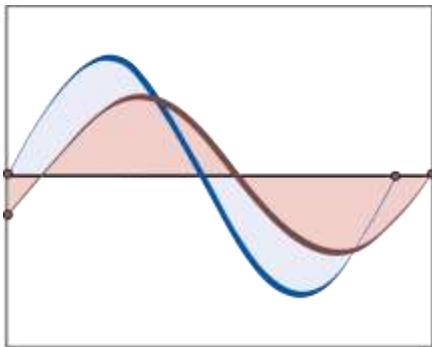


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Assessing the Exchange Rate Pass-Through to Inflation: The Case of Trinidad and Tobago

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The exchange rate pass through (ERPT) to domestic inflation is relevant for a small, open and developing economy like Trinidad and Tobago that is heavily reliant on imported goods for intermediate and final consumption. The recent depreciation episodes of the exchange rate coupled with the limited foreign exchange supply has prompted an investigation of the exchange rate transmission to both domestic food and headline inflation rates. The paper examines the relationship, speed and magnitude of the ERPT using quarterly data between 1995 and 2016 of variables such as the nominal effective exchange rate (NEER), Gross Domestic Product, import prices, money supply, and government spending. Through the employment of a Vector Error Correction Model (VECM), impulse response functions and variance decomposition, the authors found that transmission to domestic inflation rates were faster than previous research, taking four (4) quarters to pass through. Based on the results, it is recommended that monetary and exchange rate policy should be conducted in tandem with one another.

JEL Classification Numbers: E31, E27, F31

Keywords: Exchange rate, Inflation, Pass-through, VECM

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Assessing the Exchange Rate Pass-Through to Inflation: The Case of Trinidad and Tobago

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1. Introduction

Trinidad and Tobago is a small open economy with increasing reliance on imported commodities both for direct consumption and use as intermediate goods in the production process. Therefore, the economy is vulnerable to external shocks which have the potential to disrupt foreign exchange earnings and also filter into higher domestic prices. Furthermore, the domestic economy is not an inflation targeter, as such the impact of exchange rate pass-through to inflation poses a greater risk (Mishkin and Schmidt-Hebbel 2006) when compared to economies that directly pursue inflation stabilization policies. In light of this reality, this paper aims to assess the degree of exchange rate pass-through to inflation in Trinidad and Tobago.

According to the literature, “exchange rate pass-through” refers to the degree to which exchange rate changes are transmitted to import prices and subsequently to final consumer prices. As countries opened their borders and increased trading relationships with each other, the theoretical underpinnings of exchange rate pass-through began manifesting itself into reality. Moreover, the advent of globalization brought the concept to the forefront of considerations for economists and policy-makers alike. The theory of purchasing power parity posits that any adjustments in the exchange rate results in a proportional change in the inflation rate. Most exchange rate models and balance of payments techniques assume purchasing power parity and therefore a one-to-one relationship exists between exchange rate fluctuations and changes in domestic prices. Therefore, a complete exchange rate pass-through to inflation is identified by this one-to-one relationship. For example a one per cent depreciation of the exchange rate is expected to result in a one per cent increase in domestic prices; however an incomplete pass-through results in a less than one per cent change in domestic prices. Nevertheless, the extent of exchange rate pass-through is directly impacted by several other factors such as the level of economic openness, monetary policy regime, composition of imports and overall economic conditions.

Over time, economies have adopted policies in the form of inflation targeting which has catapulted the need to thoroughly examine exchange rate pass-through and inflation in order to better inform monetary policy. Understanding the role of exchange rate pass-through is necessary as the magnitude and speed of exchange rate changes across varying commodity categories differ. A study by An (2006) stated that the knowledge of the degree

¹ The views expressed in this paper are that of the authors and do not necessarily represent that of the Central Bank of Trinidad and Tobago.

and timing of pass-through is of particular importance for the assessment of monetary policy transmission on prices and also for inflation forecasting; inflation targeting demands information on the size and speed of exchange rate pass-through into inflation; as well as the level of exchange rate pass-through has important implications for “expenditure-switching” effects from the exchange rate. In a situation where there is limited exchange rate pass-through, trade flows will remain insensitive to movement in the exchange rate. However, if prices respond rapidly to changes in the exchange rate and trade flows are sensitive to movement in prices, then the impact will be observed in the balance of payments as the current account adjusts to changes in import demand.

Despite the aforementioned fundamentals, a number of studies have been documented over time indicating that exchange rate pass-through is not only partial but is also falling in most economies. Taylor (2000) presented the argument that there has been a decline in the extent to which firms pass-through changes in costs to prices from either external or domestic shocks. He went on to indicate that the decline appears to be correlated with a decline in inflation within most countries. Additionally, Gagnon and Ihrig (2004) stated that the pass-through of exchange rate adjustments into domestic inflation appears to have waned since the 1980s and is largely credited to increased emphasis on inflation stabilization by Central Banks. This finding is significant as a low exchange rate pass-through leaves room for exercising more independent monetary policy actions and provides a greater degree of freedom for implementation of inflation targeting.

The paper will therefore explore the domestic experience of the exchange rate pass-through to inflation and provide insight for future monetary policy measures. The sections are developed as follows; section two provides details on various sources of literature that have been published on the topic over time and is followed by a third section which looks at relevant facts on the economy of Trinidad and Tobago. The fourth and fifth sections employ the use of a Vector Error Correction Model (VECM) model in estimating the case of Trinidad and Tobago and subsequently analyses the empirical findings. The paper concludes in a sixth section that looks at the value being added to the current pool of literature on the topic along with policy recommendations to better assist in decision-making within the domestic economy.

2. Literature Review

With the increased openness of most economies, movements in the nominal exchange rate have incited concerns regarding the pass-through of these fluctuations onto domestic prices. The concept has been broadly defined as *“the percentage change in destination-currency import prices resulting from a one percent change in an exchange rate between exporting and importing countries”* (Goldberg and Knetter 1996). The concept of exchange rate pass-through bears two significant functions; firstly it plays an important role in influencing the forecasting capacity of inflation, and secondly the inflation forecasts help to inform Central Banks when conducting monetary policy. In light of this, monetary authorities, economists and researchers have studied and analyzed the topic in order to properly inform policy prescriptions for varying economies. Therefore, a vast amount of literature exists which examines the exchange rate pass-through and inflation both regionally and internationally.

In a study by J. B. Taylor (2000), the argument was presented that a low inflation environment would support a low exchange rate pass-through to domestic prices while a high inflation environment would automatically achieve a high exchange rate pass-through. Inflation has the characteristic of inertia where a currently low period of inflation will predict low inflation in the future and high inflation normally precludes periods of high inflation in the future. Furthermore, in an existing low inflation environment, firms may not increase prices brought on by exchange rate shocks, as higher prices will result in reduced competitiveness for firms. However, if the firm expects the inflationary pressure in a high inflation environment to be persistent, it may increase prices in response to exchange rate shocks. This is possible as any increase in price within this regime will seem reasonable to consumers. Taylor (2000) went on to indicate that this relationship of price adjustment to movements in the exchange rate points to a high degree of exchange rate pass-through. However, Dornbusch (1987) highlighted that the relationship between high inflation and high exchange rate pass-through is minimal in certain industries such as manufacturing.

According to Bacchetta and Wincoop (2005), who examined the optimal invoicing choice exercised by firms, exchange rate pass-through to import prices is significantly affected by the currency in which prices are set. If firms wield a significant market share and as a result benefit from pricing power, they would favour setting prices in foreign currency during times of exchange rate volatility. Consequently, this would lead to high exchange rate pass-through to domestic prices. However, if firms face less international competition, as reflected in the size of their market share, there is greater incentive to price in the domestic currency resulting in a lower degree of exchange rate pass-through. Based on these factors laid out by Bacchetta and Wincoop (2005), exchange rate pass-through is determined by both the level of exchange rate volatility and the characteristics of the domestic market. Some additional factors that determine the exchange rate pass-through were also highlighted by An (2006) namely the micro factors of market structure, pricing behaviour of firms, responsiveness to markups and demand elasticity of imports and the macro

factors of the size of the country, openness, aggregate demand volatility, inflation environment and monetary policy environment.

As previously mentioned, one of the important functions of inflation is the role it plays in formulating monetary policy. A paper by Mishkin and Schmidt-Hebbel (2007) looked at the function of inflation targeting in achieving lower long-run inflation using data for 34 countries over the period 1989-2004. According to the authors, the results indicate that inflation targeting helps countries achieve lower inflation in the long run and induces weaker inflationary responses to exchange rate shocks. When compared to the countries' pre-targeting experience, the adoption of inflation targeting reduced the short-term pass-through of exchange rate movements to domestic prices. This finding was more significant for emerging market economies when compared to industrial inflation targeters as the latter did not exhibit any major changes in pass-through performance. The evidence indicated that inflation targeting regimes are useful to emerging market economies for reducing the inflation rate as well as lowering the pass-through effect of the exchange rate to prices.

Reviewing economies closer to home, Borensztein and Queijo Von Heideken (2016) analysed the exchange rate pass-through and its determinants for a group of countries within South America. According to the evidence, in the short and medium terms, a moderate degree of exchange rate transmission to domestic prices for traded and non-traded goods exists when compared to previous decades. This finding is reflective of the stronger degree of credibility of the economies' monetary policy frameworks over time. Notwithstanding, the strength of the monetary policy action, it has been aided by the success of floating exchange rates and inflation targeting systems. According to Calvo and Reinhart (2000), the region appears to have broken free from the policy dilemmas underlying its epidemic case of 'fear of floating.'

It is crucial to note that several empirical studies have indicated the exchange rate pass-through to inflation has not only been partial, but it has also been falling since the 1990s for most economies. Dornbusch (1987) articulated the view that in the short-run prices tend to be rigid, therefore the extent of price adjustment is limited resulting in an incomplete pass-through of the exchange rate to inflation. Moreover, Goldberg and Knetter (1996) posited that incomplete pass-through of exchange rate movement to inflation is not solely as a result of changes in international prices but is also a consequence of third-degree price discrimination. Over half of the effect of exchange rate changes is outweighed by destination-specific adjustments of markups over cost, albeit there are variations amongst different industries.

A study by Campa, Goldberg and Gonzalez-Minguez (2005) looked at the transmission of exchange rate movement across countries and product categories, to import prices in the Euro Area over a fifteen year period. According to the findings, the transmission of exchange rate adjustment to import prices is high in the short-run although it is incomplete, and different across industries and countries. Meanwhile, in the long-run, transmission is higher and

close to unity. The paper concludes that the equality of pass-through elasticities for the various countries among the different industries cannot be rejected in the long-run. However, empirical evidence pointed to a statistically significant trend towards a lower degree of pass-through for manufacturing industries.

There are many studies that employ econometric approaches in analysing and interpreting the degree and magnitude of exchange rate pass-through and inflation within economies (**Appendix 3**). Some of the methodologies used in the international literature were the Ordinary Least Squares (OLS) regression technique, Johansen Maximum Likelihood Procedure, Two-staged single equation method, panel cointegrating techniques, the time-varying parameter and the Vector Autoregression (VAR) model. However, in several of the more recent studies, the VAR model was the primary instrument used to estimate the relationship between the exchange rate and inflation. Robinson (1998) attempted to forecast inflation in Jamaica using a VAR model. According to the results presented, a decline in the rate of depreciation of the exchange rate had an immediate dampening effect on prices within the first year, while contractionary monetary policy had a lagged effect of approximately two months. Christopher-Nicholls and Des Vignes (2002) also modelled the exchange rate pass-through to inflation in Trinidad and Tobago using a VAR model which revealed that there exists a high pass-through effect to inflation in Trinidad and Tobago, and the effect of the exchange rate shock persisted up to two and a half years. Similar to the conclusions drawn by Robinson (1998), a depreciation of the exchange rate has a dampening impact on production which constrains supply and against the backdrop of strong demand, increases the inflation rate.

Numerous recent studies have also examined the pass-through effect to inflation by employing the use of VAR methodologies. Bozdog, Demirel and Karagoz (2015) compared the transmission of exchange rates to prices in the framework of inflation targeting policy for Asia-Pacific, South American and Turkish economies through the use of a panel VAR model. Through the findings, it was noted that Asia Pacific economies experience a lower degree of exchange rate pass-through in contrast to Latin America and Turkey, given that the latter countries have historically faced inflationary problems. In 2016, Morales-Zumaquero and Jimenez-Rodriguez researched the exchange rate pass-through to domestic prices and to import prices for the G-7 countries by employing VAR techniques. Based on the empirical evidence, the exchange rate pass-through decays over time, which is associated with the credible monetary policy actions taken by these economies, and is also partial in scope due to the existence of imperfect competition and menu costs.

Given the relationship that exists between monetary policy and inflationary pressures, it is prudent that a thorough analysis of the concept is carried out bearing in mind the experiences cited in both regional and international literature. Furthermore, the twin island state is an open economy which is highly susceptible to fluctuations in the exchange rate.

3. Stylized Facts

As a small developing economy, Trinidad and Tobago is susceptible to external shocks due to the heavy reliance on external relationships to meet the shortfall in domestic supply. The country's vulnerability is compounded by its large degree of openness which can be measured by its imports to Gross Domestic Product (GDP) ratio. Trinidad and Tobago's imports to GDP averaged 37.9 per cent over the period 1995 to 2016 with its lowest level at 29.2 per cent in 2010 reflective of the spillovers of the global recession. (**Chart 1**). The country's main import categories comprise fuel (SITC 3 and 5), capital goods (SITC 7) and manufactured goods (SITC 6) (**Table 1**). According to the literature, fuel imports possess a high exchange rate pass-through to domestic prices whilst manufacturing and capital imports possess a low transmission to domestic prices (Campa et al. 2005).

Table 1: Import Share by SITC Categories

SITC Categories	Share in Imports (Per Cent)					
	2011	2012	2013	2014	2015	2016
0. Food	7.8	7.3	7.1	8.1	9.6	8.0
1. Beverage & Tobacco	0.7	0.7	0.7	0.9	1.1	1.1
2. Crude materials	5.2	4.1	3.5	4.5	3.9	3.3
3. Minerals, fuel, lubricants and related materials	38.9	41.8	51.1	43.4	28.5	32.6
4. Oils & fats	0.6	0.5	0.4	0.5	0.5	0.5
5. Chemicals	6.5	6.2	5.5	6.2	7.6	7.5
6. Manufactured goods	8.4	7.9	7.9	9.4	11.3	9.3
7. Machinery and transport equipment	27.7	27.0	19.2	22.5	31.1	31.5
8. Miscellaneous manufactured articles	4.2	4.4	4.6	4.6	6.3	6.0
9. Miscellaneous items	0.1	0.1	0.1	0.1	0.1	0.1

Source: Central Statistical Office of Trinidad and Tobago

The domestic economy's high import bill² reflects the changes in the sectoral composition of the country's GDP over time. The decreased levels of economic activity in the agriculture sector coupled with contractions in the manufacturing sector have resulted in increased demand for imports for both immediate consumption and use as intermediate products³. The US continues to be one of the country's major sources of imports, supplying the country with an average of 26.0 per cent of its total imports over the period 2000 to 2015⁴ and due to the popularity of the

² Over the period 2000 to September 2015, Trinidad and Tobago's food import bill averaged TT\$3.1 billion.

³ In 1995, the manufacturing sector contributed 8.2 per cent to GDP while the agricultural sector contributed 1.7 per cent to GDP. However by 2016, the manufacturing sector and agricultural sectors declined contributing 7.5 per cent and 0.4 per cent to GDP respectively.

⁴ Latest available data is September 2015.

United States Dollar (USD) as a vehicle currency; it is the most frequently used trading currency for Trinidad and Tobago. As such, fluctuations in the exchange rate have direct implications on the cost and the demand for imports.

The fluctuations in the domestic headline inflation have been mainly influenced by its components- core and food inflation over the period 1995 to 2016. Changes in the international commodity price environment have also contributed to fluctuations in domestic inflation rates via their costs to importers. This is primarily due to the large imported components of the highest weighted categories for domestic food and core inflation. The highest weighted categories for food inflation are “Bread and Cereals” (19.0 per cent) and “Meat” (17.9 per cent) while the highest weighted categories for Core inflation are “Housing, Water, Electricity, Gas and Other Fuels” (33.3 per cent) and “Transport” (17.8 per cent). Moreover, the fluctuations in the headline inflation rate became more pronounced after 2001 as the food component became the main driver of movements in the domestic inflationary conditions. Despite the lower overall weighting, price movements within the food index are more prominent and more common than price changes across the consumer durables segment of household consumption and other non-food items such as education, health, and transport. As such, food inflation has been the main driver of headline inflation.

Over the period 2004 to 2008, inflation was high and volatile due to demand pull inflation. The subsequent decline in the domestic headline and food inflation rates in 2009 were primarily driven by slower increases in food items both abroad and domestically. However, the resurgence in inflation rates in mid-2010 was as a result of adverse domestic weather conditions coupled with challenges posed by imported inflation as international prices for staples such as wheat increased. The rise in inflationary pressures in 2016 was attributed to the several revisions to domestic taxes⁵ and the 5.5 per cent (year-on-year) depreciation of the Trinidad and Tobago dollar (TTD) relative to the USD by the end of the year (**Chart 1**). The inflationary pressures exhibited by these circumstances such as adverse weather conditions, changes in fiscal policy and energy prices, would have been addressed through more onerous monetary policy decisions and tools. However, low aggregate demand in the context of subdued domestic economic activity may have dampened the full pass-through effect of the depreciation of the currency to domestic retail prices.

The nominal effective exchange rate (NEER) index is a trade-weighted measure of an economy’s exchange rate relative to the currencies of the country’s main trading partners⁶. The NEER indirectly measures fluctuations between the USD and other primary trading currencies such as the Euro dollar, pound sterling and Japanese yen. Through the inclusion of various currencies, the NEER reflects exchange rate movements in trading partner currencies rather than a single exchange rate, which is a direct limitation in applying the USD exchange rate (**Chart 1**). The fluctuations in

⁵ Several revisions to existing tax measures include; revisions to the Business Levy and Green Fund Levy (January 2016), the widening of the Value Added Tax (VAT) base (February 2016) and the reduction of the fuel subsidy on diesel and gasoline (April 2016).

⁶ The NEER is calculated as a geometric average of the bilateral rates between the Trinidad and Tobago Dollar and other trading partner currencies unadjusted for inflation changes.

the NEER over 1995 to 2016 displayed several periods of improvements and deteriorations in the international competitiveness relative to the trading partners. In particular, the largest loss of competitiveness was 2008 – a 7.0 per cent appreciation of the NEER which implied that imports became cheaper from the domestic economy's perspective. The cheaper costs of imports coupled with the accelerated growth in domestic money supply manifested in increased demand for imports and were reflected in the higher value of imports during the year. The appreciated NEER also corresponded with an increase in imports as a percent of GDP between 2014 and 2016

Broad money or M2 is defined as currency in active circulation plus demand, savings and time deposits held by residents other than the Central Government. Over the initial ten-year period of 1995 to 2004 money supply recorded a significant boost moving from TT\$10.5 billion at the end of 1995 to TT\$20.8 billion at the end of 2004 (**Chart 1**). Subsequently, the period over 2004 to 2014 saw unprecedented growth above 300.0 per cent in money supply totaling TT\$87.1 billion at the end of 2014. This strong growth in money supply was accompanied by a rapid increase in nominal GDP of approximately 100.0 per cent while net official reserves tripled over the similar ten-year period. Due to the expansion in money supply over this period, the domestic economy experienced a structural liquidity overhang prompting the Central Bank of Trinidad and Tobago (CBTT) to implement a gamut of monetary policy instruments to tighten monetary policy conditions. Following the implementation of the repo rate⁷ in 2002, the additional tools employed by the CBTT during this period included net open market operations, reserve requirements, and liquidity absorption bonds.

Trinidad and Tobago can be described as a rentier state given the significant reliance of the economy on indigenous natural resources and the relationship between government expenditure and revenue. Much of Trinidad and Tobago's government expenditure is financed through income earned by monetization of the country's energy deposits. Over the period 1995 to 2016 the economy experienced a surge in government expenditure backed by increasing international energy prices (**Chart 1**). In particular, over the period 2005 to 2014 government expenditure more than doubled from TT\$4,843.3 million to TT\$ 11,998.90 million as the economy benefited from substantial growth in energy revenue. Interestingly, the data revealed ongoing expansion in government expenditure in response to the 2008 Global Financial Crisis which has continued to present. According to Cheong and Ramrattan (2015), Trinidad and Tobago's expansionary fiscal policy post 2008 highlights the Government's approach to stimulate domestic economic activity through increased expenditure. Therefore, the Government has acted through fiscal policy measures to maintain a certain level of production in the economy.

⁷ In mid-2002 the Central Bank of Trinidad and Tobago implemented a new monetary policy framework which included the introduction of the Repurchase of Repo Rate.

Chart 1: Stylized Facts - Trinidad and Tobago

Figure 1: Import Share to GDP

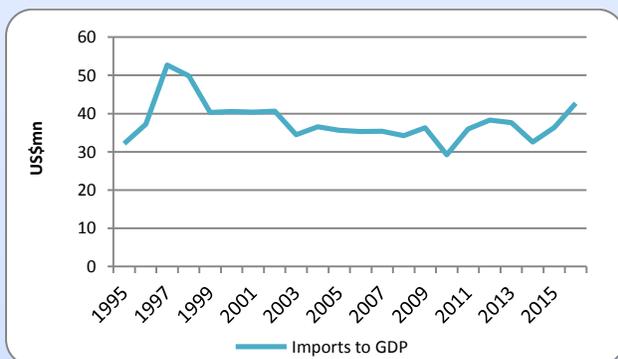


Figure 2: Domestic Quarterly Inflation Rates (Year-on-Year)

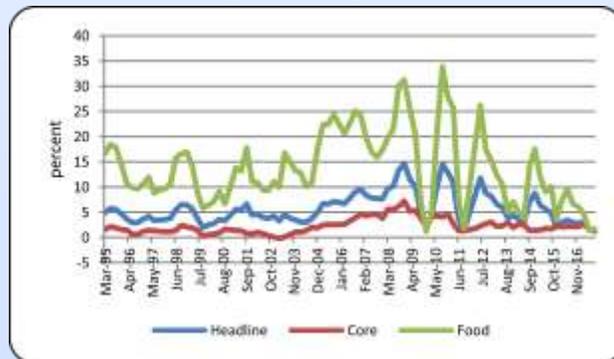


Figure 3: NEER and TTD/USD exchange rate

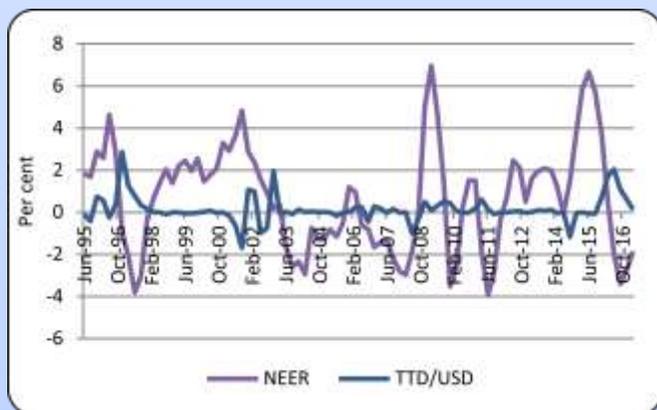


Figure 4: Broad Money (M2) and Imports

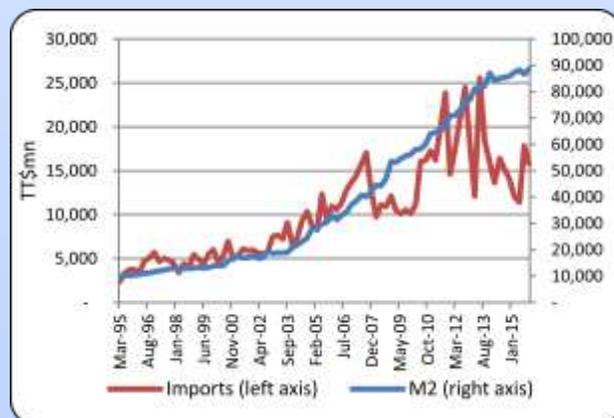
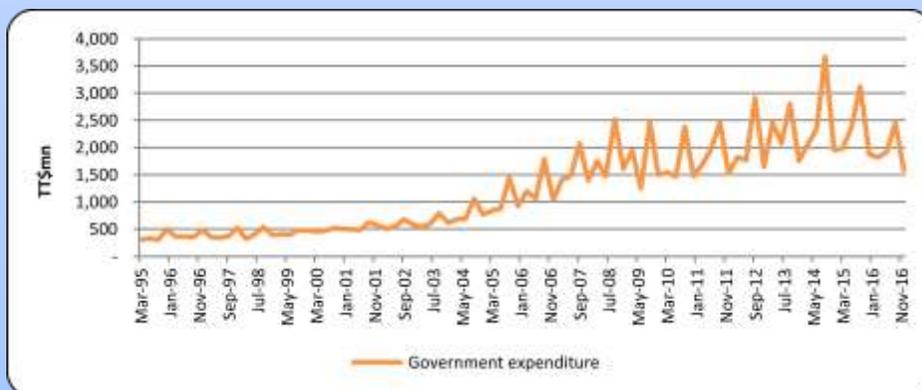


Figure 5: Central Government Total Expenditure



Sources: Central Statistical Office and Central Bank of Trinidad and Tobago

4. Modeling the Exchange Rate Pass-Through

The Vector Autoregression (VAR) Model has been the predominantly used econometric technique in the literature to examine the relationship between the inflation rate and its determinants as well as to investigate the speed and magnitude of the Exchange Rate Pass-Through (ERPT). This paper follows a similar pattern by employing a VAR model in the context of Trinidad and Tobago using quarterly data over the period 1995 to 2016. The data was obtained from the Central Statistical Office (CSO), the Central Bank of Trinidad and Tobago (CBTT) and the United States (US) Bureau of Labour Statistics.

Two iterations of the VAR model were estimated; one for headline inflation rates and the other for food inflation rates. It was essential to include the latter iteration of the VAR model in our investigation of the ERPT as domestic food inflation has a large imported component, and it also removes the energy products from consideration. The two equations are defined below:

$$INFL_t = \alpha_0 + \alpha_1 LOILP + \alpha_2 REPO + \beta_1 INFL_{t-1} + \beta_2 LIPI_TT_t + \beta_3 NEER_t + \beta_4 LM2_t + \beta_5 LQGDP_t + \beta_6 LGEXP_t + \mathcal{E}_t \quad (1.0)$$

$$INFL_F_t = \alpha_0 + \alpha_1 LOILP + \alpha_2 REPO + \beta_1 INFL_F_{t-1} + \beta_2 LUSEXPRF_t + \beta_3 NEER_t + \beta_4 LM2_t + \beta_5 LQGDP_t + \beta_6 LGEXP_t + \mathcal{E}_t \quad (2.0)$$

Where $INFL_t$ and $INFL_F_t$ are the year-on-year percentage changes in inflation rates (end of period) for all commodities and food respectively. The exogenous variables in the model are the WTI oil prices represented by $LOILP$ and the Central Bank's monetary policy instrument (repo rate) represented by $REPO$. The $LIPI_TT_t$ is the change in Trinidad and Tobago's import price index while the $LUSEXPRF_t$ is the change in the US export prices index for food which are proxies for import prices. The US food export price index was used as a proxy for the domestic economy's food import prices due to the lack of available data on imported food prices and the fact that the US has supplied Trinidad and Tobago with an average of 44.4 per cent of its overall food imports over the period 2011 to 2016.

The $NEER_t$ is the year-on-year change in the nominal effective exchange rate which is used as a proxy for the changes in the value of the domestic currency; $LM2_t$ is the change in the domestic money supply which represents the purchasing power of consumers in the domestic economy. Meanwhile, $LGEXP_t$ denotes government spending which is used to represent a fiscal policy variable; $LQGDP_t$ is the change in the quarterly index of economic activity which we used as a proxy for the unobservable local demand conditions and the epsilon term \mathcal{E}_t is the error term. All of the variables, with the exception of the inflation rates, the repo rate and the NEER, were expressed in natural logarithms⁸.

⁸ The use of logarithmic transformations to the variables was to infer elasticities for the explanation of the results.

Prior to estimating the equations, a series of diagnostic tests were conducted to examine the stability (or stationarity) of the variables. The individual unit root processes, namely, the Augmented Dickey-Fuller (ADF) and Philips Perron (PP) unit root tests were performed to determine whether the variables are integrated of the same order. The results of these tests suggest that all variables (with the exception of the NEER⁹) were integrated of order one, i.e., I(1) (**Appendix 1**). Therefore, those variables must be first differenced for there to be stationarity. Next, the optimal lag length suggested by the Akaike Information Criterion (AIC) was used for Equations 1.0 and 2.0 which were seven (7) and four (4) respectively (**Appendix 1**). Following this, the Johansen cointegration test for the existence of cointegration was carried out, and the results concluded to reject the null hypothesis of no co-integration at all conventional levels of significance for both equations. The trace test indicated three (3) cointegrating equations were present for equation 1.0 and four (4) cointegrating equations present for equation 2.0.

Consequently, the unrestricted VAR model was not the most appropriate model to be used for Trinidad and Tobago. A Vector Error Correction Model (VECM) was instead employed as this model is designed for non-stationary variables that are found to be co-integrated. The unique design of the VECM restricts the long run behaviour of the variables to converge to their cointegrating relationship while allowing for short-run dynamics. The VECM used the lag length and cointegrating equations for each iteration as indicated by the lag length criteria and the results indicated by the Johansen test. Specification tests such as the AR Roots and Lagrange Multiplier (LM) tests were conducted and confirmed stability of the model (**Appendix 1**).

The results of the two iterations of the VECM estimated a negative Error Correction Term (ECT) of approximately 1.04 and 0.97 for the overall domestic inflation and food inflation rates respectively. Given the speed of adjustment is over 0.50, it indicated that the domestic economy has a relatively fast speed of adjustment of the short term dynamics of the variables to converge to its long run equilibrium (**Table 3**). Further analysis of the relationships and transmission path to overall domestic and food prices were derived from conducting a VEC Granger Causality/Block Exogeneity Wald Test. However, since Granger Causality is limited to static relationships, the Impulse Response Functions (IRFs) and the Variance Decomposition were also used to augment the analysis of the transmission path.

Table 3: The Vector Error Correction Model (VECM) Equation

Equation 1.0		
Variable	Coefficient	T-Statistic
Error Correction Term	-1.044732	-2.68047*
Equation 2.0		
Variable	Coefficient	T-Statistic
Error Correction Term	-0.971075	-4.32750*

*Denotes rejection of the null hypothesis at all levels (1%, 5%, 10%) of significance.

⁹ The NEER year-on-year percentage change was I(0) as its calculation is already differenced.

5. Reviewing and Analyzing the Empirical Findings

Granger Causality

The relationships established by the VEC Granger Causality test¹⁰ revealed two avenues affecting domestic inflation; the first via the NEER and the second via the money supply (**Appendix 2**). The unidirectional relationship between the NEER and the domestic headline and food inflation rates implies cost push inflation as changes in the exchange rate influences the cost of production and in turn domestic prices. The causal link between the money supply (M2) and the domestic food inflation rate demonstrates demand-pull inflation. Demand-pull inflation occurs when increases in the purchasing power of consumers, represented by growth in the money supply, leads to upward price pressures from increased demand. This is simply expressed as “too much money chasing too few goods”.

Impulse Response Functions

The impulse response functions demonstrate the effects of shocks emanating from the endogenous variable to other variables. The inflation rate dynamics varied for both the domestic headline and food inflation rates in the short run and long run.¹¹ Firstly, the shock to the NEER was analyzed. In the short run, the shock to the NEER had the strongest immediate inflationary impact on domestic inflation rates. The positive shock to the NEER, interpreted as a depreciation of the domestic currency, implies that imports are more expensive to domestic consumers.

The inflationary impact of the one per cent depreciation can lead to a 0.46 percentage point increase in the year-on-year headline inflation rate and 0.52 percentage point increase in the year-on-year food inflation rate in the first quarter. By the second quarter of the forecast, the effect of the depreciation continued to rise for headline inflation with an increase of 0.84 percentage points while the inflationary impact decelerated to 0.18 percentage points for food inflation. The inflationary effects of the depreciation began to wane in the third and fourth quarters of the forecast for headline inflation and by the fifth quarter the inflationary impact from the depreciation was no longer reflected in the headline inflation rate. Meanwhile, the inflationary effects of depreciation were no longer reflected in the food inflation rates by the third quarter of the forecast (**Table 4**).

Moreover, the results of a one per cent depreciation revealed that Trinidad and Tobago’s ERPT to domestic headline and food inflation rates was incomplete as domestic prices did not react proportionally to the depreciation in the exchange rate.¹² This implies that price agents in the market only partially transfer costs resulting from the depreciation to domestic consumers. Generally, prices in the short-run tend to be rigid and price adjustments limited as articulated by Dornbusch (1987). In addition, the imperfect competition in the domestic market coupled with the

¹⁰ The results were evaluated at 10% significance level.

¹¹ The short run was classified as four quarters (one year).

¹² Balance of payments models normally assume a one-to-one response of import prices to exchange rates which is known as complete pass through (Peter 2003).

recent deceleration of the domestic headline inflation rate may have also played a role in the firm's reluctance to pass through price increases to domestic consumers. This behavior is corroborated by the findings of J.B. Taylor (2000) that in a low inflationary environment, firms may not pass through the increased prices brought about by an exchange rate shock as the higher prices will result in reduced competitiveness.

The short-lived rise in inflation rates resulting from a depreciation of the exchange rate reiterates the relatively fast short run adjustment suggested by the coefficients of the VECM. Moreover, the findings for the ERPT to headline inflation, revealed an increased responsiveness and a faster speed of EPRT to domestic inflation compared to a previous paper conducted by Christopher-Nicholls and Des Vignes in 2002. In the previous paper, there was an initial delay in Trinidad and Tobago's ERPT which subsequently rose in the fourth quarter of the forecast and gradually led to an inflationary effect of 0.7 percentage points in the tenth quarter (two and a half years) before declining to a lower level of pass-through. A possible reason for the increased speed of ERPT between the studies could be attributed to the Central Bank's increased implementation of monetary policy instruments to tighten liquidity conditions subsequent to 2002. The monetary policy environment was highlighted by An (2006) as one of the macro factors influencing the exchange rate pass through. Similar results have been demonstrated in South American countries as active monetary policy actions have proven to lessen the transmission effect of exchange rate shocks to domestic inflation over time (Borensztein and Queijo Von Heideken 2016).

Table 4: Short Run Effects of Inflation Rates to One Percent Depreciation in the NEER.

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5
Headline Inflation	0.46	0.84	0.66	0.40	-0.37
Food Inflation	0.52	0.18	-0.33	-0.28	-1.52

Imported inflation was also found to increase inflationary pressures in the short-run. Both food and headline inflation rates responded immediately to a shock in the US food export prices and import prices respectively. However, by the second quarter of the forecast, inflationary effects diminished for the headline inflation rate. Meanwhile, the shock to US food export prices continued to contribute to a rise in the food inflation rate in the second and third quarters, however it decelerated by the fourth quarter of the forecast.

The large degree of responsiveness of food inflation to the shock to US food export prices may have been primarily due to the high imported component of food. Overall, the results were consistent with cost push inflation theories as increased import costs were transferred to domestic consumers in the form of higher prices. Despite the initial one (1) quarter delay, the shocks to money supply and quarterly GDP also contributed to increased inflationary pressures to the food and headline inflation rates in the short run, consistent with the monetarist view of inflation and the law of

supply respectively¹³. A positive shock or increase in government spending resulted in an initial two (2) quarter lagged effect on the headline inflation rate. However, in the third and fourth quarters of the forecast the shock to government spending contributed to an increase in year-on-year headline inflation rate of 0.3 and 0.2 percentage points respectively. Meanwhile, the shock to government spending also exhibited an initial two (2) quarter lagged effect before contributing a 0.6 and 0.7 percentage point increase in the year-on-year food inflation rate in the third and fourth quarters of the forecast respectively. The largest proportion of government spending is recurrent expenditure such as wages. Increased public sector wages may result in increased demand for food and given the price inelasticity of demand for imported food in the Caribbean (Walters 2016) would also contribute to increase inflationary food pressures. Moreover, the results demonstrated that increased government spending generates a higher demand for goods which in turn results in 'demand-pull inflation'¹⁴. Furthermore, there is a dampening impact on production from the exchange rate depreciation which results in supply constraints in the short run as seen in Robinson (1998), this coupled with the backdrop of increased demand from government spending places upward pressures on domestic prices. With regards to the medium to long run (the five to thirty quarter horizon), the impulse response functions displayed fluctuations in the contributions of the variables to both domestic headline and food inflation rates. The NEER, government spending and GDP were significant factors influencing the upward movements of the domestic headline inflation rate in the long run. Meanwhile, the US food export prices and GDP were the main drivers of food inflation rates in the long run.

Variance Decomposition

When examining the variance decomposition for domestic headline inflation, it was evident that contemporaneously, the most relevant shock to headline inflation was the inflationist expectation which contributed 88.8 per cent of the variation in headline inflation in the first quarter. However, its contribution declines to 57.4 per cent by the fourth quarter of the short run (**Appendix 2**). The contributions of the shocks to NEER, GDP and government spending gradually increased over the short run accounting for 32.0 per cent, 3.9 per cent and 3.2 per cent of the variation in domestic headline inflation by the fourth quarter respectively. Meanwhile, the contributions of shocks to the import prices and money supply contributed the least to headline inflation rates by the fourth quarter, accounting for 2.4 per cent and 1.0 per cent of the variation respectively. However, through the medium to long term, the results revealed that contributions of the shocks to the NEER and GDP surpassed the contributions of all other endogenous variables at the end of the thirty quarters with 22.8 per cent and 20.2 per cent respectively.

Similar to the variance decomposition of the domestic headline inflation rate, shocks to the food inflation rate was dominated by its own lag which accounted for 98.6 per cent of its variation in the first quarter. By the fourth quarter,

¹³ The monetarist view of inflation is that an increase in the money supply is the principal cause of demand pull inflation.

¹⁴ The law of demand states that as demand increases, prices increase thus having a fundamental positive or direct relationship.

the contribution of the shock to food inflation declined to 79.7 per cent of its variation. Over the short run, the shocks to the US food export prices, money supply and government spending increased in its importance to the overall variation in domestic food inflation accounting for 8.5 per cent, 5.9 per cent and 3.2 per cent respectively in the fourth quarter. However, in the long run, contributions from the shocks to the NEER and government spending increased and accounted for 18.2 per cent and 16.2 per cent of the variation in food inflation respectively. Although the results from the IRF's revealed that US food export prices and GDP were the main drivers of inflationary pressures for food inflation in the long run, the contribution of the shocks to US food export prices and GDP toward the overall variation in food inflation were lower than that of the NEER and government spending¹⁵. Moreover, the combined impact of the variables may result in an overall deflationary impact on the domestic food inflation rates as also evidenced in Cheong and Ramrattan (2015).

¹⁵ Several alternative iterations of the VECM were conducted for comparative analysis. Variables such as the Bureau de Change rates and the bilateral TTD per USD were used as substitutes for the NEER; however the latter had dissimilar results to the NEER as it indicated that it took four and five lagged periods for the depreciation to reflect inflationary pressures in the domestic headline and food inflation rates respectively. However results were inconsistent based on the historical domestic inflationary trends and the domestic economy's reality. The use of the NEER was a better reflection of the domestic economy's reality as it provided a holistic sense of Trinidad and Tobago's trading partners rather than limiting the analysis to exchange rate movements to the USD per TTD. The US export price index for all commodities was used as an alternative to Trinidad and Tobago's import price index, however we found this to be impractical as the US is not the only source market for imports as the US accounts for 26.0 per cent of total imports. We included the output gap in the model, however it proved insignificant. Based on the results of the different iterations, it was concluded that the combination of the variables chosen for VECMs of equations (1) and (2) were the most suitable and more importantly, significant at all conventional levels

6. Conclusion and Recommendations

Given the openness of the Trinidad and Tobago economy, it is anticipated that exchange rate fluctuations will pass-through onto domestic prices. Exchange rate pass-through (ERPT) is an important topic of consideration for two primary reasons in that it assists in forecasting the direction and magnitude of domestic prices changes and secondly, it is influential in the determination of monetary policy. Therefore for most monetary authorities, the assessment of ERPT to inflation is necessary for providing proper policy recommendations.

Several relationships were identified among the key variables during the reference period. The preliminary results indicate that during the period of 1995 to 2016, a unidirectional causal relationship existed between the NEER and domestic food prices, and also the NEER and overall commodity prices. These relationships imply 'cost-push inflation' as changes in the exchange rate influences domestic prices due to changes in the cost of imported intermediate goods in the production process. In the short-run the shocks to money supply and GDP also contributed to increased inflationary pressures to food prices which is consistent with the monetarist view of inflation that money supply is the principal cause of demand pull inflation

The dynamic nature of the variables utilized in impulse response functions of the VECM revealed that Trinidad and Tobago's ERPT to domestic inflation rates were incomplete. Evidence also indicated that the domestic economy's ERPT to the headline inflation rate is relatively short-lived compared to a previous study done by Christopher-Nicholls and Des Vignes in 2002. This was attributed to the use of several monetary policy instruments such as net open market operations, reserve requirements, and liquidity absorption bonds and the introduction of the repo-rate in 2002 by the Central Bank to achieve price stability. The results of a one per cent depreciation in the exchange rate revealed an immediate increase of 0.46 per cent and 0.52 per cent in headline and food inflation rates respectively. The inflationary effects to headline inflation were reflected for four (4) quarters or one year while the depreciation resulted in increased food inflation for two (2) quarters. The fast transmission speed of the depreciation in the exchange rate to food prices was expected as the large imported component makes the domestic economy highly susceptible to exchange rate movements.

Based on the preliminary results of the ERPT, the shock to the NEER had a strong, immediate inflationary impact on headline and food inflation. The positive shock to the exchange rate implies that there is depreciation in the value of the TTD and as a result, the costs of imported goods become more expensive for domestic consumers. The inflationary pressures resulting from a one per cent depreciation of the domestic currency took an estimated two (2) and four (4) quarters to pass-through to food and headline inflation respectively. A positive shock to import prices also contributed to an immediate increase in food and headline inflation rates over the short run. This result is

consistent with cost-push theories of inflation which indicate that higher import costs are transferred to consumers in the form of higher prices.

In the long run, the NEER, government spending and GDP were significant contributors to the inflationary effects in the domestic headline inflation rate while US export prices and GDP were the main drivers of the increases to food inflation rates in the long run. Despite some mitigating upward pressures in the long run, the combined impact of the variables may result in an overall deflationary impact on domestic inflation rates which corroborated the findings by Cheong and Ramrattan (2015).

Due to the dynamic nature of inflation and the impact of various elements of both the domestic economy and external sector on prices, it poses a challenge for monetary authorities to address price pressures. Stemming from the results, the degree of ERPT to inflation suggests that monetary policy needs to be conducted in tandem with exchange rate policy in order to achieve a delicate balance. Any form of inflation management framework by an economy should be actively pursued not only through proper monetary policy channels, but also through the use of exchange rate policies. By focusing on monetary policy without interventions on the exchange rate, policy-makers may not be able to achieve the desired changes in the direction and/or magnitude of domestic prices.

Falling activity in the manufacturing and agricultural sectors would have partially contributed to increased demand for imports of final and intermediate goods. In small states with a narrow production base, like Trinidad and Tobago, attaining complete import substitution is not possible given that these economies are dependent on sourcing several intermediate products on the international market. However, incentives need to be put in place to encourage domestic manufacturers to either seek out local alternatives to be utilized in the production process or to manufacture these goods themselves. Shifts away from imported commodities in both of these sectors towards locally sourced products can contribute to lowering the degree of pass-through of exchange rate shocks to inflation. Furthermore, the government should increase the public's awareness of existing incentive programs in the agriculture sector and reduce the bureaucracy (red-tape) related to the acquisition of these incentives by potential farmers. This can result in increased productivity within the sector, which would subsequently lead to reduced imports of locally grown agricultural produce.

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Appendix 1

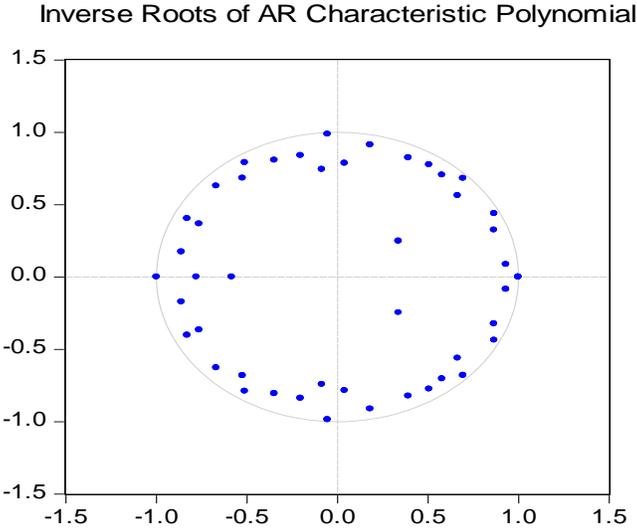
Econometric Results: Unit Root Tests

Variable	Augmented Dickey-Fuller			Philips Peron		
	Constant	Constant, Linear Trend	None	Constant	Constant, Linear Trend	None
LRPI_TT	0.99	0.54	1.00	0.99	0.68	1.00
D(LRPI_TT)	0.00*	0.00*	0.40	0.00*	0.00*	0.00*
LFXR	0.79	0.18	0.97	0.62	0.40	0.98
D(LFXR)	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
LM0	0.87	0.91	1.00	0.87	0.87	1.00
D(LM0)	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
LM2	0.94	0.72	1.00	0.94	0.65	1.00
D(LM2)	0.00*	0.00*	0.01*	0.00*	0.00*	0.00*
LQGDP	0.17	1.00	1.00	0.21	1.00	1.00
D(LQGDP)	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
LIPI_TT	0.49	0.95	0.81	0.49	0.95	0.81
D(LIPI_TT)	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
LUSEXPRF	0.16	0.00*	0.74	0.00*	0.00*	0.00*
D(LUSEXPRF)	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
LRPIF_TT	0.91	0.88	1.00	0.91	0.88	1.00
D(LRPIF_TT)	0.00*	0.00*	0.35	0.00*	0.00*	0.00*
LUSEXPR	0.79	0.53	0.85	0.80	0.82	0.91
D(LUSEXPR)	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
LBDC	0.90	0.56	0.96	0.91	0.56	0.97
D(LBDC)	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
LNEER	0.23	0.22	0.91	0.48	0.52	0.93
D(LNEER)	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
NEER	0.00*	0.00*	0.00*	0.01*	0.05**	0.00*
OG	0.01*	0.11	0.00*	0.00*	0.10***	0.00*
INFL	0.41	0.82	0.39	0.01*	0.05**	0.21
INFL_F	0.25	0.59	0.37	0.00*	0.01*	0.11
LGEXP	0.63	1.00	0.89	0.23	0.00*	0.96
D(LGEXP)	0.00*	0.00*	0.05**	0.00*	0.00*	0.00*

Significance level*- 1%, **-5%, ***-10%.

Optimal Lag Length (Equation 1.0)						
Lag	LogL	LR	FPE	AIC	SC	HQ
1	738.0738	NA	6.13e-16	-18.00185	-17.46589	-17.78697
2	842.0834	184.6170	1.12e-16	-19.70208	-18.09422*	-19.05744
3	881.6180	64.24369	1.05e-16	-19.79045	-17.11067	-18.71604
4	953.2080	105.5953	4.54e-17	-20.68020	-16.92851	-19.17604*
5	1001.280	63.69485*	3.67e-17	-20.98199	-16.15838	-19.04807
6	1044.066	50.27453	3.59e-17*	-21.15166	-15.25614	-18.78798
7	1072.965	29.62121	5.40e-17	-20.97413	-14.00670	-18.18069
8	1127.019	47.29741	4.85e-17	-21.42548*	-13.38614	-18.20228

*indicates the lag order selected by the criterion.
 LR: sequential modified LR test statistics (each test at 5% level)
 FPE: Final Prediction Error
 AIC: Akaike Information Criterion
 SC: Schwarz Information Criterion
 HQ: Hanna-Quinn Information Criterion



Granger Causality/Block Exogeneity Wald Test

Dependent variable: D(INFL)

Excluded	Chi-sq	df	Prob.
D(NEER)	18.85322	7	0.0087
D(LIPI_TT)	5.971229	7	0.5431
D(LGEXP)	1.130722	7	0.9924
D(LM2)	6.032965	7	0.5359
D(LQGDP)	12.47767	7	0.0859
All	49.50389	35	0.0530

Dependent variable: D(NEER)

Excluded	Chi-sq	df	Prob.
D(INFL)	4.876975	7	0.6750
D(LIPI_TT)	5.853321	7	0.5570
D(LGEXP)	3.953085	7	0.7852
D(LM2)	9.418701	7	0.2240
D(LQGDP)	11.36436	7	0.1235
All	31.16039	35	0.6541

Dependent variable: D(LIPI_TT)

Excluded	Chi-sq	df	Prob.
D(INFL)	14.04160	7	0.0504
D(NEER)	29.69585	7	0.0001
D(LGEXP)	20.00440	7	0.0056
D(LM2)	8.327395	7	0.3046
D(LQGDP)	30.83014	7	0.0001
All	80.55276	35	0.0000

Dependent variable: D(LGEXP)

Excluded	Chi-sq	df	Prob.
D(INFL)	20.64440	7	0.0043
D(NEER)	9.882995	7	0.1953
D(LIPI_TT)	12.43075	7	0.0873
D(LM2)	5.758071	7	0.5683
D(LQGDP)	1.986835	7	0.9606
All	80.12240	35	0.0000

Dependent variable: D(LM2)

Excluded	Chi-sq	df	Prob.
D(INFL)	11.18318	7	0.1308
D(NEER)	1.571198	7	0.9797
D(LIPI_TT)	19.60208	7	0.0065
D(LGEXP)	21.03915	7	0.0037
D(LQGDP)	10.73084	7	0.1508
All	51.16451	35	0.0381

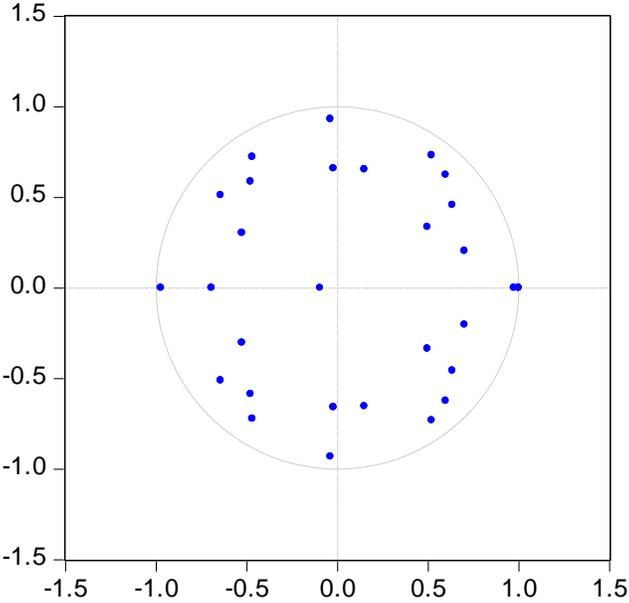
Dependent variable: D(LQGDP)

Excluded	Chi-sq	df	Prob.
D(INFL)	8.433099	7	0.2960
D(NEER)	9.224449	7	0.2369
D(LIPI_TT)	6.022368	7	0.5371
D(LGEXP)	6.313203	7	0.5037
D(LM2)	11.31224	7	0.1256
All	42.29411	35	0.1851

Optimal Lag Length (Equation 2.0)						
Lag	LogL	LR	FPE	AIC	SC	HQ
1	487.0809	NA	3.25e-13	-11.72702	-11.19107	-11.51214
2	590.8444	184.1803	6.01e-14	-13.42111	-11.81324*	-12.77647
3	629.9102	63.48195	5.69e-14	-13.49776	-10.81798	-12.42336
4	698.9497	101.8332	2.61e-14	-14.32374	-10.57205	-12.81958*
5	745.3444	61.47304*	2.20e-14*	-14.58361*	-9.760006	-12.64969
6	777.6322	37.93810	2.81e-14	-14.49080	-8.595288	-12.12712
7	807.7596	30.88058	4.09e-14	-14.34399	-7.376561	-11.55055
8	840.8703	28.97194	6.20e-14	-14.27176	-6.232419	-11.04856

*indicates the lag order selected by the criterion.
 LR: sequential modified LR test statistics (each test at 5% level)
 FPE: Final Prediction Error
 AIC: Akaike Information Criterion
 SC: Schwarz Information Criterion
 HQ: Hanna-Quinn Information Criterion

Inverse Roots of AR Characteristic Polynomial



Granger Causality/Block Exogeneity Wald Test

Dependent variable: D(INFL_F)

Excluded	Chi-sq	df	Prob.
D(NEER)	8.030110	4	0.0905
D(LUSEXPRF)	2.489786	4	0.6465
D(LGEXP)	1.688878	4	0.7927
D(LM2)	8.504157	4	0.0748
D(LQGDP)	0.488915	4	0.9746
All	20.84451	20	0.4063

Dependent variable: D(LGEXP)

Excluded	Chi-sq	df	Prob.
D(INFL_F)	4.183126	4	0.3818
D(NEER)	6.413789	4	0.1703
D(LUSEXPRF)	1.574498	4	0.8134
D(LM2)	1.461903	4	0.8334
D(LQGDP)	0.533231	4	0.9702
All	18.76220	20	0.5373

Dependent variable: D(NEER)

Excluded	Chi-sq	df	Prob.
D(INFL_F)	9.020370	4	0.0606
D(LUSEXPRF)	2.871342	4	0.5796
D(LGEXP)	6.295325	4	0.1782
D(LM2)	15.01498	4	0.0047
D(LQGDP)	17.68352	4	0.0014
All	48.22155	20	0.0004

Dependent variable: D(LM2)

Excluded	Chi-sq	df	Prob.
D(INFL_F)	2.516512	4	0.6417
D(NEER)	2.907149	4	0.5735
D(LUSEXPRF)	1.839375	4	0.7653
D(LGEXP)	0.920399	4	0.9216
D(LQGDP)	3.377639	4	0.4967
All	11.62767	20	0.9283

Dependent variable: D(LUSEXPRF)

Excluded	Chi-sq	df	Prob.
D(INFL_F)	2.728830	4	0.6042
D(NEER)	4.708248	4	0.3186
D(LGEXP)	1.925700	4	0.7494
D(LM2)	2.363999	4	0.6691
D(LQGDP)	3.273305	4	0.5132
All	20.06095	20	0.4541

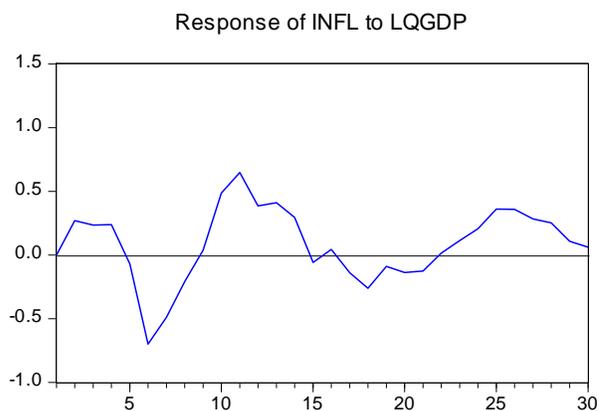
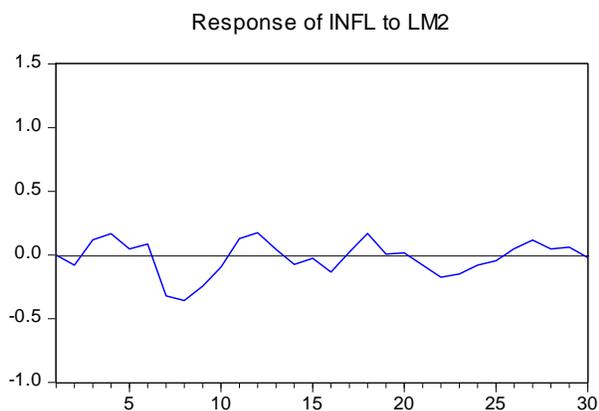
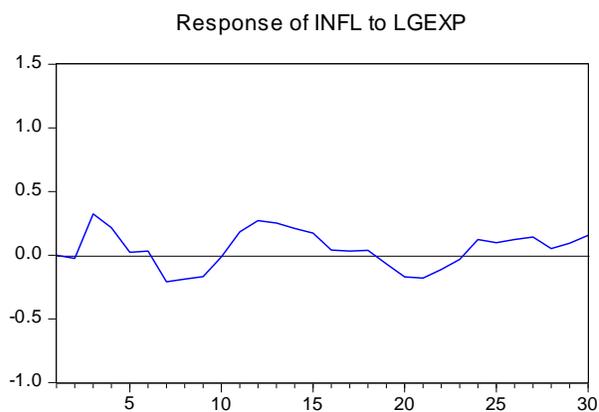
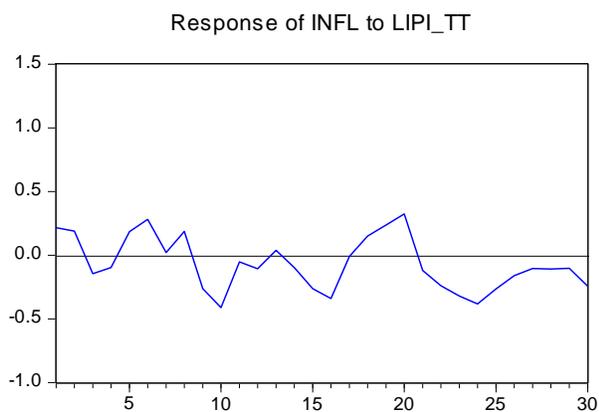
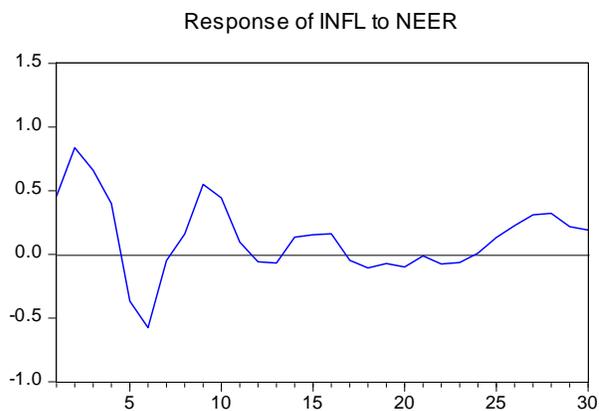
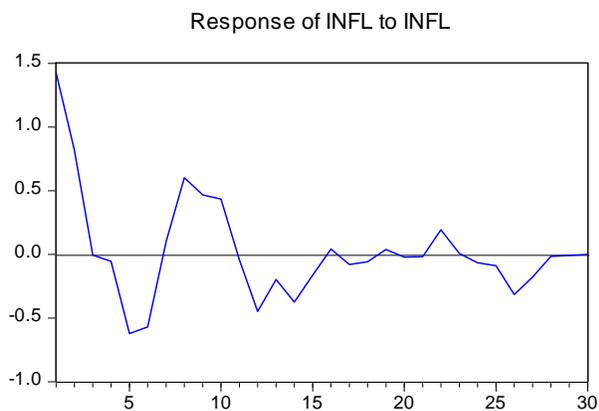
Dependent variable: D(LQGDP)

Excluded	Chi-sq	df	Prob.
D(INFL_F)	1.258736	4	0.8683
D(NEER)	2.558535	4	0.6342
D(LUSEXPRF)	5.285042	4	0.2593
D(LGEXP)	2.587557	4	0.6290
D(LM2)	5.738668	4	0.2195
All	18.88212	20	0.5295

Appendix 2

Impulse Response Functions (Headline Inflation)

Response to Cholesky One S.D. Innovations



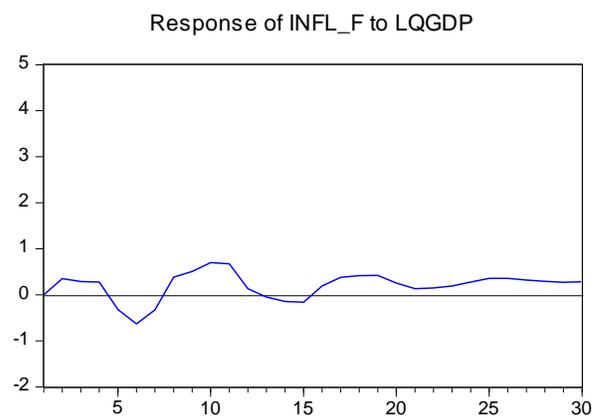
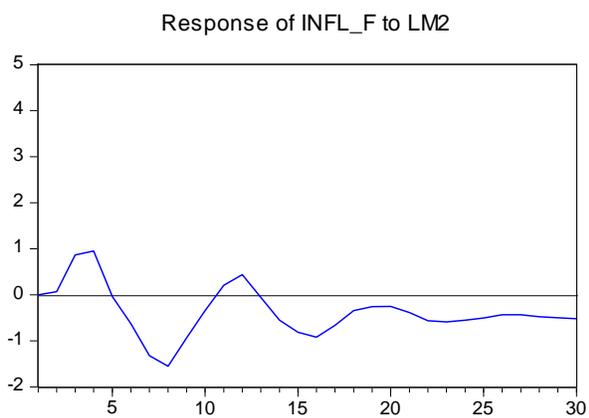
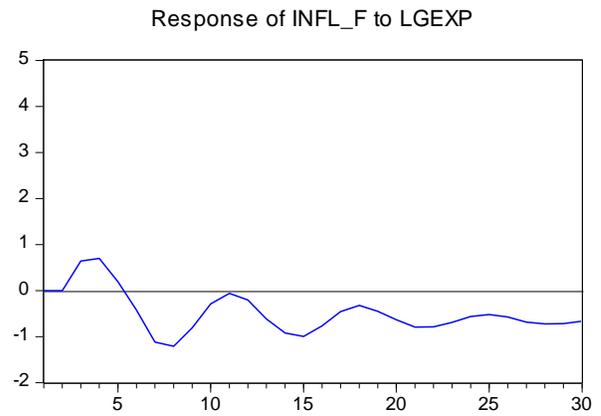
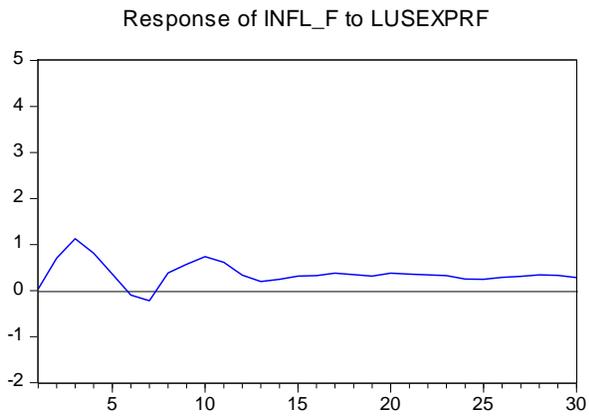
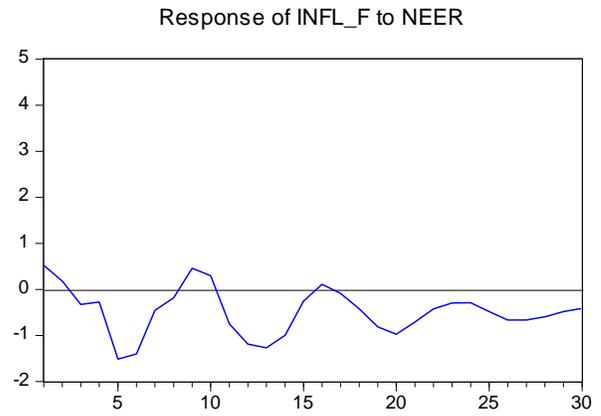
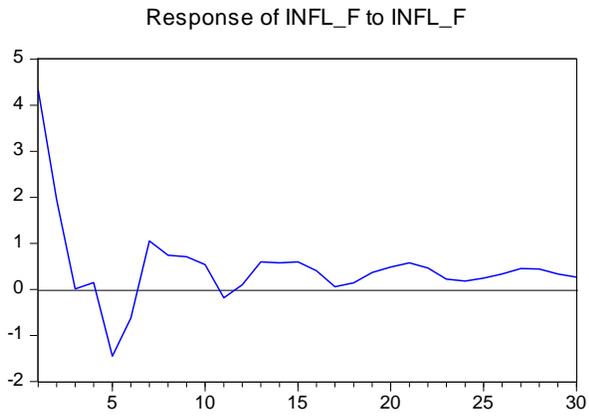
Variance Decomposition of Domestic Inflation (Headline Inflation)

Period	Headline Inflation	NEER	Import Prices	Government Spending	Money Supply	GDP
1	88.81	9.14	2.05	0.00	0.00	0.00
2	71.52	24.18	2.19	0.02	0.17	1.93
3	61.27	30.62	2.35	2.40	0.46	2.89
4	57.39	32.04	2.41	3.23	1.02	3.92
5	58.60	31.17	2.79	2.90	0.95	3.59
6	52.47	30.37	3.47	2.36	0.89	10.44
7	49.56	28.64	3.28	2.865	2.33	13.32
8	50.23	26.58	3.47	3.09	3.85	12.78
9	48.73	28.05	4.03	3.19	4.26	11.74
10	46.49	27.74	5.56	2.91	3.99	13.32
11	44.14	26.42	5.31	3.11	3.95	17.07
12	44.09	25.21	5.17	3.71	4.07	17.75
13	43.27	24.57	5.04	4.22	3.98	18.91
14	43.36	24.03	4.99	4.52	3.92	19.19
15	42.99	23.91	5.56	4.73	3.87	18.94
16	42.35	23.78	6.55	4.67	3.98	18.67
17	42.29	23.74	6.53	4.67	3.97	18.80
18	41.80	23.55	6.66	4.62	4.18	19.19
19	41.53	23.44	7.11	4.64	4.15	19.13
20	40.93	23.19	7.94	4.83	4.09	19.02
21	40.68	23.04	8.02	5.09	4.12	19.05
22	40.49	22.80	8.43	5.13	4.34	18.81
23	39.99	22.56	9.21	5.08	4.48	18.69
24	39.30	22.15	10.28	5.11	4.45	18.71
25	38.59	21.86	10.66	5.09	4.38	19.41
26	38.39	21.70	10.60	5.08	4.29	19.94
27	37.88	22.03	10.47	5.14	4.31	20.17
28	37.34	22.51	10.41	5.09	4.26	20.38
29	37.11	22.74	10.43	5.12	4.26	20.34
30	36.75	22.79	10.79	5.26	4.23	20.18

Cholesky Ordering: Import prices > NEER > Headline Inflation > Government Spending > Money Supply > GDP

Impulse Response Functions (Food Inflation)

Response to Cholesky One S.D. Innovations



Variance Decomposition of Domestic Inflation (Food Inflation)

Period	Food Inflation	NEER	Food Import Prices	Government Spending	Money Supply	GDP
1	98.56	1.43	0.01	0.00	0.00	0.00
2	96.05	1.30	2.10	0.00	0.02	0.53
3	86.43	1.59	6.75	1.56	2.88	0.79
4	79.71	1.73	8.53	3.15	5.87	1.00
5	74.79	8.48	7.70	2.81	5.05	1.17
6	68.97	13.13	7.02	3.05	5.67	2.17
7	64.11	12.19	6.37	5.79	9.35	2.20
8	58.61	10.99	6.02	8.41	13.68	2.30
9	56.21	10.78	6.34	9.27	14.70	2.69
10	54.97	10.61	7.23	9.14	14.47	3.59
11	53.46	11.40	7.76	8.89	14.13	4.37
12	51.67	13.69	7.71	8.66	14.02	4.25
13	50.08	15.99	7.44	8.98	13.42	4.07
14	48.44	17.01	7.22	10.05	13.36	3.93
15	47.26	16.50	7.12	11.33	13.96	3.83
16	46.19	16.05	7.08	11.96	14.94	3.78
17	45.51	15.82	7.20	12.11	15.41	3.95
18	45.03	15.93	7.31	12.14	15.43	4.18
19	44.31	16.61	7.31	12.20	15.21	4.36
20	43.43	17.58	7.32	12.46	14.88	4.34
21	42.80	17.86	7.32	13.05	14.72	4.25
22	42.21	17.74	7.33	13.66	14.86	4.19
23	41.62	17.59	7.36	14.12	15.12	4.18
24	41.16	17.49	7.36	14.40	15.35	4.24
25	40.68	17.57	7.34	14.57	15.49	4.35
26	40.13	17.87	7.32	14.76	15.47	4.45
27	39.60	18.10	7.30	15.09	15.41	4.50
28	39.09	18.20	7.31	15.47	15.41	4.52
29	38.59	18.20	7.33	15.87	15.47	4.54
30	38.14	18.16	7.32	16.21	15.59	4.58

Cholesky Ordering: Import prices > NEER > Food Inflation > Government Spending > Money Supply > GDP

Appendix 3
Summary of Empirical Methodologies Found in Literature

Authors	Country	Model	Inflation Targeter	Exchange Rate Regime	Time Period	Results
De Vignes and Christopher-Nicholls (2002).	Trinidad and Tobago	VAR/VECM	No	Managed Float	Quarterly data: 1985-2001	A depreciation in the NEER results in an initial decline of 0.2 per cent in domestic prices. The effect is not felt until the fourth quarter where prices begin to rise and the ERPT persists up to quarter 10 (two and a half years) before leveling off at a new and higher equilibrium.
Rowland (2004)	Colombia	VAR and Johansen framework of multivariate cointegration	Yes	Floating	Monthly data; 1983:2002	Exchange rate pass through is incomplete, import prices respond quickly to exchange rate movements where 80.0 per cent is passed from import prices in 12 months, 28.0 per cent for producer prices and 15.0 per cent for consumer prices. The Exchange rate shock therefore only has a little impact on consumer prices.
Aliyu, Yakub, Sanni and Duke (2009)	Nigeria	VAR/VECM	No	Gradual deregulation of foreign exchange market.	Quarterly data : 1986:2007	ERPT is low and incomplete. A one percent shock to the exchange rate results in 14.3 per cent and -10.5 per cent pass through to import and consumer prices respectively. ERPT in Nigeria declines over the distribution chain and partly overturn the conventional wisdom that ERPT is always considerably higher in EMDE's than in developed economies.
Nidhaleddine Ben Cheikh (2011)	27 OECD countries	Panel Cointegration Technique: FM-OLS and DOLS	Various types	Various types	Quarterly data: 1994-2010	Individual estimates of ERPT are heterogeneous across 27 OECD countries, ranging from 0.23 per cent in France to 0.98 per cent in Poland (incomplete ERPT). However, it is important to mention that there is an evidence of complete pass-through for 5 out of 27 countries, namely Czech Republic, Italy, Korea, Luxembourg and Poland. The results indicate a regime-dependence of ERPT, that is, countries with higher inflation regime and more exchange rate volatility would experience a higher degree of pass-through. Both FM-OLS and DOLS estimators show that pass-through elasticity does not exceed 0.70 per cent. These results are in line with estimates in the literature of exchange rate pass-through into import prices for industrialized countries. These findings are in line with Taylor's hypothesis.

Nidhaleddine Ben Cheikh, Wael Louhichi (2014)	12 Euro Area countries	VECM	Various types	Various types	1990-2010	A higher pass-through to import prices with a complete pass-through (after one year) detected for roughly half of Euro Area countries. These estimates are relatively large compared to single-equation literature. The magnitude of the pass-through of exchange rate shocks declines along the distribution chain of pricing, with the modest effect recorded for consumer prices
Nidhaleddine Ben Cheikh, Wael Louhichi (2014)	63 countries	Panel Threshold Approach	Various types	Various types	Annual data: 1992-2012	Examined the role of inflation regime in explaining the ERPT to import prices. Found two (2) thresholds in study and objectively divided sample into three (3) inflation regimes for comparison using grid search. Higher inflation rates experience the higher degree of ERPT.
Mujica and Saens (2015)	Chile	Single Equation	Yes: gradual implementation	From a band system to a floating regime	Quarterly data: 1986-2009	ERPT to prices diminishes significantly in countries that adopt an inflation targeting regime.
Jimenez-Rodriguez, Morales-Zumaquero (2016)	G-7: Canada, Japan, Italy, Germany, France, UK	Single Equation, VAR, time varying approach	Yes	Varying	Quarterly data: 1970-2014	The Taylor's hypothesis holds. The ERPT declines over time and has been low for those economies with low inflation. ERPT is positively related to inflation volatility. ERPT depends on the exchange rate regime (higher ERPT for fixed regimes)
Karagoz, Demirel and Bozdag (2016)	Asia Pacific, South America and Turkey	VAR	Yes	Variable traits of dollarization	Quarterly data: 2002-2010	There is a positive relation between inflation and pass through. Pass through effects in Asia Pacific economies is lower than the pass through effect in Latin America and Turkey. Exchange rate based shocks and commodity based shocks (such as increases in gold or oil prices) may cause more of an effect on Latin America and Turkey. Pass through coefficients for producer prices are higher than the pass through to consumer prices for both groups.
Lariau, El Siad and Takebe (2016)	Angola and Nigeria	VAR for Nigeria VECM for Angola.	Nigeria -Yes	Nigeria: Shift from fixed to a managed float Angola; de-dollarized	Monthly data: 1995-2005	For Angola, the long run ERPT to prices is high, although it has weakened in recent years reflecting the de-dollarization of the economy. There was no stable long run relationship between exchange rate and prices and changes in the exchange rate do not have a significant pass through effect on inflation. However the pass through on core inflation is significant. Nigeria's low ERPT to headline inflation is the non-responsiveness of food prices to changes in the NEER because most of the food is

						locally produced (Agricultural sector accounts for 20.0 per cent of GDP). In contrast, Angola's long run ERPT has been relatively high given the country's less diversified economic structure and therefore heavy reliance on imports. However, the pass through effect has weakened as a consequence of de-dollarization.
Borensztein and von Heideken (2016)	Brazil, Chile, Colombia, Paraguay, Peru and Uruguay	VAR	Yes	Floating Exchange Rate Regimes	Monthly data: 1999 (Chile) 2002 (Brazil) 2003 (Uruguay, Peru and Colombia) 2004 (Paraguay) to 2015	The ERPT in the countries were moderate and has become lower over time. The moderation has benefitted from adoption of the floating exchange rate regime and monetary policy credibility. Despite the lower ERPT, exchange rate continues to be a large determinant of inflation in several countries.