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Trade Openness and Inflation in Nigeria: A Nonlinear ARDL Analysis

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Abstract
This study investigated the relationship between trade openness and inflation in Nigeria between 1980 and 2015. It employed the nonlinear auto-regressive distributed lag (NARDL) modelling approach to co-integration based on the standard theoretical and empirical literature on trade openness-inflation relationship. Our approach allows us to simultaneously test the short- and long-run nonlinearities through positive and negative partial sum decompositions of the predetermined explanatory variables. Empirical evidence revealed that the direction of the relationship between openness and inflation is time specific. While there is a significant positive long-run relationship between inflation and trade openness, the analysis in contrast found a strong and robust negative link between openness and inflation in the short run. In addition, the obtained results indicate that trade openness affect inflation in an asymmetric and nonlinear manner. The results were found to be robust to different specifications.
Key words: Inflation, Monetary Policy, Openness, NARDL, Nigeria.
JEL Classification: E31, F41.

1. Introduction

The association between trade openness and inflation is a celebrated proposition in the international trade context. The relationship has been referred to as one of the modern puzzles of international macroeconomics (Temple, 2002). The basic argument of the advocates of trade openness (spillover hypothesis) is that trade openness is associated with declining prices, so that protectionism is inflationary. Although, there are still concerns about lingering tariffs, non-tariff barriers, and other protectionist practices, it is apparent that the global economy has become more integrated. However, the obvious question is whether these macroeconomic factors (openness and inflation) are related. The argument is that there are different mechanisms through which openness may affect inflation. According to new growth theory, openness can reduces inflation through its positive influence on output, mainly through increased efficiency (which is likely to reduce costs via changes in the composition of inputs procured domestically and internationally), increased foreign investment (which could stimulate output growth and ease pressure on prices), better allocation of resources, and improved capacity utilization, (Jin, 2000; Ashra, 2002).

In addition, openness alters inflation via two mechanisms. The Mundell-Fleming extensions of the Barro and Gordon (1983) model suggest there is an inverse relationship between openness and inflation. In these models, expansionary monetary policy causes an increase in domestic output, deterioration in the terms of trade and the economy will get surprise inflation. As openness changes, the incentives the (discretionary) monetary policy maker faces change because openness alters the slope of the Phillips curve and the effect of monetary policy on output. The inflation cost is increased and the output gain from surprise inflation is reduced. As the degree of openness rises, the Phillips curve trade-off becomes less favourable and optimal policy is less expansionary. This mechanism therefore generates an inverse relationship between openness and inflation. There is also a second effect in the model because the socially optimal level of output depends on openness and this helps pin down the position of the monetary authority's set of indifference curves (Cooke, 2004).

Nevertheless, according to the conventional view, inflation is lower in more open countries because real depreciation, which could be due to unanticipatory monetary expansion, produces harms like increased cost of production that are greater in more open countries. As a result, the authorities will expand less and hence inflation rate will be less (Romer, 1993; Zakaria 2010). On the contrary, the less open an economy is, the greater is the incentive to expand, and so the higher is the equilibrium rate of inflation. This is because as the economy opens up, the fiscal and monetary authorities tend to lose their ability to control inflation through fiscal and monetary policies. Thus, models of inefficiently high inflation arising from the absence of pre-commitment predict an inverse relationship between openness and inflation. Nevertheless, many factors are believed to have contributed to the global drop in inflation: globalization, better monetary policy, luck, the attendant acceleration

of productivity, and the increased level of competition in both product and labour markets. All these factors likely played a role, and disentangling the relative importance of each remains an important challenge (Rogoff 2003; and Wynne and Kersting 2007). The main obstacle in empirical study is that certain economic variables are very complex to measure accurately.

Until the mid-1980s, Nigeria pursued an economic policy that was strongly interventionist. During the late 1980s, Nigeria turned from inward-looking policies toward trade liberalization and export promotion strategies with the adoption of the structural adjustment programme. Under the SAP, Nigeria eliminated import licenses and agricultural marketing boards, lifted price controls, allowed foreign ownership in most manufacturing. In addition, the country liberalized and accelerated administrative procedures for new investment, launched a program of privatization, and took steps toward the deregulation of the banking system. Consequently, one of the most striking events of the last three decades has been the remarkable decline in inflation in Nigeria. For example, inflation declined from 29.3% in December 1996 to 17.9% in December 2005. It fell further to 12.5% in December 2009 and was 8.9% in December 2015. Although the manipulation of the Monetary Policy Rate (MPR) and the cash reserve requirements (CRR) by the Central Bank of Nigeria (CBN) contributed to the lower inflationary trend, the period coincided with when the country recorded a remarkable increase in trade openness.

However, the literature on the effect of trade openness on inflation is still inconclusive. It is still an empirical question in the economic literature. While some of the studies (Alfaro, 2005; Kim and Beladi, 2005) have reported a positive relationship, some other studies (Sachsida *et al.*, (2003), Romer (1993), Gruben and McLeod (2004)) established a negative relationship. In addition, there are also studies (Temple, 2002; Alfaro, 2003; Gruben and McLeod, 2004; Thomas (2012) that reported non-existence of the relationship. Some of the areas of controversy have been around the stage of development of the country, the level of indebtedness of the country, theoretical justification, significance of complementary reforms, sample coverage and the set of control variables in empirical analysis as well as methodological and measurement issues. Even among the set of studies that observe a positive or negative relationship, they differ over the mechanisms, which link them.

Thus, the relation between openness and inflation is one of the ways to check temporal consistency theory. That is, in countries where independent central banks operate or have credibility, there should not be any relationship between inflation and openness. However, in countries which do not have independent monetary authorities, the openness would act to control the incentive of the government in generating inflation. Therefore, in these countries, a negative relationship between inflation and trade openness would be expected. However, majority of the studies that have addressed this subject matter are cross-section analyses, and adopt the average of the variables under study in diverse countries to verify the relationship between inflation and openness. Inflation is a very complex phenomenon and its causes and levels differ from one country to another and from one period to another which there give rise to a variety of governmental, non-governmental, structural and non-structural problems. These studies cannot specifically identify the differences in each country. This is because while we do observe high periods of inflation, we do not see them in all countries at all times. Hence, our judgement is that the results of a specific country will be more accurate and closer to reality.

Currently, the literature on the trade openness-inflation association in Nigeria is scanty. Only the study of Ada, Oyeronke, Odunayo, Okoruwa and Obi-Egbedi (2014) has been conducted for Nigeria. However, their study suffers from one serious limitation: it combined stationary and non-stationary variables using the Johansen cointegration technique. The combinations of such variables in a framework that required only non-stationary series are likely to yield spurious results. In addition, this study considers the role of other variables that affect the short and long term dynamics that drive inflation. The choice of Nigeria is informed by its relevance in the African and global economy. Nigeria is ranked as the 21st largest economy in the world in terms of nominal GDP, and the 20th largest in terms of Purchasing Power Parity. Currently, it is the largest economy in Africa. Therefore, the assumption is that Nigeria's openness and inflation pattern might influence the continents openness and inflation pattern.

Consequently, this paper attempts to contribute to the existing literature by exploring the inflation and openness relationship in Nigeria. Our study is differs from the existing studies with the utilization of a different approach. Specifically, the study employed the nonlinear auto-regressive distributed lag (NARDL) modelling approach to co-integration. One advantage of this cointegration framework is that it can be applied regardless of whether the variables have a unit root or stationary at their levels. In addition, the method corrects for endogeneity and serial

correlation and allows for possibly asymmetric (i.e. nonlinear) adjustments of inflation to movements in other variables. In other words, increases and decreases in other variables are allowed to affect inflation differently. Besides, the outcome of the study is expected to assist policy makers, as an input, in decision making with regard to devising policies in combating inflation. The sequence of the study is clear. Section provides the stylized facts on openness and inflation while a brief review of the literature is presented in section three. Section discusses the methodology. The empirical analysis is the focus of section five while section offers concluding remarks.

2. Openness and Inflation in Nigeria: Stylized Facts

In the immediate period after independence, Nigeria initially followed commercial policies that favored import substitution, which created a highly protected environment for industrialization. The import-substitution strategies adopted were meant to produce locally the consumer goods, which had previously been imported from developed countries, so as to promote the diversification of the Nigerian economy. Tariffs, quantitative restrictions and other non-tariff barriers were the principal policy instruments used to shield the domestic import-substituting industry. Nevertheless, trade policy development actually commenced with its generalized downward review of tariffs rates and the removal of some quantitative restrictions (QRs) in 1970 in order to satisfy the pent–up demand that occurred after the civil war. Surcharge on imports was reduced from 7.5% to 5% in 1970 while tax exemptions were also granted to exporters of manufactured goods. Hence, the year 1974 witnessed substantial reductions in import duties on a wide range of commodities. These include industrial raw materials, vehicles and building materials, and several consumer goods.

Thus, between 1975 and 1976 licensing requirements for a wide range of goods were liberalized while the ban imposed on importation on most of the consumer goods was lifted. However, the liberal imports policy of the 1970-76 period was abolished in 1977. During the period, import duties were raised, import- licensing requirements were re-introduced and importation of several goods was prohibited. The objective was to correct the adverse balance of payments position. Similarly, the 1983-85 period witnessed more stringent trade policy laws due to the economic challenges the country witnessed. About 152 imported finished goods were placed under specific import-license, import duties were increased and the open general import license framework was abolished. Exporters were also required to repatriate export proceeds while failure to do so could lead to prosecution.

The economic stagnation witnessed after the collapse of oil price necessitated the adoption of the Structural Adjustment Programme (SAP) in September 1986. It was adopted to focus on the removal of price through abolishing the import- licensing system, elimination of price controls as well as scrapping of the commodity boards. Exchange rate regime was also liberalized with the introduction of the second tier foreign exchange market (SFEM). Tariff measure that was meant to protect the local industries from foreign competition was enacted. The policy of a liberalized foreign exchange market was also reasonably maintained during the period. Given the success of the period recorded, the import liberalization measures that was undertaken in 1995 significantly reduced tariff rates and reliance on quantitative restrictions.

Hence, by 2004, Nigeria's trade regime has become generally more liberalized. To support the argument, Figure 1 presents some evidences on average tariff rates for a variety of products. It is obvious there is a clear trend towards lower formal barriers to trade over the past four decades. The simple average applied most favoured nation (MFN) tariff rate on all products declined from 25.93% in 1988 to 23.00% in 1998 and 10.82% in 2008. It increased slightly to 11.76% in 2014 (Figure 1). Similar decline was reported for the tariff rates of primary and manufactured products. Much of this decline has been driven by successive rounds of trade liberalization under the auspices of the World Trade Organization and its predecessor, the General Agreement on Tariffs and Trade. In addition, Nigeria has aligned its tariff with that of the Economic Community of West Africa Common External Tariff (ECOWAS CET). Although concerns remain about lingering tariffs, nontariff barriers, and other protectionist practices, it is hard to deny that the Nigerian trade regime has become more liberal. Nevertheless, the naira (the national currency) has been depreciating rapidly against the currencies of Nigeria's major trading partners. The associated restrictions in the foreign exchange market result have been strongly linked to the continued premium between the official and non-official exchange rates. These restrictions and Nigeria's increasing barriers to trade have fuelled informal trade with its neighboring countries.

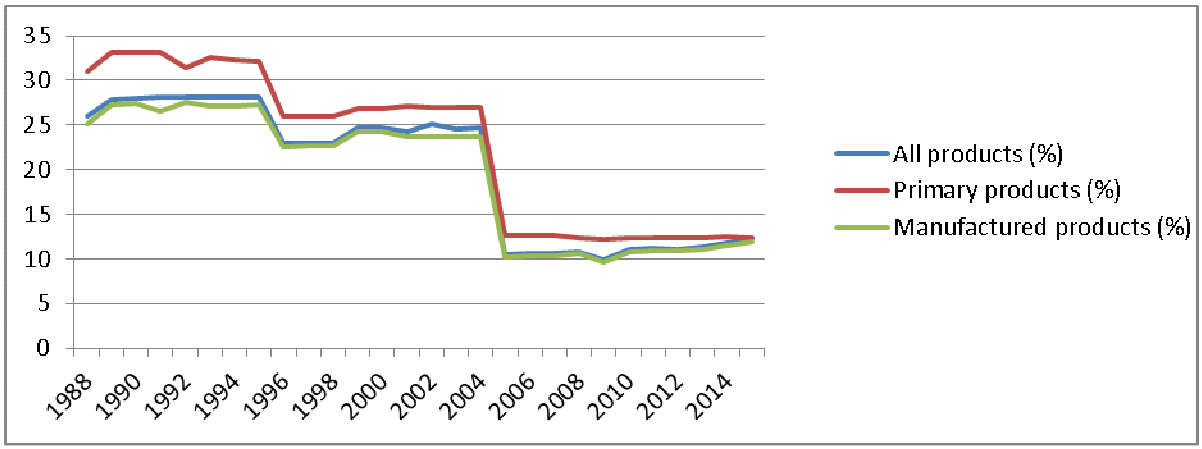

Figure 1: Average Tariff Rates: 1988-2014.
Source: Drawn from the Statistics Obtained from the World Bank World Development Indicator (2016).

Inflation in Nigeria over the last 50 years had an erratic trend, ranging as high as 57 per cent in 1993 and as low as -3.72 per cent in 1967. Table 1 reveals that during 1960s when total trade was low (25.33% of GDP) inflation was also low (3.48%); however, during 1990s when trade has increased to 59 per cent of GDP, inflation also reaches about 30.64%. The pattern however changed in the 2000s when the average openness index increased to 64.68% and inflation declined to 12.23%. Although, average openness declined to 37.20% in the 2010-2015 period, inflation also declined to 10.38%. A similar pattern holds between inflation and the components of trade openness measures i.e. exports and imports (both expressed as percentage of GDP). These trends provided the idea that inflation and trade openness remained positively correlated in Nigeria between1960 and 1999. However, the trend changed to an inverse relationship between 2000 and 2015.

Perhaps, the economic conditions in the country of the various decades could have been responsible for the observed relationship between openness and inflation. The debt forgiveness from the Paris club in 2005 and the surge in the crude oil prices in the 2000's decade made resources available for productive efforts in the economy. As a result, Nigeria benefited from several years of robust economic growth, averaging over 6% per year in real terms since 2005. Growth was quite broadly based with wholesale and retail trade, communications, and agriculture contributing most strongly. This is therefore suggesting that the prevailing economic situation in a country may be part of the defining factor on the direction of the relationship between openness and inflation.

Table 1: Inflation and Trade Openness Indicators (1960 -2015)

	Inflation, consumer prices (annual %)	Exports of goods and services (% of GDP)	Imports of goods and services (% of GDP)	Total Trade GDP
1960-1969	3.489863	9.838009	15.49528	25.33329
1970-1979	15.80619	17.71017	17.86579	35.57596
1980-1989	20.89364	22.41172	14.81093	37.22264
1990-1999	30.64056	34.60305	24.96645	59.5695
2000-2009	12.23142	38.22413	26.45991	64.68405
2010-2015	10.38815	22.52907	14.67204	37.2011
Average	15.57497	24.21936	19.04506	43.26442

Source: Computed from Statistics Obtained from World Bank World Development Indicator (2016).

Tight monetary policy (combined with fiscal consolidation) also appears to have contributed to this low-inflation environment. For example, the Central Bank of Nigeria (CBN) introduced the Monetary Policy Rate (MPR)[1], cash reserve requirements (CRR), standing lending order and deposit facility. Specifically, the need to fight against inflation and maintain credibility with markets and economic agents led the authorities to give priority to the MPR**.** This is because changes in MPR by the CBN affects aggregate demand, growth and inflation through

[1] The CBN introduced the Monetary Policy Rate to replace the Minimum Rediscount Rate (MRR) in December 2006.

various transmission channels and induce changes in employment. For example, if the CBN is worried that inflation is likely to increase, then it may decide to increase the MPR to reduce demand and reduce the rate of economic growth. The success of the manipulation of the MPR can be seen in the downward trend of inflation in Nigeria (Figure 2).

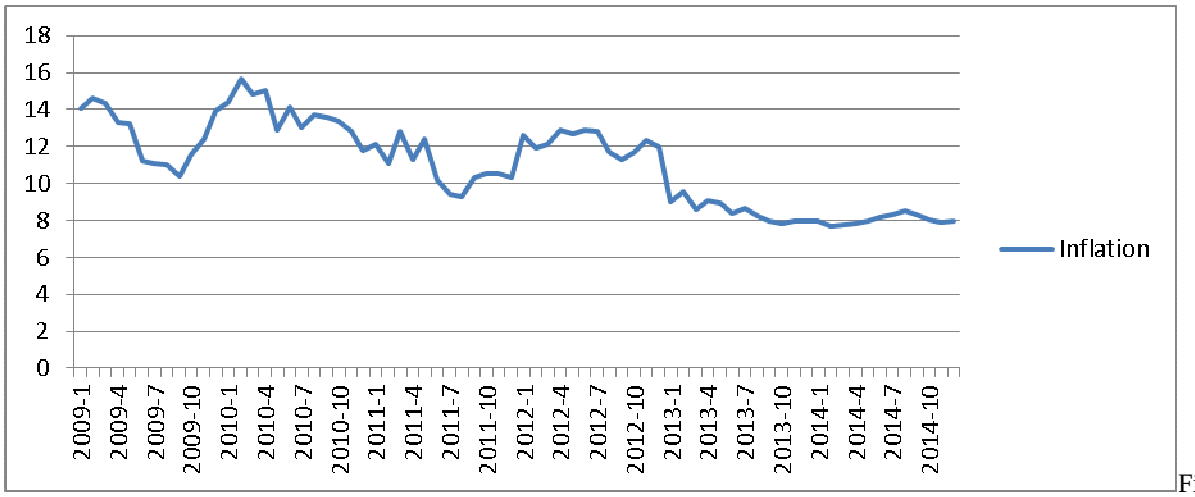

Figure 2: Inflation trend in Nigeria 2009: to 2014:12
Source: Drawn from Statistics obtained from CBN Bulletin (2016)

3. Review of Related Studies

The theoretical foundation of the openness and inflation relationship was laid by Barro and Gordon (1983). Barro and Gordon (1983) argued that discretionary regimes increases inflation at higher and inefficient levels than monetary regimes that followed rules. Broad monetary policy increases in local output and deterioration in terms of trade in time-consistent policy framework. However, as openness alters, the advantage faced by discretionary monetary policy makers changes because openness modifies the Phillips curve slope and effect of monetary policy on output.

Thereafter, the first structural model directly addressing the question of openness and inflation was provided by Rogoff (1985). Rogoff (1985) approach is to extend the Barro and Gordon (1983) time-consistent policy framework to a two-country Mundell–Fleming model. Similar to the Barro and Gordon framework, a labor market friction causes the optimal time-consistent policy of the monetary authority to increase inflation in order to raise the level of employment. However, in the Rogoff international model, the increased inflation has an extra cost since optimal employment is a function of the real exchange rate and the real exchange rate depreciates with higher inflation. The depreciation in turn reduces the incentives to undertake expansion. Therefore, the optimal time-consistent inflation rate chosen by a monetary authority is lower as the deteriorating effect on the exchange rate increases. More openness leads to a lower equilibrium inflation rate in this time consistent environment. This becomes even weaker in politically instable economies with independent central banks.

Adopting the Kydland and Prescott (1977) and Barro and Gordon (1983) type models, Romer (1993) provided the empirical foundation of the inflation and openness relationship. Romer (1993) worthy contribution is to test the prediction that the absence of pre-commitment in monetary policy, given by the degree of openness, leads to inefficiently high inflation. Accordingly, the study empirically showed that there is a negative relationship between openness and inflation for a cross-section of 114 countries between 1973 and 1988. Two distinct explanations were provided for the inverse relationship between openness and inflation. The first is that since unanticipated monetary expansion causes real exchange rate depreciation and the harms of real depreciation is greater in more open economies; the benefits of surprise monetary expansion are a decreasing function of the degree of openness. Hence, the Phillips curve is steeper while the central bank will have less incentive to generate surprise inflation in such open economies.

The second one is that, the more open the economy is, the more revenue the country gets from tariff. Hence, the possibility of relying on other sources of revenue such as seignorage will be less. As a result inflation is low in more open economies than less open economies. The result was established to hold across almost all types of countries with the exception of the most highly developed countries. Average inflation in the world's richest countries tends to be low regardless of how open they are. Romer interprets this as suggesting these countries have largely solved the time-consistency problem that leads to higher inflation in less developed countries. The negative relationship between inflation and openness was also supported by Iyoha (1973), Lane (1997), Sachsida (2003), Al-Nasser et al. (2009), Mukhtar (2010), Ahmad Mahmood (2013), and Salimifar, Razmi, and Taghizadegan (2015).

Nevertheless, for some of the studies that reported a negative openness-inflation-relationship, there is a debate that the correlation varies across countries, choice of openness measure, initial inflation condition, stage of development, and level of indebtedness of the country. It was also argued that the results are also sensitive to the period evaluated and the countries included in the sample. For example, Lane emphasizes a different transmission link through which openness and inflation may be related: the degree of imperfect competition and price rigidity in the non-tradable sector. Lane reported that in the presence of additional variables (country size, per capita income, and central bank independence), the relationship between openness and inflation is statistically significant (and negative) even for advanced industrial nations. Therefore, the study argued that a more open country has less to earn with the generation of a surprise inflationary condition due to the deterioration of the exchange terms is limited in focus.
In a similar vein, Campillo and Miron (1997) while controlling for other variables (prior inflation experience, optimal tax considerations, and time-consistency issues in areas other than monetary policy) found statistically significant negative relationship between openness and inflation. This is made more significant by the fact that the authors failed to find central bank independence to be a substantial causal factor. The authors concluded that it was mainly structural factors (openness, political stability and tax policy) that drive cross-country differences in inflation in contrast to institutional arrangements. There is also a time dimension to the inflation-openness relationship argument. Samimi et al. (2011) applied autoregressive distributed lag (ARDL) approach to test the relationship in Iran. While their study pointed out a significant inverse relation between openness and inflation in the short run, empirical evidence revealed that it had no effect in the long-run. Mukhtar (2010) used multivariate co-integration test and vector error correction model to investigate the relationship between inflation and trade openness in Pakistan between the years (1960- 2007) and came to the conclusion that there was a negative relationship between inflation and trade openness in the long run.

The inverse inflation and openness relationship was also found to be conditional on the level of economic integration among countries. Brahmbhatt and Dadush (1996) reported that between 1984 and 1993, inflation volatility in countries that were slow to integrate was much more in countries that achieved rapid integration. Bowdler and Malik (2005) revealed that countries that have opened up to trade more rapidly than the global average have experienced larger reductions in inflation volatility, independently of the exchange rate regime. The debt level is also another factor that influences the negative relationship. For example, Terra (1998) pointed out that the negative link between openness and inflation found by Romer (1993) is largely driven by the response of the severely indebted countries to the debt crisis of the 1980s.

The final result of the openness and inflation relationship is also predicated on the concentration of wage bargaining in the country. Cavallari (2001) inserted the relation of trade openness and inflation in monopolistic production model and unionized labour market of domestic sector by adopting the Game Theory Approach. Cross-sectional regressions for 19 OECD countries were estimated over the period of 1973-1988 as well as panel data for 1980, 1990 and 1994.The result of the theoretical model showed that trade openness can affect inflation in a positive or negative way and the final result depends on level of concentration of wage bargaining in country. This implies that in countries where wage bargaining is concentrated, there is no relation between openness and inflation. However, in countries where wage bargaining is decentralized, there is a negative relationship between openness and inflation.

The role of exchange rate regimes, country and time specific effects was reported as being important. Bleaney estimated relationship of inflation and trade-openness for 100 countries from 1973 to 1988 and 1988 to 1998. The study argued that the negative correlation between inflation and openness found in some cross-section studies was a characteristic phenomenon of the 1970's and 1980's. This is because such correlations

disappeared in the decade of 1990. It can therefore be inferred that the correlation between openness and inflation has both country and time specific effects. Nevertheless, the same results were obtained when per capita income levels, population, area and exchange rate regimes were employed as control variables. The study concluded that shift from pegged to floating exchange rate was predicted to add at least 10 percent to inflation rate and in both periods land area and inflation was positively correlated.

Alfaro (2003) explored the other variables that might affect inflation. In particular, Alfaro analyzed the relationship between inflation, openness, and the exchange-rate regime as a commitment device. This is because Romer (1993) argued that the choice of exchange-rate regime is not an important determinant of inflation. However, Frankel (1999) observed that fixing the exchange-rate has the advantage of providing an observable commitment to monetary policy. This argument implies that fixed exchange-rate regimes could be associated with higher levels of trade. Consequently, excluding a fixed exchange-rate variable from an analysis that considers the relationship between inflation and openness can therefore bias the results. Thus, Alfaro found a significant negative relationship between a fixed exchange-rate regime and inflation that is robust to the inclusion of other control variables used in the literature.

According to Gruben and Mcleod (2004), countries that are most open to trade have experienced the greatest reduction in their inflation rates during the 1990s. Hence, the trade openness-inflation relationship has strengthened during the 1990s. This relationship was found to be robust across all country groups and high-income countries. Sachsida *et al.* (2003) also supported the negative relationship and found that the negative link is not specific to a group of countries or a certain period of time. The initial inflation condition is also a driver of the inflation and openness relationship. Lin (2010) investigated the relationship between trade openness and inflation through the analysis of panel data for 106 countries (including 58 countries in debt crisis in 1980) over the 1970-2007 periods. The results of the study suggested that a negative effect of trade on inflation is true when inflation is high, but if inflation is low, economic openness does not affect inflation. This negative effect is directly correlated with inflation increase and increases along with it.

Cooke (2004) suggested that inflation is inversely related to openness when accounting for real balances alone. However, for a full analysis of inflation it is necessary to account for steady state consumption, and this depends on foreign demand. When foreign demand is low the inverse relationship holds, but when foreign demand is sufficiently high inflation rises and falls with openness. The choice of methodology is also very critical. Haq and Zhu (2016) established two models on the basis of two different indexes of trade openness. Economic growth and money supply were employed as control variables. The results of ordinary least squares and generalized method of moments (GMM) confirmed the Romer's hypothesis for both indexes. However, the random effect model suggested new comprehensive index for Romer's hypothesis over the traditional index. On the other hand, dynamic least square suggested that it is the traditional index and not the new comprehensive index responsible to hold the Romer's hypothesis. Therefore, it cannot be claimed as some empirical studies did that new index against traditional gives the desired results. Hence, it can be concluded that methodology matters for the observed relationship rather than just the proxy of openness.

However, there are some studies that do not support the Romer hypothesis. They argued that trade openness does not necessarily reduce inflation but rather increases it. For example, Terra (1998) opposed the hypothesis by arguing that the negative correlation between openness and inflation was only observed in severely indebted countries during the 1980s crisis period. If the indebted countries are less open economy, they will need a larger exchange rate devaluation to generate the trade surplus for making debt repayments. The devaluation of the exchange rate, in turn raise the value of external liabilities in domestic currency. When inflation tax is taken as the major source for payment of this liability, a higher inflation rate will result. Therefore, the less open a country is, the higher its inflation will be during a debt crisis.

Kim and Beladi (2005) investigated the effect of trade openness on inflation and reported a positive relationship between inflation and trade openness for some advanced economies, such as the United States, Belgium, and Ireland, while for other countries, both developed and developing, their finding is the same with Romer's hypothesis. Also, Evans (2008) argues that openness has a positive effect on inflation. This positive effect of openness on inflation is driven by the possibility of importing inflation from the rest of the world via the prices of manufactured imports or raw material imports. Moreover, as the economy opens up, the fiscal and monetary

authorities tend to lose their ability to control inflation in the domestic economy through fiscal and monetary policies. Mehmet *et al.* (2009) and Thomas (2012) arrived at the same conclusion.

Thomas (2012) investigated the impact of the degree of trade openness on inflation for a total of eight Caribbean countries between 1980 and 2009. The empirical results suggested a positive relationship between openness and inflation. These results are also observed in various sub-samples when the time-series dimensions of the panel are changed. Moreover, the study concluded that the relationship between inflation and openness are neither restricted to any group of countries nor to a specific time period. Thus, there are countries that may increase their levels of openness and experience a reduction in the levels of inflation.

Similarly, Ghaderi, Samimi and Sanginabadi (2012) investigated the hypothesis that inflation is lower in more open economies for MENA region during 2000-2007 and have found evidence of a positive relationship between trade openness and inflation for those countries. Bowdler (2003) rejects the explanation of Romer (1993) for the negative relationship between openness and inflation. The argument is that the negative relationship between openness and inflation is due to a moderate degree of pass-through of the exchange rate to the inflation. Lotfalipour, Samaneh Montazeri, Somayeh, Sedighi (2013) found out that countries with more open degree of international trade are exposed to higher rate of inflation.

Nevertheless, some studies also argued that there is no effect of openness on inflation. For example, Tootell (1998), investigated whether globalization could account for the missing inflation of the late 1990s. Using a standard Phillips curve approach, the author found little evidence that globalization—specifically, measures of foreign slack—help determine U.S. inflation. However, Tootell's sample period covered only 1973 to 1996, therefore missing much of the acceleration in globalization that occurred in the past decade. Similarly, Manni and Afzal (2012) empirically assessed the impact of trade openness on inflation in Bangladesh and found that trade openness is not statistically significant in affecting inflation in the country. Similarly, Gruben and McLeod (2004) showed that there is no any significant openness–inflation relationship among OECD economies. Alfaro (2001) includes both a fixed effect of a country and as a time effect in the regression between openness and inflation. The results indicated that, in the short run, there is no influence of trade openness on the inflation level.

In another study, Alfaro (2003) analyzed whether openness serves as a commitment mechanism for restraining inflation in the short-run. The author argued that the correlation in the cross-section analysis might be driven by time-invariant omitted variables that often are difficult to measure. As a result, it is possible to find evidence of a negative effect of openness on inflation where no such restraint on inflationary policy takes place. For instance, when time and country dummies are considered to capture the difference, there was no negative relationship between openness and inflation. In the short-run, there is no robust evidence that openness has restrained inflation. Temple (2002) empirically tested the correlation between openness and inflation by formulating a link between trade openness and the Phillips curve. Temple found that the basis on which the slope of the Phillips curve is associated with openness is based on small open economy models with nominal rigidity. The findings further showed that there is little support of a correlation between openness and the output-inflation trade-off. Also, Badinger (2009), which employed Rogoff-style model including Phillips curve, could not find negative relationship between openness of the economies and inflation in OECD countries.

Taking a brief overview of these studies, it is obvious that the literature is inconclusive regarding the relationship between openness and inflation, although the studies reviewed have tried to generate a clearer understanding of the relationship. There is therefore hardly any doubt that a possible relationship between openness and inflation could exist. Discounting the entire evidence amounts to throwing the baby out with the bath water. A fundamental reason why it is difficult to reach a definitive conclusion regarding the link is the web of interrelationships that is involved in the determination of a country's inflation. Trade openness can have a significant impact on inflation, but so can many factors that are related to inflation. Thus, a negative (positive) relationship between openness and inflation could have well existed but because there is methodological problem, initial inflation condition, exchange rate regimes, country and time specific effects, the results have been inconclusive. The suspect may have shot the victim but the jury may still have insufficient evidence to indict her. Hence, establishing the extent of association between openness and inflation in the presence of other relevant variables is the focus of this study.

4. Methodology

4.1 Theoretical Framework

The Romer (1993) framework is employed as the theoretical basis for this study. Romer (1993) considered a standard closed-economy model of the dynamic inconsistency of optimal monetary policy with two components. In the framework, the first component involved unanticipated monetary shocks that affect both prices and real output, and therefore implied that the departure of output from its *natural* or equilibrium value is positively related to departures of actual inflation from expected inflation. If we assume a linear relationship:

$$y = y^{*} + \beta(\pi - \pi^{e}) \qquad (1)$$

where y is actual output, y* the natural rate, π is inflation, and π^{e} is expected inflation. In this case $\beta > 0$. The possibility of such a relationship could be from imperfect information about the aggregate price level or from incomplete price adjustment. In the second component, higher output (that is close to the natural rate) is assumed to be desirable to the policy-maker while higher inflation is undesirable. Also in this context, the sub-optimality of the natural rate could be from imperfect competition or from positive marginal tax rates. If we assume a simple functional form, the objective function of the policy maker can be written as:

$$W = -\frac{1}{2}\pi^{2} + \gamma y \qquad (2)$$

where $\gamma > 0.$

At equilibrium, the policymaker decides the rate of growth in money supply while taking equation (1) and π^{e}. In this context, the policymaker chooses π directly. The optimization problem faced by the policymaker is well known to the private agents. Given the absence of uncertainty, expected and actual inflation must be equal. The substitution of equation (1) into (2) and maximizing will make the policymaker to set $\pi = \gamma\beta$. Therefore, the equilibrium is $\pi^{e} = \pi = \gamma\beta,$ and which implies that inflation is positive, and $y = y*$ that output level is at the natural rate. However, the sub-optimality of this outcome is the basis for which the policy maker should have pre-commitment to a no-inflation policy in order to be better off.

An increase in the level of imports affects equilibrium inflation in two ways. In the first case, a greater degree of openness reduces the benefits of increases in output above its natural rate. Domestic expansion increases output at home relative to output abroad and therefore reduces the relative price of domestic goods (except where domestic and foreign goods are perfect substitutes).This is because as long as domestically produced goods consumed at home and imports are imperfect substitutes, real depreciation is necessary even if the country faces a perfectly elastic demand curve for its export goods. Consequently, the higher the fraction of goods that are purchased from abroad, the greater is the cost of this real depreciation. Therefore, γ is decreasing in the degree of openness.

In the second case, openness affects the trade-off between output and inflation. Once more, due to the real exchange rate depreciation, increased openness raises the amount of inflation associated with a given expansion of domestic output. Specifically, the exchange rate depreciation affects inflation through two channels. In first channel, the real depreciation implies that the prices of foreign goods in domestic currency units rise faster than those of domestic goods. Therefore, for a given impact of output on the prices of domestic goods, the impact on inflation (defined by the changes in consumer price index) is increasing in the share of a country's imports from abroad. In the second scenario, openness affects the link between output and domestic goods prices since real depreciation raises the costs of domestic firms. By way of illustration, the flexibility of nominal wages will cause wages to increase due to the rise in the CPI. Consequently, increased openness causes a monetary expansion to lead to a larger increase in domestic prices for a given increase in output.

Thus, under the discretionary monetary policy, openness affects the output-inflation trade-off and the benefit of higher output relative to the cost of higher inflation. Hence, policy-makers' incentives to expand are therefore lower in more open economies, and equilibrium inflation under the discretionary policy is smaller. The final round of effects is due to the fact that the expansion of domestic output relative to output abroad drives down the relative price of domestic goods. The impacts are likely to be robust to the details of why monetary shocks have real effects and why expansion of output above the natural rate is desirable.

4.2 Empirical specification of the model

Inflation is a complex process and it is difficult to find a single empirical model that fits the circumstances of all countries. However, it is possible to identify key determinants in addition to openness measures that might influence the inflation process in different economies. For example, we expect the impact of trade openness on inflation to be negative because the direct and indirect price effects of cheaper imports of finished goods and intermediate inputs may net out to a decline in the overall price level. Also, opening up an economy to the rest of the world may alter the incentives through which central banks respond in determining a country's long-run inflation rate. In addition, openness could lead indirectly to lower inflation by fostering faster domestic productivity growth as a result of increased competition. Since trade enables countries to specialize in activities in which they have a comparative advantage, sectors in which countries are relatively inefficient shrink, while sectors in which countries have a comparative advantage expand. Faster productivity growth therefore allows firms to pay higher wages without necessarily passing these costs on in the form of higher prices.

The exchange rate has a deterministic effect on the level of prices in underdeveloped economies. In Nigeria, an exchange rate depreciation (appreciation) could increase (decrease) the price of imported commodities. Nigeria's productive markets are based significantly on imported commodities, implying that a depreciation of the exchange rate would be rapidly reflected in an increase in the price of the consumer's basket of commodities. We therefore anticipate an inverse relationship. Depending public expectations, the fundamental state and development of the economy, and the transmission mechanism, a sustained increase in the money supply of a country will lead to a rise in the general price level. Thus, the higher the money supply to the economy the higher the price level. Hence, we expect a positive relationship between money supply and inflation.

Economic growth is also expected to have a negative impact on inflation rate because the growth in the availability of goods and services in the economy eases pressure on the domestic price growth. The impact of oil price shocks on inflation in inconclusive. The impact depends largely on the magnitude and persistence of the decline or increase in the crude oil price. Nigeria is a major oil exporter and oil revenue accounts for about 95% of foreign exchange earnings and 75% of government expenditure. For example, we anticipate that when oil prices fall, domestic prices will increase since oil revenue earnings are used to provide foreign exchange needed to import intermediate goods. Foreign exchange is therefore rationed to prospective importers which lead to a depreciation of the currency. It is vice versa for an increase in oil prices. An increase in oil prices will bring about a decline in the general price level. This means that movement in oil prices will have consequences for the Nigerian economy. As a result, we estimate a specification with inflation as the dependent variable and the degree of openness and other control variables as the explanatory variables. This is given in equation (3):

$$Inf_t = \alpha_0 + \alpha_1 OPEN_t + \alpha_2 REER_t + \alpha_3 EG_t + \alpha_4 MS_t + \alpha_5 OP_t + \varepsilon_t \qquad (3)$$

where *inf* is defined as inflation (measured as the annual percentage change in the log difference of the consumer price index); OPEN is the degree of openness (measured as export and import divided by the gross domestic product; and tariff rate, applied, simple mean, all products (%)); REER[1] is the real effective exchange rate (measured as the nominal effective exchange rate[2] divided by a price deflator or index of costs); EG is economic growth (measured as annual percentage change in the real gross domestic product); MS is growth in money supply (measured as annual percentage change of the sum of currency outside banks; demand deposits; the time, savings, and foreign currency deposits of resident sectors; bank and traveler's checks; and other securities); OP is crude oil price (measured as annual percentage change of the price of Bonny light).

4.3 Estimation Technique

We investigate how openness affects inflation by using the nonlinear auto-regressive distributed lag (NARDL) modelling approach to co-integration. The nonlinear autoregressive distributed lag (NARDL) model is an asymmetric extension of the linear ARDL approach to modeling long-run level relationships. Developed by Pesaran, Shin, and Smith (2001) and advanced by Shin, Yu, and Greenwood (2009), NARDL model introduces nonlinearity by means of partial sum decompositions. By modeling the long-run relationship and the pattern of dynamic adjustment simultaneously in a coherent manner, NARDL allows to capture both the short-run and

[1] The REER is adopted in the study as a measure of exchange rate because it serves as a measure of a currency's overall alignment. It is an average of the bilateral RERs between the country and each of its trading partners, weighted by the respective trade shares of each partner. This is against the RER index which is just a measure of exchange rate between two countries.

[2] A measure of the value of a currency against a weighted average of several foreign currencies.

long-run asymmetries in the transmission mechanism. The NARDL method can be applied regardless of whether variables have a unit root or are covariance stationary. Furthermore, the method corrects for endogeneity and serial correlation. It also allows for possibly asymmetric (i.e. nonlinear) adjustments of inflation to movements in other variables. In other words, increases and decreases in other variables are allowed to affect inflation differently. Following Shin et al. (2014), we adopt an error correction model (ECM) to estimate the linear relationship:

$$\Delta Inf_t = c + \rho_i Inf_{t-1} + \rho_o OPEN_{t-1} + \rho_r REER_{t-1} + \rho_g EG_{t-1} + \rho_m MS_{t-1} + \rho_p OP_{t-1} + \sum_{i=1}^{p} b_i \Delta Inf_{t-i}$$
$$+ \sum_{i=1}^{p} c_i \Delta OPEN_{t-i} + \sum_{i=1}^{p} d_i \Delta REER_{t-i} + \sum_{i=1}^{p} e_i \Delta EG_{t-i} + \sum_{i=1}^{p} f_i \Delta MS_{t-i} + \sum_{i=1}^{p} g_i \Delta OP_{t-i} + v_t \qquad (4)$$

where $\Delta$is the first difference operator; ρ_i, $\rho_o/-\rho_i$, $\rho_r/-\rho_i$, $\rho_g/-\rho_i$, $\rho_m/-\rho_i$, $\rho_p/-\rho_i$ are the error correction term, long-run coefficients of the openness, real effective exchange rate, economic growth, growth in money supply, and oil price respectively; c_i, d_i, e_i, f_i, g_i are the short-run coefficients.

In order to determine asymmetric pass-through of openness to inflation, we follow the approach of Shin et al. (2014). This approach requires the decomposition of the variable of interest. In this case, we decompose the openness variables (the sum of export and import as a percentage of GDP and the tariff rate) into positive and negative sub-variables. The partial sums of positive and negative changes in openness are given by $OPEN^+$ and $OPEN^-$. They are calculated as follows:

$$OPEN_t^+ = \sum_{j=1}^{t} \Delta OPEN_j^+ = \sum_{j=1}^{t} \max(\Delta OPEN_j, 0);$$
$$OPEN_t^- = \sum_{j=1}^{t} \Delta OPEN_j^- = \sum_{j=1}^{t} \min(\Delta OPEN_j^-, 0) \quad (5)$$

Given the presentation in equation (5), equation (6) can then be expressed by separating long and short runs asymmetric relationships:

$$\Delta Inf_t = c + \rho_i Inf_{t-1} + \rho_o^+ OPEN_{t-1}^+ + \rho_o^- OPEN_{t-1}^- + \rho_r REER_{t-1} + \rho_g EG_{t-1} + \rho_m MS_{t-1} + \rho_p OP_{t-1} + \sum_{i=1}^{p} \lambda_i \Delta Inf_{t-i}$$
$$+ \sum_{i=0}^{q} \left\{ \pi_i^+ \Delta OPEN_{t-1}^+ + \pi_i^- \Delta OPEN_{t-1}^- + d_i \Delta REER_{t-i} + e_i \Delta EG_{t-i} + f_i \Delta MS_{t-i} + g_i \Delta OP_{t-i} \right\} + v_t \qquad (6)$$

where $L_{open}^+ = \rho_o^+/-\rho_i$ and $L_{open}^- = \rho_o^-/-\rho_i$ are positive and negative long-run coefficients of openness to inflation respectively, and $L_r = \rho_r/-\rho_i$, $L_g = \rho_g/-\rho_i$, $L_m = \rho_m/-\rho_i$, $L_p = \rho_p/-\rho_i$ the long-run coefficients of the real effective exchange rate, economic growth, growth in broad money supply and oil price to inflation. Following Shin et al. (2014), Equation (6) can be modified to allow for long-run symmetry and short-run asymmetry (to yield Equation (7)) and long-run asymmetry and short-run symmetry (to yield Equation (8)).

Only the short-run asymmetry:

$$\Delta Inf_t = c + \rho_i Inf_{t-1} + \rho_o OPEN_{t-1} + \rho_r REER_{t-1} + \rho_g EG_{t-1} + \rho_m MS_{t-1} + \rho_p OP_{t-1} + \sum_{i=1}^{p} \lambda_i \Delta Inf_{t-i}$$
$$+ \sum_{i=0}^{q} \left\{ \pi_i^+ \Delta OPEN_{t-1}^+ + \pi_i^- \Delta OPEN_{t-1}^- + d_i \Delta REER_{t-i} + e_i \Delta EG_{t-i} + f_i \Delta MS_{t-i} + g_i \Delta OP_{t-i} \right\} + v_t \qquad (7)$$

Only the long-run asymmetry:

$$\Delta Inf_t = c + \rho_i Inf_{t-1} + \rho_o^+ OPEN_{t-1}^+ + \rho_o^- OPEN_{t-1}^- + \rho_r REER_{t-1} + \rho_g EG_{t-1} + \rho_m MS_{t-1} + \rho_p OP_{t-1} + \sum_{i=1}^{p} \lambda_i \Delta Inf_{t-i}$$

$$+ \sum_{i=0}^{q} \left\{ \pi_i^+ \Delta OPEN_{t-1}^+ + d_i \Delta REER_{t-i} + e_i \Delta EG_{t-i} + f_i \Delta MS_{t-i} + g_i \Delta OP_{t-i} \right\} + v_t \qquad (8)$$

Equations (6), (7), and (8) present the cointegrating relationship between inflation and positive (negative) component of openness with the four control variables such as the real effective exchange rate, economic growth, growth in broad money supply, and oil price. In order to test the existence of an asymmetric long-run cointegration, we propose the bounds test which is a joint test on all the lagged levels regressors. The F-statistic tests the null hypothesis of $\rho_i = \rho_o^+ = \rho_o^- = \rho_r = \rho_g = \rho_m = \rho_p = 0$ for the case of long-run asymmetry; and $\rho_i = \rho_o = \rho_r = \rho_g = \rho_m = \rho_p = 0$ for the case of only the long-run symmetry. If we reject the null hypothesis of no cointegration, it indicates that there is no a long-run relationship among the variables. The long-run symmetry can be tested by the Wald test of the null hypothesis $L_{open}^+ = L_{open}^-$. In order to test the existence of short-run symmetry, we use the Wald test to test the null hypothesis of $\sum_{i=0}^{q} \pi_i^+ = \sum_{i=0}^{q} \pi_i^-$. The rejection of the null hypothesis of symmetry imply that the model is asymmetric. If the null hypothesis of symmetric is rejected, we can find the asymmetric dynamic multiplier of the change of the openness $OPEN^+$ and $OPEN^-$ respectively as:

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial Inf_{t+j}}{\partial OPEN_t^+}; \; m_h^- = \sum_{j=0}^{h} \frac{\partial Inf_{t+j}}{\partial OPEN_t^+} \qquad (9)$$

where $h \to \infty, m_h^+ \to L_{OPEN}^+, and \; m_h^- \to L_{OPEN}^-$. where $h \to \infty, m_h^+ \to L_{OPEN}^+, and \; m_h^- \to L_{OPEN}^-$. The dynamic multipliers captures the positive and negative shocks of openness on inflation from an initial equilibrium to the new equilibrium.

4.4 Scope of the study and Data Sources

The analysis is between 1980 and 2015 due to data availability. Also, the choice of the period corresponds with the adoption of significant trade policy reform measures in Nigeria. The data on the consumer price index, export and import as a share of gross domestic product, real effective exchange rate, tariff rate, growth in broad money supply, economic growth were sourced from the World Bank World Development Indicators. The data on Bonny Light crude oil price is sourced from the Statistical Bulletin of the Central Bank of Nigeria (various issues).

5. Empirical Results and Discussions

5.1 Descriptive Statistics and Correlation Analysis

The stochastic properties of the variables employed in the empirical analysis are presented in Table 2. The Table highlighted the mean, standard deviation, skewness and kurtosis coefficients, and the Jarque-Bera statistics to test the null hypothesis that all the variables are normally distributed. Variability is higher for economic growth (EG), crude oil price (OP), degree of openness (OPEN) and real effective exchange rate (REER), while other variables are lower in terms of their mean values. All the series are positively skewed except growth in money supply and degree of openness that is negatively skewed. In addition, the Jarque-Bera statistics reject the null hypothesis of normality for all our series.

Table 2: Stochastic Properties of the Variables

	EG	INF	M2	OP	OPEN	REER
Mean	6.530	2.673	2.951	3.551	3.891	4.822
Median	6.412	2.476	2.950	3.372	3.969	4.601
Maximum	7.001	4.288	4.173	4.734	4.404	6.303
Minimum	6.203	1.683	0.669	2.549	3.162	3.907
Std. Dev.	0.259	0.723	0.775	0.680	0.340	0.658
Skewness	0.569	0.854	-0.594	0.414	-0.703	0.822
Kurtosis	1.751	2.663	3.526	1.870	2.555	2.453
Jarque-Bera	4.284	4.551	2.535	2.942	3.262	4.502
Probability	0.117	0.103	0.282	0.230	0.196	0.105
Sum	235.064	96.221	106.224	127.853	140.090	173.578
Sum Sq. Dev.	2.345	18.297	21.016	16.164	4.057	15.138
Observations	36	36	36	36	36	36

Source: Author's computation

Table 3 presented the pair-wise correlation analysis of the variables used in the estimation. The results of the correlation analyses showed different association and strength among the variables. Only the oil price and economic variable reveals a strong association in the correlation. The correlation analysis is very important to determining the type of association that exists between each of the series used which has implication for their inclusion in the same model. According to the Dickey-Fuller and the Ng-Perron tests in Tables 4 and 5, at conventional levels of significance the variables represent a mixture of first difference and stationary levels. While some of the variables (economic growth, oil price, openness, and real exchange rate) are integrated of order one, that is, I(1), some other variables in the model are stationary at their levels (inflation rate and money supply). The unit root tests results allows the choice of NARDL to be suitable for the analysis. One of the advantages of the NARDL technique is that it can combine stationary and non-stationary variables in its estimation.

Table 3: Correlation Results

	EG	INF	M2	OP	OPEN	REER
EG	1.000					
INF	-0.400	1.000				
M2	-0.198	0.206	1.000			
OP	0.890	-0.461	-0.076	1.000		
OPEN	-0.175	0.089	0.585	-0.074	1.000	
REER	-0.007	-0.165	-0.521	-0.105	-0.566	1.000

Source: Author's computation

Table 4: Dickey-Fuller Test with GLS Detrending (DFGLS) unit root test results

Variables	Constant		Constant and Linear Trend		Order of Integration
	Levels	First Diff.	Levels	First Diff.	
Economic Growth (EG)	-0.3841	-1.8456*	-1.5479	-4.6728*	I(1)
Inflation rate (INF)	-3.1765**	-5.3052*	-3.4426**	-5.8873*	I (0)
Money Supply (M2)	-4.0645**	-3.2423*	-3.2423**	-5.3840*	I(0)
Oil Price (OP)	-1.8622	-8.2413*	-2.7302	-8.3758*	I(1)
Openness (OPEN)	-2.2155	-7.4681*	-2.2679	-7.4417*	I(1)
Real Effective Exchange Rate (REER)	-1.5738	-4.4253*	-1.8719	-4.4740*	I(1)
Asymptotic Critical Values:					
1%	-2.6326	-2.636901	-3.770000	-3.770000	
5%	-1.9506	-1.951332	-3.190000	-3.190000	
10%	-1.6110	-1.610747	-2.890000	-2.890000	

Note: The Null Hypothesis is the presence of unit root. *,**, significant at 1% and 5% respectively. Lag length selected based on Schwarz information criterion (SIC). The Elliott-Rothenberg-Stock DF-GLS test statistics are reported.

Table 5: Ng-Perron unit root test results

Variables	Constant (Model 1)		Constant and Linear Trend (Model 2)		Order of Integration
	Levels (MZα)	First Diff (MZα)	Levels (MZα)	First Diff (MZα)	
Economic Growth (EG)	-0.5281	-6.1053*	-1.6145	-15.4436*	I(1)
Inflation Rate (INF)	-12.3380**	-16.6812*	-13.0984**	-16.7828*	I (0)
Money Supply (M2)	-13.2120**	-14.1671*	-13.8369**	-15.6844*	I(0)
Oil Price (OP)	-5.9806	-14.6166	-9.35145	-14.4209*	I(1)
Open (OPEN)	-7.8167	-15.7413	-8.1904	-15.7854*	I(1)
Real Effective Exchange Rate (REER)	-3.97536	-15.8707*	-5.94792	-15.9195*	I(1)
Asymptotic Critical Values:					
1%	-13.8000	-13.8000	-23.8000	-23.8000	
5%	-8.10000	-8.10000	-17.3000	-17.3000	
10%	-5.70000	-5.70000	-14.2000	-14.2000	

Note: The Null Hypothesis is the presence of unit root. *,**,*** significant at1%, 5% and 10%. Ng-Perron test statistics are reported. Spectral GLS-detrended Auto Regressive based on Schwarz Information Criterion (SIC).

5.2 Asymmetric Effect of Trade Openness on Inflation in Nigeria

Table 5 shows that the estimated coefficients of the symmetric and three asymmetric openness-inflation models. The NARDL models comprises of estimation with long run (LR) asymmetry, short run (SR) asymmetry, and short run (SR) and long run (LR) asymmetry respectively. The symmetric auto-regressive distributed lag (ARDL) model is presented in Column 1 of Table 5. The ARDL estimation combines the short run and the long run estimation together. In the long run, there exists a significantly positive relation between trade openness and inflation rate in Nigeria at the 10% level of significance. A 1% increase in trade openness increases inflation by 0.85% in Nigeria. This result supports the empirical results of Kim and Beladi (2005), Pehnelt (2007), Gopal (2007), Evans (2007), Razin and Loungani (2007), Berument, Dogan and Tansel (2008) and Zakaria (2010). In addition, economic growth was found to be a positive determinant of inflation in the long run. Crude oil price has an inverse relationship with inflation. At low level of oil prices, the revenue from oil export will decline and lead to exchange rate depreciation because the government is not able to defend the exchange rate. Money supply and real effective exchange rate were found to be insignificant determinant of inflation in the long run.

However, in the short run, we noted a contrasting result. We found an inverse relationship between openness and inflation in Nigeria. In the short run, we noted that an increase in trade openness in the short run declines inflation by 1.345% and 0.957% in the first and second period respectively. Our result agrees with the findings of Sachsida *et al.*, (2003), Romer (1993), Gruben and McLeod (2004), Aron and Muellbauer (2007), and Kim *et al*. (2012) which proposed a negative relation between trade openness and inflation. Also in the short run, the analysis revealed that the one-period lag value of oil price, real effective exchange rate and money supply influences inflation in Nigeria. Past level (two period lag values) of inflation were also found to be significant determinant of current inflation in Nigeria. The insight from this analysis is that the impact of trade openness on inflation is influenced by the time horizon of the result. In the immediate short run, there is an adverse relationship between trade openness and inflation in Nigeria while in the long run a positive relationship dominates.

The NARDL with the long run asymmetry is presented in Column 2 of Table 5. According to the AIC and SIC information criteria, the NARDL (3,3) specification with long-run asymmetry is the most suitable model for the trade openness-inflation case. The estimated result revealed that trade openness affects inflation in an asymmetric manner in the both short and long run. The asymmetric effect of openness is captured by $OPEN^{+}$ and $OPEN^{-}$ indicating positive and negative changes of trade openness, respectively. The estimated coefficients of the positive and negative asymmetric changes are positive and statistically significant at the 5 and 10 per cent for positive coefficients respectively.

The asymmetric positive and negative long-run coefficients are both positive (1.075 and 1.125) and significant at 10 and 5 per cent level, indicating that in the long run inflation is increasing in trade openness in the long run irrespective of the asymmetric nature of the variable. The asymmetric magnitude of response of inflation to trade openness however differs in the long run. The results of the overall model showed that the asymmetric positive and negative long-run coefficient 4.136 and 4.704 respectively. They are significant at the 1% level, indicating that increases in trade openness (decreases) cause inflation to move up (down). Economic growth and oil price are still major determinants of inflation in Nigeria. Money supply and real effective exchange rate retained their non-significance nature. The short run model however indicated an inverse relationship between trade openness and inflation in Nigeria in the short run which is similar to the short run estimates of the restricted symmetric model in column 1. We found that an increase in trade openness will reduce inflation by 1.712% and 1.184% in the first and second period respectively in the short run. This lends credence to our earlier findings that the impact of trade openness on inflation is dependent on the horizon that we are evaluating.

Table 5: Estimation Results for Trade Openness-Inflation Nexus

Symmetric ARDL (1)		**NARDL with LR asymmetry (2)**		**NARDL with SR asymmetry (3)**		**NARDL with LR and SR asymmetry (4)**	
Variable	**Coefficient**	**Variable**	**Coefficient**	**Variable**	**Coefficient**	**Variable**	**Coefficient**
INF_{t-1}	-0.156 (0.922)	INF_{t-1}	-0.010 (-0.056)	INF_{t-1}	-0.565** (2.472)	INF_{t-1}	-0.509*** (2.269)
EG_{t-1}	2.289* (3.264)	EG_{t-1}	2.770* (3.515)	EG_{t-1}	2.161* (3.898)	EG_{t-1}	2.434* (4.211)
$M2_{t-1}$	0.065 (0.411)	$M2_{t-1}$	0.034 (0.211)	$M2_{t-1}$	0.346** (2.835)	$M2_{t-1}$	0.406** (3.429)
OP_{t-1}	-0.814* (3.279)	OP_{t-1}	-0.881* (-3.420)	OP_{t-1}	-0.917* (5.360)	OP_{t-1}	-0.862* (5.299)
OPEN	**0.850*** (2.040)**	**$OPEN^{-}_{t-1}$**	**1.075*** (2.034)**	**$OPEN_{t-1}$**	**1.110** (2.841)**	$REER_{t-1}$	0.807** (2.783)
REER	-0.250 (1.093)	**$OPEN^{+}_{t-1}$**	**1.127** (2.169)**	$REER_{t-1}$	0.927** (3.432)	**$OPEN^{-}_{t-1}$**	**0.934*** (2.268)**
ΔINF_{t-2}	-0.261*** (2.112)	$REER_{t-1}$	-0.283 (-1.075)	ΔINF_{t-1}	0.999* (3.800)	**$OPEN^{+}_{t-1}$**	**1.046** (2.595)**
ΔINF_{t-3}	0.126 (1.133)	ΔINF_{t-2}	-0.350** (-2.521)	ΔINF_{t-2}	-0.149 (0.932)	ΔINF_{t-1}	1.044* (4.051)
ΔEG_{t-2}	-1.622 (1.012)	ΔINF_{t-3}	0.143 (1.202)	ΔINF_{t-3}	0.508** (3.391)	ΔEG_{t-1}	-2.243*** (-2.196)
$\Delta M2_{t-1}$	0.508* (3.567)	ΔEG_{t-2}	-3.148*** (-1.780)	ΔEG_{t-1}	-2.238*** (2.206)	$\Delta M2_{t-1}$	0.856* (5.123)
ΔOP_{t-1}	-1.175* (3.672)	$\Delta M2_{t-1}$	0.690* (3.584)	ΔEG_{t-2}	-1.698 (1.403)	ΔOP_{t-1}	-2.423* (-4.202)
ΔOP_{t-2}	-0.406 (1.718)	ΔOP_{t-1}	-1.648* (-3.478)	$\Delta M2_{t-1}$	0.730* (4.715)	$\Delta REER_{t-1}$	-2.788* (-4.428)
$\Delta OPEN_{t-1}$	**-1.345* (3.763)**	**$\Delta OPEN_{t-1}$**	**-1.712* (-3.241)**	$\Delta M2_{t-2}$	-0.435** (2.732)	**$\Delta OPEN^{-}_{t-1}$**	**-2.975* (-4.939)**
$\Delta OPEN_{t-2}$	**-0.957** (2.340)**	**$\Delta OPEN_{t-2}$**	**-1.184** (-2.604)**	$\Delta M2_{t-3}$	-0.177 (1.842)	**$\Delta OPEN^{-}_{t-2}$**	**1.153 (1.723)**
$\Delta REER_{t-1}$	-0.832*** (1.911)	$\Delta REER_{t-1}$	-1.444** (-2.532)	ΔOP_{t-1}	-1.751* (3.692)	**$\Delta OPEN^{+}_{t-1}$**	**-2.974* (-5.427)**
C	-13.979** (2.533)	$\Delta REER_{t-2}$	0.948*** (2.002)	ΔOP_{t-2}	1.431** (3.420)	**$\Delta OPEN^{+}_{t-2}$**	**0.930 (1.462)**
		$\Delta REER_{t-3}$	-0.517 (-1.600)	**$\Delta OPEN^{-}_{t-1}$**	**-2.595* (4.201)**	$\Delta OPEN^{+}_{t-3}$	-0.131** (3.599)
		C	-17.982** (-2.758)	**$\Delta OPEN^{-}_{t-2}$**	**0.201** (3.192)**	ΔEG_{t-2}	-2.596 (-1.894)
				$\Delta OPEN^{+}_{t-1}$	**-2.696* (4.716)**	$\Delta M2_{t-2}$	-0.406*** (-2.313)
				$\Delta OPEN^{+}_{t-3}$	**-0.113** (3.190)**	ΔOP_{t-2}	1.591** (3.360)
				$\Delta REER_{t-1}$	-2.271* (3.828)	$\Delta REER_{t-2}$	3.441* (5.057)
				$\Delta REER_{t-2}$	2.379* (4.976)	ΔINF_{t-2}	0.452** (3.178)
				$\Delta REER_{t-3}$	-1.945* (4.457)	$\Delta M2_{t-2}$	-0.228** (2.539)
				C	-18.975* (3.652)	$\Delta REER_{t-2}$	-2.134* (4.773)
						C	-20.177* (-3.957)
Lopen	5.093**	$Lopen^{+}$	4.136***	Lopen	8.069**	$Lopen^{+}$	6.865**

	(0.038)		(0.061)		(0.025)		(0.028)
		Lopen -	4.704** (0.048)			Lopen -	2.195 (0.189)
AIC	**1.184**	**AIC**	**1.213**	**AIC**	**-0.023**	**AIC**	**-0.249**
SIC	**1.917**	**SIC**	**2.037**	**SIC**	**1.087**	**SIC**	**0.907**
JB	**1.499 (0.473)**	**JB**	**1.184 (0.553)**	**JB**	**0.173 (0.917)**	**JB**	**1.948 (0.378)**
ARCH	**2.485 (0.102)**	**ARCH**	**0.395 (0.677)**	**ARCH**	**0.114 (0.893)**	**ARCH**	**1.986 (0.158)**
Ramsey Reset Test	**0.510 (0.611)**	**Ramsey Reset Test**	**1.254 (0.320)**	**Ramsey Reset Test**	**0.174 (0.845)**	**Ramsey Reset Test**	**0.817 (0.504)**
LM	**0.021 (0.979)**	**LM**	**0.303 (0.744)**	**LM**	**0.233 (0.800)**	**LM**	**0.535 (0.622)**
Breusch-Pagan-Godfrey	**0.659 (0.792)**	**Breusch-Pagan-Godfrey**	**0.797(0.675)**	**Breusch-Pagan-Godfrey**	**0.702 (0.757)**	**Breusch-Pagan-Godfrey**	**0.764 (0.709)**

Source: Author's computation; We employ a general to specific approach to select the final specification, Note: *,** and*** denote significance at 1%, 5% and 10% levels respectively while Lopen+ and Lopen- indicates the positive and negative long-run coefficients from Wald test and values in parenthesis are the t-statistics. AIC and SIC are information criteria. JB and ARCH are the empirical statistics of the Jarque-Bera test for normality and the Engle (1982) test for conditional heteroscedasticity, respectively. Meanwhile, in the diagnostic tests, we reported F-statistics and figures in parenthesis are the probability value. The SIC information criterion selects $p = 3$ and $q = 3$ as the optimal lag length.

Columns 3 and 4 in Table 5 present the NARDL with short run (SR) asymmetry. The result is similar to the findings of the ARDL model was reported in Column 1 of Table 5. Openness affects inflation positively in the LR and negatively influences it in the SR. Results from the NARDL with short-run asymmetry revealed that one-period lagged of the positive and negative asymmetry coefficients are both negative (2.595 and 2.696 respectively) and significant at 1 per cent. They also indicated that contemporaneous increases and decreases in trade openness in the short-run are negatively passed through to inflation. Other short-run inflationary determinants also showed that increases (decrease) in one-time lagged of growth, oil price and exchange rate cause inflationary pressure to move down (up) for the period considered in this study.

Finally, the results from the NARDL that combines the long and short-run asymmetry showed that the long run positive and negative asymmetry coefficients of openness are positive (1.046 and 0.934) and significant at 5 and 10 per cent level. The result also supported our findings that the concurrent increases and decreases in the degree of openness in the long-run positively influenced inflation. On the contrary, we found out that the one-period lagged value of the asymmetric positive and negative trade openness are negatively related to inflation in the short-run at one per cent significant level. The summary from these three NARDL estimations is that inflation responds asymmetrically to trade openness and there is a temporal delay in their reaction to changes in trade openness. Our analysis partly confirmed the result of Ada et al. (2014) for Nigeria. However, the Ada et al. (2014) study did not analyse the horizon of the relationship.

The explanation for the divergent short and long run effect of trade openness on inflation is not far-fetched. An enduring feature of the Nigerian economy is the chronic dependence on imports for input in the production process (raw materials, technology and, indeed, human resources) and for final consumer and investment goods. As a result, the decline in the price of crude oil which is the major foreign exchange earner for Nigeria will usually lead to the depreciation of the exchange rate. However, given the economy's dependence on imports, the import level rather than decline will increase. Since there is a lag when the exchange rate is depreciated and when the impact is felt in the economy, the higher openness due to a surge in imports will appear to have a negative relationship with exchange rate in the short run. However, this would stoke production costs directly and indirectly in all sectors of the economy exacerbating the cost-push inflationary pressure in the long run. Hence, the paradox of inverse relationship between trade openness and inflation in the short run but positive relationship between the variables in the long run.

Other variables (economic growth, oil price, and money supply) were found to be significant determinants of inflation rate in the short run and long run. Nevertheless, unlike the estimations in columns 1 and 2, real effective exchange rate was found to be an important determinant of inflation in Nigeria. With reference to the model's diagnosis tests in across the four estimations in Columns 1 to 4 in Table 5, the residual series are normally distributed from the Jarque–Bera statistics, while the Breusch–Godfrey LM test statistics indicated that the

model does not have significant serial correlation problem. In addition, the ARCH test and the Ramsey RESET test respectively show that the residuals are homoscedastic and the model has correct functional form.

VI Concluding Summary

This paper has shed light on the openness-inflation puzzle in the case of Nigeria. Most of the studies relating to trade openness and inflation relationship have examined the issue from a cross-country perspective. There are very few studies in the single country context, and the present study is an attempt in this direction. It therefore investigated the relationship between inflation and openness in Nigeria between 1980 and 2015. It employed the nonlinear auto-regressive distributed lag (NARDL) modelling approach to co-integration based on the standard theoretical and empirical literature on inflation-openness relationship. Our approach allowed us to simultaneously test the short- and long-run nonlinearities through positive and negative partial sum decompositions of the predetermined explanatory variables. It also offered the possibility to quantify the respective responses of inflation to positive and negative trade openness shocks from the asymmetric dynamic multipliers. The empirical results in this paper, to some extent, substantiate the existing literature.

This is because the evidence confirmed that while there is a significant positive long-run relationship between inflation and trade openness, there is a strong and robust negative link between openness and inflation in the short run. In addition, the obtained results indicate that trade openness affect inflation in an asymmetric and nonlinear manner. The implication is that the negative relationship between inflation and openness is specific to a determined period of time. As the economy gets more open, it becomes more exposed to higher rate of inflation. Also, economic growth drives up consumer prices abruptly while money supply is a major cause to enhance the prices in long-run significantly. The same applies to exchange rate, demonstrating that large deprecation in money value increases demand for money printing, which pushes up the price level in the economy. The decline in crude oil price also pushes up the inflation rate in the short and long run horizon.

Nigeria is an oil producing economy and monetary authorities should understand the determinants of the changes in the general price level. This is because the economy can be so vulnerable to the factors such as external oil shocks which are results from more open degree of international trade and directly affect the aggregate domestic price level. Therefore, diversifying the economy from oil into other productive sectors should be a major policy target. The Nigerian economy depends on importation of nearly all its inputs which made it susceptible to the vagaries of external shocks. The positive impact of trade openness on inflation can be also be as a result of monetary authorities' policy having a monopolistic power in the international markets as foreign customers, to adjust the benefits of money growth. To overcome the positive effect of openness on inflation the policymakers would generate some policies which increase the elasticity of aggregate supply curve as well as increase the aggregate supply (i.e. shift the aggregate supply curve to the right). Such policies may include adequate infrastructural supply, increase in investment on education (i.e. human capital), and technology.

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