Oil Price and Consumer Price Nexus in South Africa Revisited: A Novel Asymmetric Causality Approach

Ajmi, A. N., Gupta R., Babalos V., Roulof Hefer

Abstract

The relationship between oil and the price level has always garnered attention from policy makers and researchers. Periods of high oil price volatility is thought to induce negative repercussions for domestic price levels in an oil importing country. Research in the past has revealed that there exists an asymmetric component in the causal relationship between oil prices and consumer prices. To this end, we opt for a novel asymmetric causality test developed by Hatemi-J (2012) to explore the relationship between oil prices and the price level in South Africa for a period that runs from 1921:M02 to 2013:M10. This method disentangles the effects of positive shocks from negatives ones allowing to test for an asymmetric relationship. Our evidence are in favour of a causal relationship that runs from oil prices to the price level, but this relationship is observed only for the short term since there is no cointegrating relationship. The asymmetric tests reveal that both a positive and negative oil price shock leads to a positive price level shock, however the evidence in favour of a negative oil price shock is stronger.

Keywords: Oil prices, Consumer prices, asymmetric causality

JEL Codes: C32, E31

I. Introduction

The volatility and the level of oil prices have always been a cause of concern for policy makers. More specifically oil price shocks are thought to cause macroeconomic instability and inflation. Oil price changes are communicated to price level through first and second round effects. The first round transmissions are captured in the production of goods and services which include an oil component, whereas second round effects are captured in the inflation expectations of consumers, where the latter critically depend on monetary policy credibility and labour market flexibility (Misati, Nyamongo and Mwangi, 2013).

The literature on the relationship between oil prices and the price level has been inconclusive. A number of studies set off to determine the causal nexus between oil prices and inflation (Leblanc and Chinn, 2004; de Gregorio et al., 2007; Chen, 2009; Alvarez, Hurtado, Sanchez and Thomas, 2011) but few find evidence in favour of a strong relationship. One of the most recent by Pasaogullari and Waiwood (2014) concludes that the inclusion of oil prices in the predictions of core and headline inflation does little to improve the forecasts, however the predictions do explain short term movements in the CPI (Consumer Price Index). Speculating on the causes of the divergence in evidence, Castro, Poncela and Senra (2012) stated that the varying consumptions structures and regulatory frameworks could be the source. Similarly Peersman and Van Robays (2009) comment on not only the differences in the transmission channels but also on the monetary policy reactions in the US and the Euro area. Greater insight is catered by the use of structural breaks methodology and sectoral data. The authors have shown that the impact of oil shocks on inflation has marked a downward trajectory and has been confined to the short run. Bachmeier and Cha (2011) use sectoral US data and attribute the decline in the impact to more energy efficient production and to a lesser degree to more effective monetary policy.

The consumption of oil in South Africa has increased following democratisation with a steady increase in economic growth. However South Africa is a small oil importing country and as such high oil prices could potentially dampen growth. Not only could increases in the oil price lead to slower growth, specifically in the mining and transport sectors which are oil intensive, but without sufficient policy reaction it could also lead to greater poverty (Wabiri and Amusa 2009; Chitiga, Fofana, and Mabugu, 2012).

Given that South Africa is exposed to highly volatile international oil prices, the import of oil could conceivably lead to a form of imported inflation or cost-push inflation. The oil-inflation relationship in South Africa has been studied and again the results are not unanimous. Gupta and Kanda (2014) implement a frequency domain approach and show that oil prices do include a forecasting element for South African inflation. Chisadza, Dlamini, Gupta and Modise (forthcoming) disaggregates the data to oil supply and demand shocks in South Africa and use a sign restricted vector autoregressive (VAR) model. The authors conclude that an oil supply shock has a significant impact on the inflation rate but only in the short run. Nyimbanira (2013) finds a significant and causal relationship between oil prices and inflation using a cointegration approach. Gupta and Hartley (2013) test the ability of nominal and real oil prices to predict inflation out-of-sample. The authors use an autoregressive distributed lag (ARDL) framework to show that the inclusion of oil prices increases the power of forecasting inflation over the short and mediums terms. On the other end of the scale is Swanepoel (2006), who uses a VAR framework and finds the relationship to be statistically insignificant.

The monetary framework has some influence on the extent and the duration of the shock but should be exercised with caution. Mishkin and Schimdt-Hebbel (2007) concludes that countries with an inflation targeting framework are less susceptible to oil price shocks. However Kahn (2008) highlights the fact that monetary policy can do little to curb the first round effects of supply shocks and that the committee should rather focus on the second round effects. A short term shock requires little attention given policy credibility, if action is taken the lags in policy execution could result in an amplification of the shock. Monetary response would depend on the strength and the persistence of the shock, policy response should thus be practised with caution as ex ante the longevity of the shock is unknown.

There are a number of important contributions to the literature. In view of the existing literature on oil prices and the price level in South Africa, our paper uses a new method developed by Hatemi-J (2012), to the best of our knowledge, the first to use the method in this context. This method allows us to reinvestigate the relationship between oil prices and the consumer price level using the cumulative sum of positive and negative shocks respectively to test the asymmetric relationship.

This is not the first time that the asymmetric effects of oil price shocks on the macroeconomy are tested (Mork, 1989; Hooker, 1996, 2002; Raymond and Rich, 1997; Cunado and de Gracia, 2003, 2005; Ghosh and Kanjilal, 2014). Research in the past has argued that the upward shifts in the volatility of oil prices require non-linear and asymmetric specifications to correctly capture the causal effects (Hooker, 2002). Hamilton (2003) used a flexible framework to test the existence of a non-linear relationship between oil price changes and economic growth. The author highlights that a rising oil price has more significance in predicting future growth than a decline in oil prices. However fewer studies have directly focussed on the asymmetric relationship between oil and consumer prices. Cunado and de Gracia (2005) separate the effects of positive and negative oil price shocks and find evidence in favour of an asymmetric relationship in their sample of Asian countries. The relationship is however confined to the short run. Castro et al (2012) does not find evidence in favour of a non-linear relationship for a small sample of Euro countries. In contrast to past literature Ghosh and Kanjilal (2014) found that negative oil price shocks have a greater effect on inflation than positive price shocks.

It is important to separate the causal effects of a positive and a negative shock as economic agents might react stronger to shocks of a specific sign. To account for the time-varying volatility and non-normality of the data our methodology uses a robust bootstrap distribution to generate the critical values. The decision to use the headline price level is justified by Marques, Neves and Silva (2002), under circumstances of high commodity price inflation, the use of core inflation could misspecify inflation and lead to lags in policy response. In the same vein Misati, Nyamongo and Mwangi (2013) use Kenya as an example of a small oil-importing country and find that the focus on core inflation could be misguided in an environment of volatility.

Previewing our results we document the absence of a long run cointegrating relationship between oil prices and consumer prices.This finding suggests that any shock from oil to consumer prices will have a transitory effect. The asymmetric tests reveal that both a positive and negative oil price shock leads to a positive price level shock, however the evidence in favour of a negative oil price shock is stronger

The rest of the paper is structured as follows: the next section outlines the methodology and the employed data, section three explains the basic transmission mechanism of oil prices to inflation. Section four discusses the results while section five concludes.

II. The oil price pass-through into consumer prices

It has long been recognized that the importance of international oil prices to the formation of consumer prices inflation stems from two sources. On the one hand, households spend a significant amount of their disposable income on various oil products and byproducts such as gasoline or heating oil. On the other hand, oil and other refined oil products serve as resources in the production of many goods and services. To this end, Alvarez et al. (2011) claim that the oil prices pass-through into inflation can be described as a multi factor process that consists of first-round (direct and indirect) and second-round effects. The direct effect of oil prices can be tracked in the changes of refined oil products prices faced by consumers in the market which react promptly in response to the variability of crude oil prices. The direct impact also depends on the pass through of the price of international oil prices to final consumer prices. It should be noted that crude oil comes in various qualities all with different prices.

The indirect effect emanates from the fact that oil products serve as production input for various goods and services. As such, soaring oil prices will cause production costs to rise and this will in turn translate into higher retail prices for final goods and services. Needless to say, oil prices variability render industries that rely on oil intensive technologies more vulnerable to adverse shifts in the price of oil. This indirect effect takes significantly more time to affect final consumer prices and is dependent on various exogenous parameters such as market competition, cyclical developments or the nature of the price shift.

Finally oil prices and consumer prices are related through what is known in the literature as second-round effects. In a sense, as Alvarez et al. (2011) point out second round effects imply that an initial price change might affect uncertainty over future price level which in turn might result in a readjustment of final prices. It is important to note that uncertainty over future inflation might affect both the demand and supply side. On the one hand, prices of goods and services may experience modest or significant changes and on the other hand nominal wages may change as well following an oil price shock.

III. Methodology and data

The traditional approach for testing Granger causality compares the prediction errors obtained by a model that relates *y* to past and current values of both the regressors (*x*) and the dependent variable (*y*). However, this approach is exposed to a main drawback which is the absence of a clear distinction between the causal impact of positive and negative shocks. The need for a model that captures asymmetric response behaviour stems from the fact that economic agents usually respond more to negative news than to good ones in absolute terms and this behaviour is coinedin the literature as leverage effect (Black, 1976).

In this article, we address this drawback by making use of Hatemi-J (2012)'s asymmetric causality tests. These tests will be used to investigate the asymmetric causality between the oil price (Oil) and consumer prices (CPI), each was defined as a random walk process as bellow:

$$Oil_t = Oil_{t-1} + u_{1t} = Oil_0 + \sum_{i=1}^{t} u_{1i} = Oil_0 + \sum_{i=1}^{t} u_{1i}^{+} + \sum_{i=1}^{t} u_{1i}^{-}, \tag{1}$$

and

$$CPI_t = CPI_{t-1} + u_{2t} = CPI_0 + \sum_{i=1}^{t} u_{2i} = CPI_0 + \sum_{i=1}^{t} u_{2i}^{+} + \sum_{i=1}^{t} u_{2i}^{-}. \tag{2}$$

where $t = 1,2, \dots, T$. Oil_0 and CPI_0 are constants representing initial values. u_{1i} and u_{2i} indicate white noise error terms which are defined as the sum between positive and negative shocks, i.e., $u_{1i} = u_{1i}^{+} + u_{1i}^{-}$ and $u_{2i} = u_{2i}^{+} + u_{2i}^{-}$, where $u_{1i}^{+} = \max(u_{1i}, 0)$, $u_{2i}^{+} = \max(u_{2i}, 0)$, $u_{1i}^{-} = \min(u_{1i}, 0)$ and $u_{2i}^{-} = \min(u_{2i}, 0)$.

Hatemi-J (2012) defined positive and negative shocks of each variable in a cumulative form as $Oil^{+} = \sum_{i=1}^{t} u_{1i}^{+}$, $Oil^{-} = \sum_{i=1}^{t} u_{1i}^{-}$, $CPI^{+} = \sum_{i=1}^{t} u_{2i}^{+}$ and $CPI^{-} = \sum_{i=1}^{t} u_{2i}^{-}$. Then, asymmetric causality between negative components, i.e., $y_t^{-} = (Oil^{-}, CPI^{-})$ can be implemented via the following VAR model with the length of the underlying dynamic equal to p[1]:

$$y_t^{-} = v + A_1 y_{t-1}^{-} + \cdots + A_p y_{t-1}^{-} + \varepsilon_t^{-} \tag{3}$$

where y_t^{-} is the vector of variables, v is the vector of intercepts, A_r is the matrix of parameters for the lag order $r (r = 1, \dots, p)$ and ε_t^{-} is the vector of error terms.

The asymmetric causality test consists on testing under the null hypothesis if the kth element of y_t^{-} does not Granger cause the zth element of y_t^{-}. In this order, Hatemi-J (2012) proposed the following Wald test:

$$W = \left(Cvec(D)\right)' [C((Z'Z)^{-1} \otimes V_\varepsilon)C']' \left(Cvec(D)\right) \tag{4}$$

where C is an indicator matrix with ones for restricted parameters and zeros for the rest. $D \coloneqq (v, A_1, \dots, A_p)$ and $vec(.)$ indicates the column stacking operator. $V_\varepsilon = \hat{\delta}_\varepsilon' \hat{\delta}_\varepsilon / T - q$ is the estimated variance – covariance matrix of the unrestricted VAR model with $\hat{\delta} \coloneqq (\hat{\delta}_1^{-}, \dots, \hat{\delta}_T^{-})$ and q is the number of parameters in each equation of the VAR model. The above Wald test statistic has an asymptotic χ^2 distribution with p degrees of freedom.

However, financial time series returns are characterized by volatility (the existence of ARCH effects) and usually not normally distributed. To overcome this problem, Hatemi-J (2012) proposed a bootstrap simulation technique via the following steps:

Step 1: Estimate the restricted VAR(p) model.

[1] The optimal lag order p is obtained based on the HJC information criterion suggested in Hatemi (2003, 2008).

Step 2: Simulate the bootstrap data, Y_t^* [2].

Step 3: Estimate the Wald test statistic (equation 4) for each bootstrap simulation (100, 000 times). The bootstrap generated critical value c_α^* for each α-level of significance is obtained by taking the α^{th} upper quantile of the distribution of the bootstrapped Wald test statistic.

Step 4: Finally, we estimate the Wald test statistic using the original data. The null hypothesis of absence of Granger asymmetric causality is rejected at the α-level of significance if the Wald test statistic is larger than the bootstrap critical value at that significance level.

Data

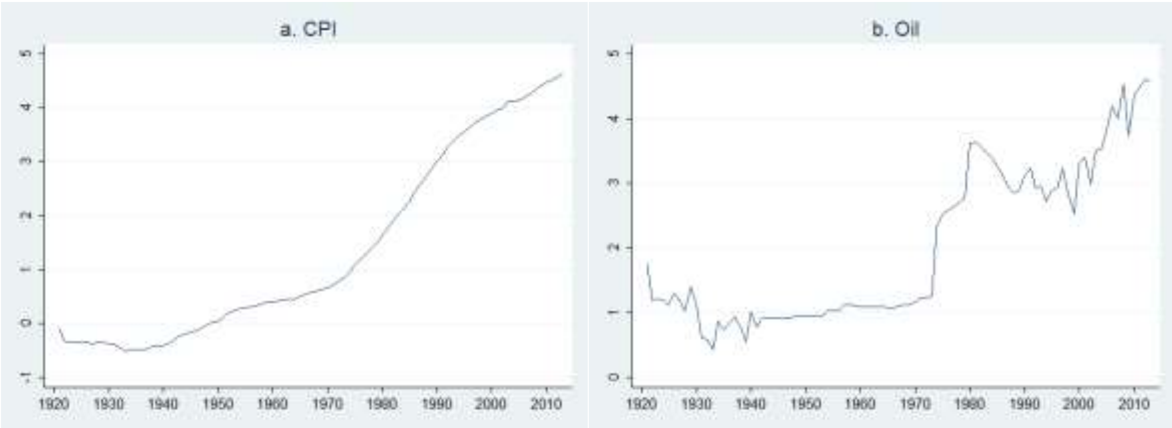
We employ monthly data on the consumer price index in natural logarithm form (hereafter referred to as CPI) in South Africa for the period 1921:M01 to 2013:M10 in order to compute the monthly growth rates of CPI, which then serve to obtain the positive and negative components of the price level. The choice between headline and core prices is determined by the availability of the data, with the core price level not available over the same timespan. The exogenous global level of oil prices is measured by the natural logarithms of the West Texas Intermediate (WTI) – Cushing Oklahoma spot prices quote for crude oil in US dollars (hereafter referred to as Oil). As with the CPI, the monthly growth rate of the Oil variable is computed to recover the positive and negative components of Oil. At this point is worth mentioning that by allowing the price of oil to be quoted in US Dollars and not in South African Rands, by using the exchange rate, we identify clearly the role of oil price in affecting domestic price level. Data on both of the employed variables were retrieved from the Global Financial Database (GFD)..

Standard stationary tests are carried out for the whole period under examination for both oil prices and consumer prices in order to insulate our analysis from spurious results.The conducted Augmented Dicky-Fuller (ADF) and Phillips-Perron (PP) (1988) unit root tests reveal that both the variables in discussion contain a unit root. The unit root test results are available in the appendix (Table 1).

Figures 1a and 1b respectively plot the CPI and Oil prices confirming the non-stationary nature of the employed variables, whereas Figures 1c and 1d respectively plot the monthly computed growth rates of the employed variables. Figures 1c and 1d are available in the appendix.

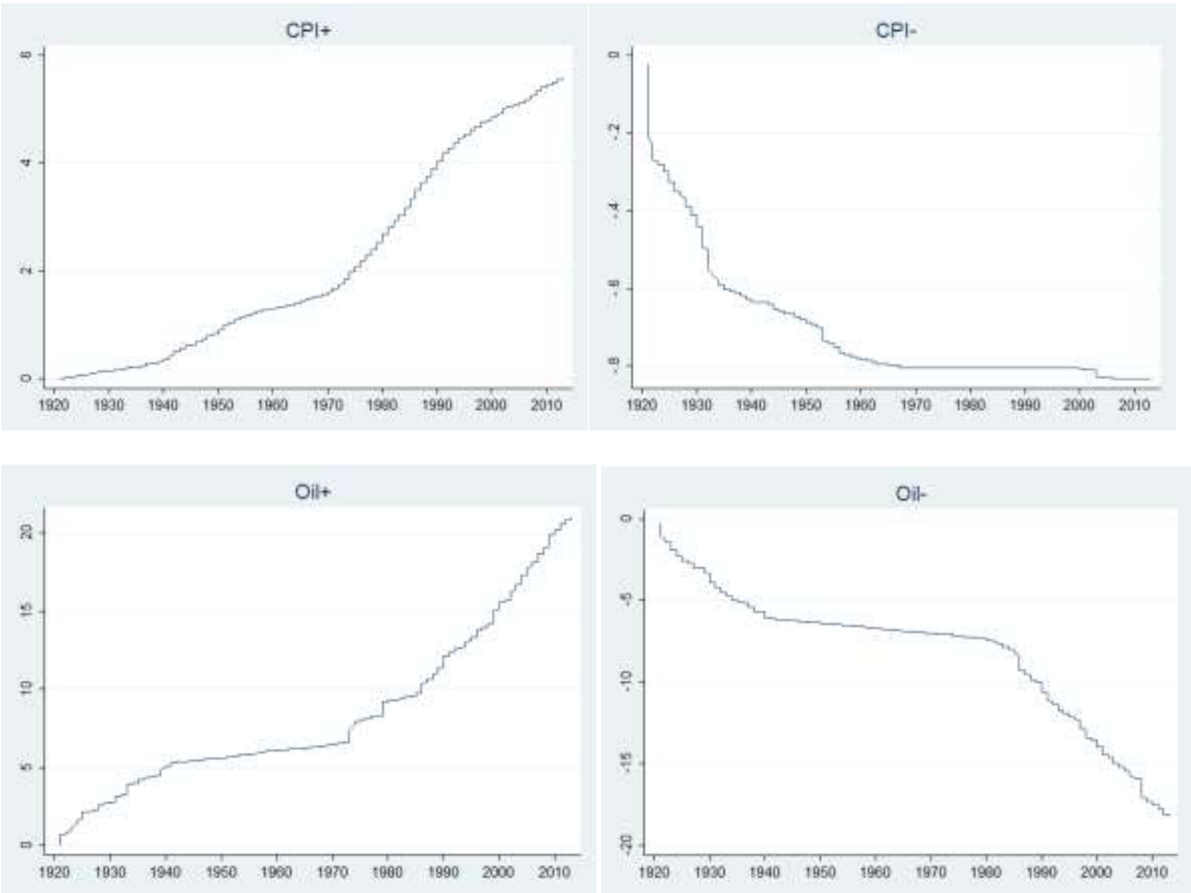
[2] Details about producing the bootstrapped residuals (δ^*) are avaible in Hatemi-J (2012).

Figure 1



Since the method for testing causality relies on the respective cumulative positive and negative sums, these two measures are presented in Figure 2. The price level is denoted by CPI, the oil price by Oil, the positive cumulative sum of each variable by + and the negative cumulative sum by -.

Figure 2: Cumulative positive and negative effect for CPI and Oil prices



IV. Empirical Results

Following the tests for unit roots, cointegration tests were performed and the results are reported in Table 2.. Toda and Yamamoto (1995) conclude that in a VAR framework cointegration is not a prerequisite for causality testing but it is necessary for the unrestricted lags to be included in the model. The Engle-Granger two-step cointegration tests reveal that there is no cointegration present between the variables of concern indicating no long-run relationship. Stated differently, the results of the cointegration analysis clearly indicate that the effect of oil shocks on consumer prices is short lived. Our results are consistent with those of Cunado & de Gracia (2005) who documented the absence of a long-run cointegrating relationship between oil prices and consumer prices for a group of Asian countries.

Assessing the conditional volatility pattern of the data requires some diagnostic tests. Multivariate normality and multivariate ARCH tests reveal that the null hypothesis of no multivariate ARCH is strongly rejected in all cases. The results of the relevant tests are reported in Table 3. This alludes to the importance of the use of the bootstrap tests to generate reliable critical values, since the standard tests are based on the assumptions of normality and constant variances, not present in this dataset.

Table 3: Multivariate normality and ARCH tests results

Variables	Multivariate normality	Multivariate ARCH
(Oil, CPI)	0.0000	0.0006
(Oil^+, CPI^+)	0.0000	0.0239
(Oil^-, CPI^-)	0.0000	0.0000
(Oil^+, CPI^-)	0.0000	0.0002
(Oil^-, CPI^+)	0.0000	0.0019

Finally the asymmetric causality tests are presented in table 4 with the critical values being generated by the bootstrap iterations. The optimal lag lengths as specified by the HJC information criterion are reported in brackets. The first impression is that the null hypothesis that shocks to the oil prices (hereafter referred to as oil shocks) do not Granger-cause price level shocks is rejected, however this result is only valid at the 10% level of significance. Disentangling the respective effects of a positive and negative shock in combinations of matching and opposite shocks provides a clearer picture of the underlying oil price pass-through inflation. The null of positive oil shocks do not Granger-cause positive price level shocks is also rejected at the 10% level of significance.

Table 4: Hatemi-J asymmetric causality test results

Null hypothesis	Test value	Bootstrap CV at 1%	Bootstrap CV at 5%	Bootstrap CV at 10%
Oil ≠> CPI (8)	14.019	18.772	14.430	12.105
Oil^{+} ≠> CPI^{+} (5)	8.108	14.229	9.794	7.865
Oil^{-} ≠> CPI^{-} (6)	5.751	15.944	11.477	9.347
Oil^{+} ≠> CPI^{-} (5)	0.301	16.341	11.396	9.232
Oil^{-} ≠> CPI^{+} (6)	10.746	14.580	9.709	7.878

Note: Numbers in parentheses indicate the lag-length used for the causality test.CV stands for Critical Value

The most striking result comes in the form of the rejection of the null hypothesis: negative oil shocks do not Granger-cause positive price level shocks. The null hypothesis is rejected at a 5% level of significance and implies an asymmetric relationship between movements in the oil price and the price level.

As proposed by Hamilton (2003) depreciations in the oil prices would do little to alter the expectations of consumers after periods of price appreciations. Taking it a step further, decreases in the price could reduce demand for specific sectors and postpone the acquisition of energy specific goods, ultimately price decreases could then have the same effect as price increases. Ghosh and Kanjilal (2014) suggest that negative oil price shocks lead to demand-driven inflation as lower prices lead to higher demand. Monetary authorities tend to only respond to positive price shocks and as such negative shocks might go undetected and lead to higher price levels.

V. Conclusion

This paper seeks to further shed light on the causal nexus of oil price shocks and the price level in South Africa during an extensive period that runs from 1921:M02 to 2013:M10. Being a small oil-importing country, South Africa is not immunized against international oil price movements which could affect the macro economy and specifically domestic prices. South Africa attempts to mitigate the effects of supply-side shocks through an inflation-targeting framework, but as a price taker South Africa has little influence over international prices and cannot actively intervene.

To gain greater insight into this situation we use a novel method developed by Hatemi-J (2012) which enables us to test for the occurrence of asymmetric causality. The critical values of the test are provided through bootstrap simulations with leverage adjustments. Even when dealing with non-normality and ARCH volatility in the distributions of the respective variables, the critical values are robust.

The linear hypothesis of no causality translating to shocks from the oil price to the price level in South Africa is weakly rejected. Moreover the null hypothesis of no causality from positive oil shocks to positive price level shocks is also rejected at the 10% critical value. This finding is consistent with higher energy prices equating to higher production costs and as such give rise to a cost-push inflation. Even greater evidence is presented in favour of the rejection of the asymmetric null hypothesis: a negative oil shock does not cause a positive shock in the price level. Explanations are provided through demand-push inflation associated with lower prices and secondly consumer expectations which are slow to adjust. It is clear that agents react differently to specific shocks and the general causal conclusion requires greater evaluation.

Whether the monetary authority should respond typically depends on the longevity of the shock. The relationship between oil and the price level is shown through cointegration tests to be non-existent in the long run and as discussed requires little policy reaction. If policy were to respond to a short term shock, lags in response would cause policy to react in the wrong direction. However if the shock is deemed to carry through to the medium term, policy makers should be more weary of negative price shocks.

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Appendix

Figure 1

Monthly growth rates of Oil and consumer prices

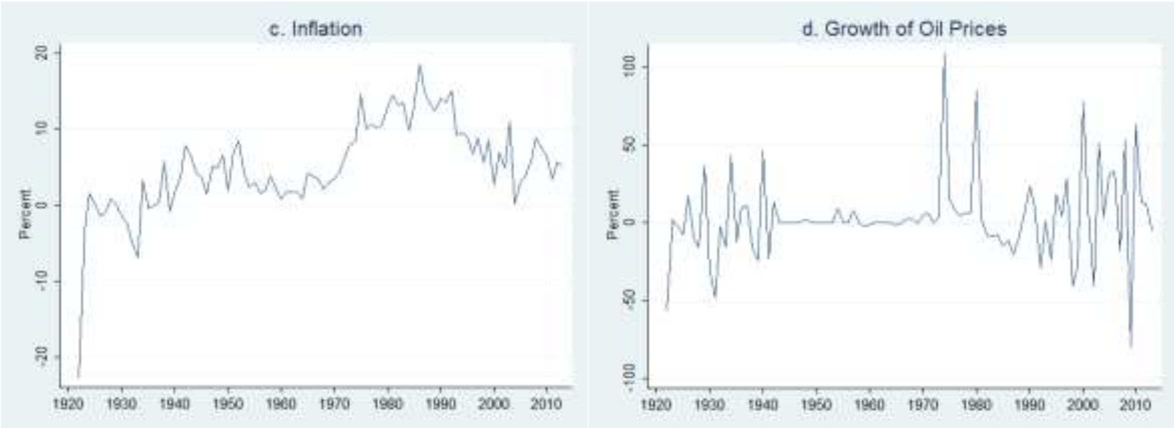

Table 1: Unit root tests results

		Trend and Intercept		Intercept		Conclusion
		Level	1st Difference	Level	1st Difference	
Oil price	ADF	-2.8958	-22.8977***	-0.4326	-22.8771***	**I(1)**
	PP	-2.9798	-21.5811***	0.0358	-21.5930***	
CPI	ADF	-1.8190	-6.0867***	1.9195	-5.5897***	**I(1)**
	PP	-3.7371**	--------	3.9298	-27.3045***	

Notes: 1. *, ** and *** indicates significance at the 10%, 5% and 1% level of significance, respectively.

2. ADF and PP statistics with trend and intercept (intercept only) are -3.966, -3.413 and -3.129 (-3.436, -2.863 and -2.568) at 1%, 5% and 10% respectively.

Table 2: Engle-Granger two-step cointegration test results

Dependent variable	Stat	Conclusion
Oil price	-2.4925	no cointegration
CPI	-2.3739	no cointegration

Notes: Critical values are -3.9096, -3.3431 and -3.1301 at 1%, 5% and 10% respectively.