elementary aggregates have higher propensity in influencing headline inflation than others. In that regard, empirical studies can look at the volatility spillover effects by ascertaining the extent of directional spillover effects among various inflation sub-groups. This will enhance deep monetary policy discourse.

REFERENCES

- Acheampong, K. (2004). The Pass-Through from Exchange Rate to Domestic Prices in Ghana. Bank of Ghana Working Paper No. 05/14, Bank of Ghana, Accra Ghana.
- Adu, G., Karimu, A., and Tei Mensah, J. (2015). An Empirical Analysis of Exchange Rate Dynamics and Passthrough Effect on Domestic Prices in Ghana. International Growth Centre working Paper no. S-33200-GHA-1.
- Asafo, S. (2019). Exchange Rate Pass-through to Prices: Bayesian VAR Evidence for Ghana. Munich: Munich Personal RePEc Archive, University Library of Munich. Available at: <https://mpra.ub.unimuenchen.de/92967> (accessed 15 November 2020).
- Bacchetta, P. and van Wincoop, E. (2003), Why do Consumer Prices React Less than Import Prices to Exchange Rates? *Journal of European Economic Association*, 1, 662-670.
- Bawumia, M. and Abradu-Otoo, P. (2003). Monetary growth, exchange rate and inflation in Ghana: An Error correction Analysis. Working paper W/P BOG 2003/05, Bank of Ghana
- Burstein et al. (2005). Large Devaluations and the Real Exchange Rate. *Journal of Political Economy*, 113, 742-784.
- Burstein, A., B. Eichenbaum, and S. Rebelo (2005), Large Devaluations and the Real Exchange Rate. *Journal of Political Economy*, 113, 742-784.
- Burstein, A., J. Neves and S. Rebelo (2003), Distribution Costs and Real Exchange Rates Dynamics During Exchange-Based-Stabilizations? *Journal of Monetary Economics*, 50, 1189-1214.
- Burstein, A., Eichenbaum, M., Rebelo, S. (2002). Why Are Rates of Inflation So Low After Large Devaluations? NBER Working Papers 8748, National Bureau of Economic Research, Inc Large Devaluations? NBER Working Paper No. 8748, Cambridge, Massachusetts, NBER.
- Canetti, E., and Greene, J. (1992). Monetary Growth and Exchange Rate Depreciation as a Cause of Inflation in African Countries. An Empirical Analysis. *Journal of African Finance and Economic Development*, 1, 37-62.
- Chaoudhri, E., and Hakura, d. (2001). Exchange Rate Pass-through to Domestic Price: Does Inflation Environment Matter? IMF Working Paper 01/194.
- Danlami, I. A., Hassan, S., & Hidhiir, M. H. (2020). Assessing the asymmetry of the exchange rate pass-through to inflation in West African Commonwealth Countries. *Academic journal of economic studies*, 6(1), 93-109.
- Danlami, I. A. (2020). Revisiting the West African Commonwealth Countries' Exchange Rate Pass-Through to Inflation. *Academic journal of economic studies*, 6(1), 70-77.
- Deureux, M.B, and Engel, C. (2003). Monetary Policy in the Open Economy Revisited: Price Setting and Exchange Rate Flexibility. *Review of Economic Studies*, Wiley Blackwell, vol.70(4):765-783
- Dornbusch. (1976). Expectations of Exchange Rate Dynamics. *Journal of Political Economy*, vol.84 *December (1976):1161-1176.
- Friedman, M (1953). The methodology of positive economics. In *Essays in positive economics*, Milton Friedman. Chicago: University of Chicago Press, 3-43. Reprinted. In *methodology of positive economics (2009)*, ed. Uskali maki. Cambridge; Cambridge University Press, 3-42.
- Frimpong, S., and Anokye, M. A. (2010). Exchange Rate Pass-Through in Ghana. *International Business Research*, 3(2), 186 – 192.
- Gagnon, J. and Ihrig J. (2004). Monetary policy and exchange rate pass-through. *International Journal of Finance and Economics*, 9:315-338.
- Godberg, P.K and Knetter M.M. (1997). Goods Prices and Exchange Rates; What Have We Learned? *Journal of Economic Literature* 35(3):1243-1272.

- Goldfajn, I., and Werlang. (2000). The Pass-through from Depreciation to Inflation: A Panel Study Working Paper No. 423, Rio de Janeiro, Department of Economics, Pontificia Universidade Catolica.
- Johnson, H.G. (1969).The Case for Flexible Exchange rates. Federal Reserve, Bank of St. Louis, Review, Vol 51,No 6, 12-24.
- Krugman,P.(1986). Pricing to Market When the Exchange Rate Changes. NBER Working Paper No w1926.. International Journal.
- Leigh, D., and Rossi, M. (2002). Exchange Rate Pass-Through in Turkey. IMF Working Paper No. 02/204, IMF.
- Loloh, Francis (2014). Exchange Rate Pass-Through in Ghana. Bank of Ghana working Papers No. 03/14.
- Mankiw,N.G (1985).Small Menu Cost of Large Business Cycles:A Macroeconomic Model of Monopoly.Quarterly Journal of Economics 100:529-37.
- McCarthy, J. (1999), Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies. BIS Working Paper No. 79, Basel,BIS.
- Menon, J.(1996).The Degree and Determinants of Exchange Rate Pass-Through: Market Structure, Non-Tariff Barriers and Multinational Corporations-The Economic Journal,106:434-444.
- Musah, A. A. I., Jianguo, D., Azibahab, J. S., & Sarpong, P. B. (2017). Exchange Rate Pass-Through (ERPT): The Inter-Connectivity between Exchange Rate and Consumer Price Index in Ghana. Canadian Journal of Applied Science and Technology, 5(2).
- Obeng, C. K., Frimpong, S., Amoako, G. K., Agyei, S. K., Asafo-Adjei, E., & Adam, A. M. (2022). Asymmetric exchange rate pass-through to consumer prices in Ghana: Evidence EMD-NARDL approach. Journal of Mathematics, 2022.
- Rabanal, P., and Schwartz, G. (2001). Exchange Rate Changes and Consumer Price Inflation: 20 Months After the Floating of the Real in Brazil: Selected Issues and Statistical Appendix. IMF Country Report No. 01/10, Washington, IMF.
- Sanusi, R.S (2010). Exchange rate pass-through to consumer prices in Ghana: Evidence from Structural vector auto-regression. MPRA Paper No.29491.
- Taylor,J.(2000). Low inflation,Pass-Through,and the primary power of firms. European Economic Review. 44,pp. 1389-1408. No 9352.
- Valogo, M. K., Duodu, E., Yusif, H., & Baidoo, S. T. (2023). Effect of exchange rate on inflation in the inflation targeting framework: Is the threshold level relevant?. Research in Globalization,6, 100119.
- Zorzi, M. C., Hahn, E., and Sanchez, M. (2007). Exchange rate Pass-through in Emerging Markets. ECB Working Paper,no.739.