The Impact of Petroleum Retail Price Shocks on Inflation in Vietnam

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Abstract

This paper attempts to measure the impact of petroleum price changes on inflation in Vietnam over the period 2004-2013. It uses Autoregressive Distributed Lags model to estimate the relationship between petroleum prices and Consumer Price Index of different commodity groups. Petroleum price is affected by the world prices, and it is exogenous to a small economy as Vietnam. The analysis result shows that when the price changes, it affects significantly to the fluctuations of CPI immediately and on several next months. In all kinds of CPI, the total CPI, food CPI, construction CPI and transportation CPI suffer the impact the most. Using results of Autoregressive Distributed Lags models for the short-run effects, we compute the long-run effects between Petroleum prices and CPIs. The result reveals that there are some long-run relationships between the petroleum price change and several CPI kinds, in which the largest impacts in long-run are of the food CPI and transportation CPI.

Keywords: Inflation, CPI, impact of petroleum price changes, impact of oil price changes

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1. INTRODUCTION

Recently, Vietnam's economy has faced the big problem of high inflation, especially in 2007-2008. High inflation has serious impacts on every household's live. There are three kinds of factors affects inflation: demand factors, supply factors, and monetary shocks. Demand-factors include monetary policy, fiscal policy, wage policy, seasonal factors. Supply-factors include weather, cost of input, level of food production, changes in administered prices.

Petroleum price is one of the supply factors of inflation in Vietnam. Petroleum has an important role in Vietnam economy because it is widely used in our everyday lives, such as to be the fuel for automobiles and machines for production. It also is the essential intermediate good in production process. In the last several years, there are many articles said that rising petroleum prices increase inflation in Vietnam. Following Dtinews (2013c), petroleum price hike drives up inflation rates in big cities. The articles computed percent changes of all CPI kinds when the gasoline prices increased by VND360 per liter and diesel prices by VND 370 per liter on late June 2013. It blamed that increasing transportation price directly caused by consecutive petroleum price hikes. Dtinews (2011a) also concluded that inflation stirred by latest petrol price hike.

In addition to Consumer Price Index (CPI), there are 11 main sub-items of CPI in Vietnam: food and foodstuff; beverage and cigarette; garment, footwear, hat; housing and construction materials, household appliances and goods; medicine and health care; transportation, postal services and telecommunication; education; culture, entertainment and tourism; other goods and services. The consumer price index can be compared with the base year, the same month of the last year, or the last month of same year. In many kinds of CPI, transportation CPI seems to suffer the most impact of petroleum price changes directly and indirectly. That because the transportation price almost depends on petroleum price. Besides, the total CPI seems to suffer the changes directly and indirectly in both short-run and long-run. In all kind of CPI, medicine CPI and education CPI may depend on the changes less. However, that is only qualitative assessments. This paper will try to measure quantitatively the impacts based on some econometric techniques, then find out which kind of CPI suffer the impact the most and the less, in both long-run and short-run.

Following Luis et al. (2009), there are two rounds of impacts of Petroleum prices on CPI: first-round impact and second-round impact. The first-round impact includes the direct impact and

the indirect impact. Because Petroleum price is included in the basket of goods to compute CPI, it has direct impact on CPI. When its price increases, CPI will increase and vice versa. Increasing Petroleum price has indirect impact on consumer price via production cost: higher the cost production of goods, higher distribution costs. Not like the first-round effect which is temporary, the second-round effect may emerge caused by raising inflationary expectations and nominal wage. Raising inflationary expectations and nominal way may affect back to CPI. This paper will use monthly time series data to estimate the impact of petroleum price changes on CPI changes with some lag time, in both short-run and long-run.

2. LITERATURE REVIEW

2.1 Empirical studies in some international countries

Abbas et al. (2002) assessed the impact of the change in Petroleum prices on inflation and household expenditures in Australia. They used a modified version of the Leontief IO price model and tried to answer the question "What is the likely distributional impact of the price rises induced by the petrol price rises?" Results showed that the hypothetical price increases would raise the price of gross output by 2.5 percent, the GDP price deflator by 1.5 percent and the CPI by 1.8 percent. The paper concluded that the Australia economy now less influenced to oil price than it was in 1970s when the first major oil prices occurred.

Also using Input-Output tables, Derry and Laura (2010) tried to estimate the impact of oil prices on Irish inflation. Model simulations and Input-Output tables were used to compute the scale of direct, indirect and second-round effects. The strong volatility in oil prices has important implications for the Irish economy because Ireland relies heavily on imported oil. The result showed that Ireland's Economics depends strongly on both oil and gas than Euro area.

In a different approach, Michael and Menzie (2004) used and Augmented Phillips Curve framework to estimate the effects of oil price shocks on inflation in United States, United Kingdom, France, Germany, and Japan. Variables in the model included seasonally adjusted CPI, lags of interest rates, unemployment rate, inflation, and the percentage change in nominal oil price. The exact channel-through which oil affects the economy was not crucial. They identified an

exogenous movement in the price of oil that has a significant and a priori plausible reduced-form impact on inflation. LM(2) was used for serial correlation test. Besides, Jarque-Bera Normaly and White Test were used for heteroskedasticity tests.

Another interesting approach is using Autoregressive Distributed Lag model (ADL) which can evaluate the impact of petroleum price change immediately on that month or several next months. Perera (2005) studied the impact of Petroleum prices on inflation in Sri Lanka. He measured the indirect impact by using ADL model with the condition that there isn't any non-stationary variable. Then, Co-integration Test was performed to find a long-run permanent relationship. The paper concluded that the permitting domestic Petroleum prices in Sri Lanka to adjust gradually rather than sharp adjustments within a short period could minimize the impact of large fluctuations in international prices on Sri Lanka's CPI. His method separated direct factors and indirect factors.

Luis et al. (2009) researched the impact of oil price changes on Spanish and Euro Area Consumer Price Inflation. The paper introduced the different transmission channels of oil price changes. It used model Bank of Spain's Quarterly Model to estimate first-round impacts (direct vs. indirect impact), and second-round impacts of increasing crude oil price fluctuations on inflation. The result showed that the direct effects are increasing overtime, reflecting the higher spending of households on refined oil products, whereas the indirect ones, defined in broad terms, are losing important.

Another way to estimate the inflation effect of changes in fuel oil prices is using VAR analysis, which was applied by Tuncay and Birol (2011) for Turkey economy. They used the Vector Error Correction Model to examine the effect using time interval monthly data of period 2005-2010. The paper found that the change in oil prices was the one-way Granger cause for change in consumer price index. It used ADF to test unit root, then used Johansen-Jeselius Maximum Likelihood Co-Integration to test the existence of a long-term relationship between the series. The study used Tramo-Seats method to remove seasonal effects. Following Tuncay, the advantage of this approach is that VAR methodology is the better approach for investigating the long-run relationship because it approximates well the unknown model of true economic structure by taking dynamic interactions among the variables in the system into consideration.

2.2 Empirical studies in Vietnam

Thanh (2008) studied the nature of inflation in Vietnam over the period 1990-2007. Her study had the result that "output growth has played an important role on causing inflation rather than relaxing inflationary pressure as it was before". She found that the important causes of high inflation before 1989 were the excess of money supply and the lack of goods caused by limited productivity. From 1990 to 2007, the major causes of inflation are growth of output, inflation inertia, exchange rate appreciation, and the changes in the economy during the period. Finally, following her study, the process of reducing subsidies in some crucial goods, the step by step relaxing the administration on energy price from early 2007, and the increase of the world inflation are the root causes of the acceleration in inflationary pressure from late of 2007.

Tuan (2012) used VAR model with sign restrictions to find the sources of recent inflation in Vietnam. The variance decomposition results showed that the supply shocks and demand shocks explain a large part of inflation over the whole period from 2004 to 2010, while the contribution of monetary shocks is much smaller. His historical decomposition results showed that from 2004Q1 to 2008 Q3 Vietnam economy faced demand shocks, and from 2008Q1 to 2010Q4 are the supply shocks.

Le and Nguyen (2011) examined the impact of oil prices on Vietnam's economy activity for the period 1995 – 2009 using VAR modeling and co-integration techniques, examined the long-run and short-run dynamics of relationship between economic activity and oil price for Vietnam. He found evidence of a long-run relationship between oil prices, exchange rate, economic activity and inflation. The results suggested that both oil prices and real effective exchange rates have significant impact on economic activity. However, the research concluded that "Vietnam economic activity is influenced more by changes of value of Vietnam currency than the fluctuations of oil prices".

Nguyen (2009) has researched about the impact of increasing the retail petroleum price on the same month CPI. He estimated the direct impact of increasing the price on CPI based on the structure of basket of consumer goods, the direct impact on household classes, and the impact of increasing the price on 112 manufactures on the whole economy based on the technique of Input-Output model. Results showed that when 1 percent petroleum price increase, the producer price will increase about 2.56 percent, the purchased price increase about 3.27percent, and CPI increase

3.67 percent. However, in fact, the percent depends on the structure of cost and structure of manufactures, over all the economy, mental factors of customers, and the structure of market. This approach was only considered the impact at the same month.

Nguyen and Nguyen (2010) also researched about factors of inflation in Vietnam from 2000 to 2010. In their conclusions, the factors include inflation inertia, exchange rate pass-through impacts in short-run, changes in M2 and interest rate, and short-run pass-through of international inflation to domestic prices is significant. However, they did not mention about micro-level determinants. Petroleum retail price is one of the micro-level determinants which may have large impact on inflation.

3. PETROLEUM PRICE AND INFLATION IN VIETNAM

3.1 Price mechanism of petroleum products

First of all, we find details information how the petroleum prices in Vietnam were decided. Before 2009, the government had directly subsidies, and decided the petroleum price. These prices were often lower compare to other countries in the world. Therefore, the government had to bear the amount that not small at all to subsidize the difference in Petroleum price. Meanwhile the petroleum smuggling from Vietnam to Cambodia was raging. This policy had an advantage when it could make the market stable but it could not prevent the inflation through the cash and fiscal channels. Though, the directly subsidies becomes the burden of the government. For example, on 2012-8-28, the petroleum price in the world increases remarkable. If the formulation is applied; they had to increase about 600-1150 VND per liter but inter-Ministry required principal businesses not to calculate the norm profit 300 VND per liter in basic pricing structure. They are concurrently allowed using the BOG fund from 300-500 VND per liter, so the adjustment in that time was limited from 300-650 VND per liter. From 2009-12, comply with the provisions of Decree No. 84/2009/ND-CP release dated 2009-10-15 of the Government on the oil and gasoline business and the Circular No 234/2009/TT-BTC of the Ministry of Financial on 2009-12, the main guiding policy of formation, management and use of petroleum price stabilization fund, the policy had

changed. The government allows the importer agency determined the oil price themselves, to fluctuate around 5 percent each time the price changes.

The petroleum price stabilization fund was called BOG. This fund was a legitimate demand and formed as a relief valve to ensure the stabilization of petroleum prices when the oil market on the world fluctuates. BOG fund is appropriate formed by a specific amount, fixed price based on provisions of Clause 9, Article 3, Chapter I of Decree No. 84/2009/ND-CP of 300 VND per liter of the actual amount fuel consumption and has been identified as a cost item in the basic pricing structure of principle trader. That means the fund was created based on money of people using petroleum. About the mechanism to form the BOG fund, Principal traders are agent to implement business methods which follows the national and world's law. They also are responsible for business results and appropriate BOG fund, only using for stabilization Petroleum prices as prescribed by the competent authority. In other necessary situations, the Ministry of Financial will adjust the amount to accordance with market fluctuations.

About the using of the fund, principal trader could use the BOG fund to stabilize the Petroleum price in some cases. First, the components which compose the variation lead the basis price increasing more than 7 percent, and less than 12 percent compared to the current retail price, principal traders are allowed to adjust the selling price. It could be increased in 7 percent plus with 60 percent of the price difference from the base rate of price increases over seven percent (greater than 7 percent) to the actual growth rate in excess of 7 percent range increase to twelve percent (less than or equal to 12 percent); the remain forty percent (40 percent) is compensate from BOG Fund. Secondly, using the BOG fund must comply with the provisions in accordance with the minimum time between two times of price adjustment. Next, if the basic price increases more than 12 percent compare to the current price, principal traders are allowed to adjust the price as the first point. The remain difference are decided by the Ministry of Industry and Trade and the Ministry of Financial through tax policies, using provisioning and the BOG Fund and other economic measures follow provisions of the current law. Finally, in case increasing the Petroleum price has bad effects on economic activities, social and life, the Ministry of Financial in coordination with the Ministry of Industry and Trade announced the decision policies to stabilize prices through tax policies administration, forming and using the BOG fund and other economic policies follow the current law.

When the government transformed from direct subsidies to indirect subsidies, it caused the positive consequences. This mechanism can be considered as the action that allows the Petroleum price changing together with the world price, reduce the burden of the government. Hence, in the recent years, the retail petroleum price changes frequently; nearly correspond in tune with prices in the world. So, the Petroleum price variable is exogenous. With new policies, it could lead to nature of market competition in the future. However, though the advantages of new policies, the policy makers have to face challenges because of changing petroleum prices took place constantly; it make big changes to inflation and the stabilization of the market as well.

3.2 Petroleum prices

In this section, we review the petroleum price's history of Vietnam from 2004 to December 2013.

Following Vietnam National Petroleum Group (VNPG), in Vietnam, there are some kinds of Petroleum: RON83, RON90, RON92, RON95, Diesel 0.5S, Diesel 0.25S, Diesel 1%S, Kerosene, Mazut 3.0S, Mazut 3.5S, Mazut 380, and Mazut N2B. Their prices are also adjusted most frequently. Once adjusted, the price fluctuations of them are almost the same. For example, following VNPG's announcement on 2013-7-17, the price of RON 92 increased by VND460 (up 1.91%), the Diesel 0.5S price increased by VND470 (about 2.15% increased), while the Kerosene price rose VND420 (up 1.94%). By drawing the graphs of changing CPI and changing the price of some kinds of Petroleum, as the three below figures, we can guess the relationship (cause-effect) between CPI and Petroleum prices.

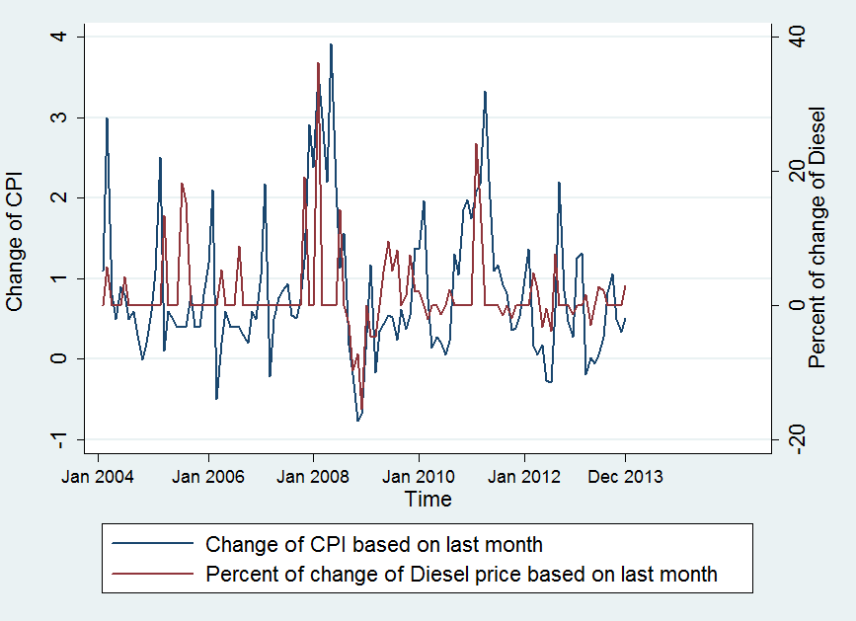

Figure 1 Changes of CPI and Diesel (prepared by author using GSO and VNPG data)

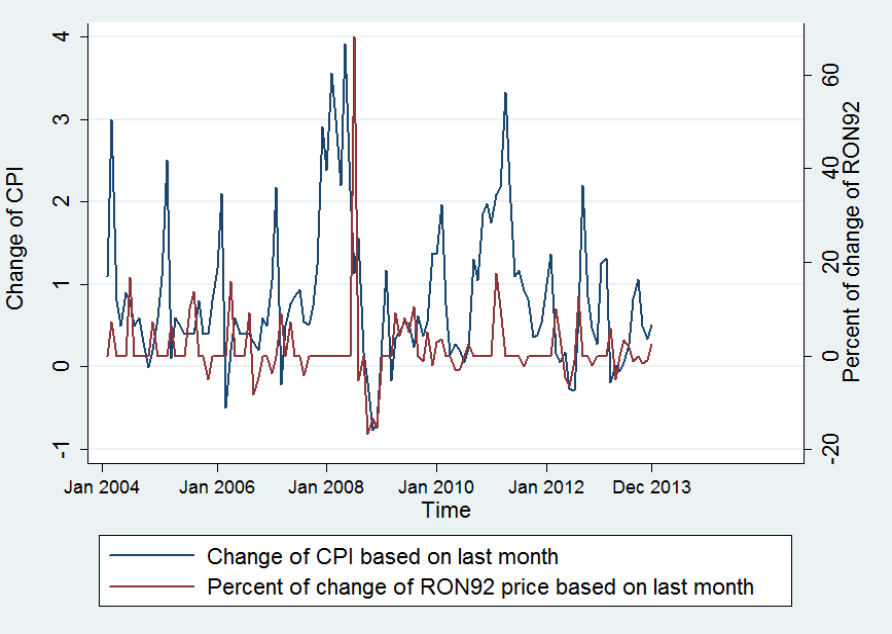

Figure 2 Changes of CPI and RON92 (prepared by author using GSO and VNPG data)

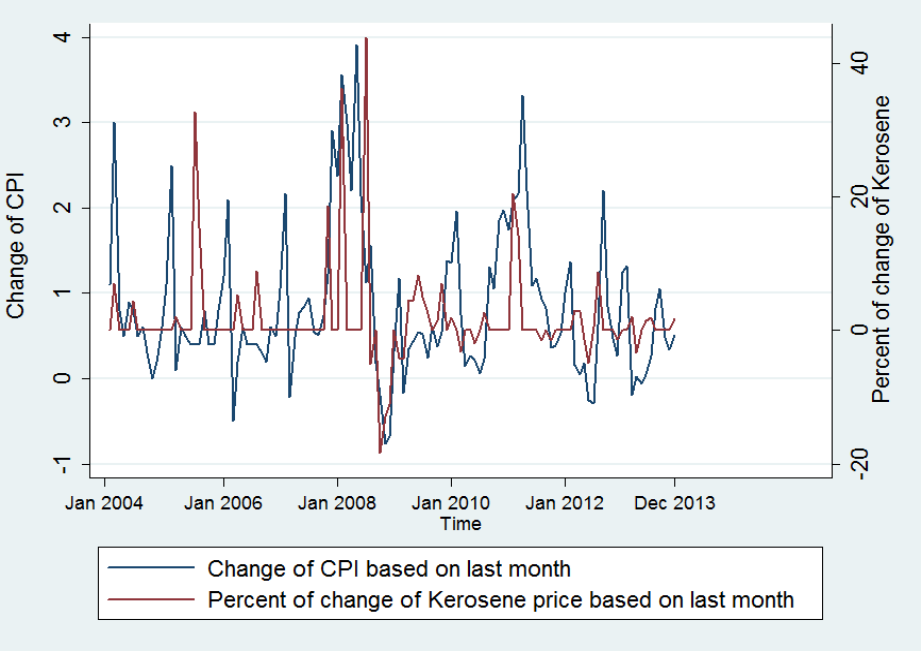

Figure 3 Changes of CPI and Kerosene (prepared by author using GSO and VNPG data)

As we can see from three above figures: when the prices of RON92, Diesel, and Kerosene change, the CPI also changes immediately or after a short time. From Jan 2004 to around 2008, the percent changes of petroleum prices have fluctuated many times. Along with it, the CPI has also changed several times. You can see there were 4 peaks of CPI changing from 2004 to 2008. The dramatically changing in CPI indicator has occurred around the 2008, whereas in this period of time, the change of RON92 was steady at that time, but changed a lot lately, and the prices of Diesel and Kerosene changed significantly. When the RON92 price increased about 60 percent, the Diesel's price increased 40 percent. The CPI indicator also changed the most, with 4 times as before. From around 2008 to December 2013, the fluctuation of CPI and the petroleum price changes took place almost at the same time.

The figure 4 below graphs the changing of prices of three main kinds of fuel energy in Vietnam including RON92, Diesel, and Kerosene.

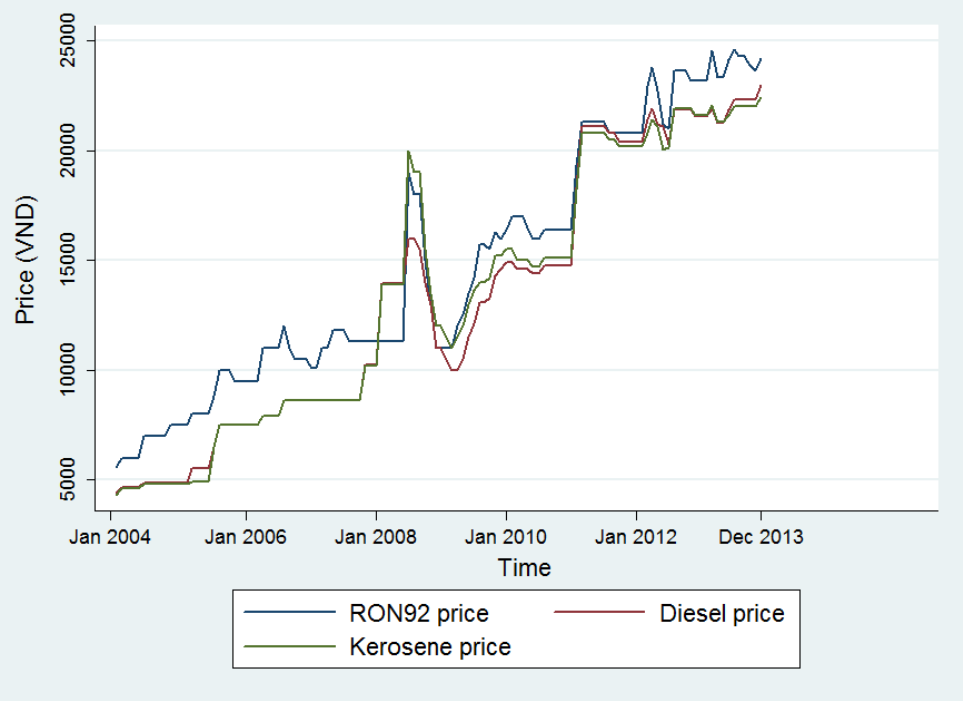

Figure 4 Petroleum Prices over time

As you can see, their amplitude changed with nearly identical. From 2004 to December 2013, their prices increased five times from nearly 5000 VND per lit to about 25000 VND per lit. In the middle of 2008, the most increasing price happened, but they decreased right after that, and then increased steadily. On the first quarter of 2011, the price of all kinds dramatically increased from about 15000 VND to larger 20000 VND per lit, approximate 4 times as 2004. For the last 3 years, their prices fluctuated slowly but rose overall. Whatever their prices rose or reduced, they happened almost together. Therefore, we can use average of percent changes of those petroleum prices as the proxy to count as impact factor.

4. DATA AND METHODOLOGY

4.1 Theories

First of all, we summaries some techniques and frameworks which can help us have overview of which technique is used to evaluate the impact of petroleum price changes on inflation. We concentrate on ADL (p, q) model and some related techniques.

Autoregressive Distributed Lags Model ADL (p, q)

An Autoregressive Distributed Lag model of order p and q, ADL (p, q) is defined as below:

$$Y_t = \alpha + \delta\, t + \rho_1 Y_{t-1} + \ldots + \rho_p Y_{t-p} + \beta_0 X_t + \beta_1 X_{t-1} + \cdots + \beta_q X_{t-q} + \epsilon_t$$

Following Yi-Yi (2010), estimation and interpretation of the model depends on whether X and Y variables are stationary or not. An important assumption of ADL (p, q) model is that both X and Y are stationary and do not follow a unit root process. So before running any time series regression, we perform unit root tests for every variable in the model. Then hypopaper testing can be done using t-statistics or F-statistics. Sequential testing procedures are used to select values of p and q. After that, we can compute the long-run equilibrium or total multiplier. The multiplier is the one of the most interest value for policy maker to compute the new equilibrium in economy and also to evaluate how their policy changes impact to economy. For ADL (p, q) model, the long run multiplier is:

$$\frac{\beta_0 + \beta_1 + \ldots + \beta_q}{1 - \rho_1}$$

Testing unit-root for stationary by using Dickey-Fuller test

Dickey-Fuller Test is one of some techniques which can be used to test unit-root. Following Dickey and Fuller (1979), the framework tests if the variable follows a random walk or not. The null hypopaper is the variable has a unit root. Dickey-Fuller assumes the model as:

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

where u_t is an independently and identically distributed zero-mean error term.

Dickey-Fuller Test tries to fit the model below using ordinary least squares (OLS) by setting $\alpha = 0$ or $\delta = 0$:

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

However, the regression maybe got some problems caused by serial correlation. To control that problem, the Augmented Dickey-Fuller Test instead fits a model of the form:

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \varsigma_1 \Delta y_{t-1} + \varsigma_2 \Delta y_{t-2} + \ldots + \varsigma_k \Delta y_{t-k} + \epsilon_t$$

where k is the lag number.

Testing $\beta = 0$ is equivalent to testing $\rho = 1$, or, equivalently, that y_t follows a unit root process.

Testing Breusch-Godfrey for serial correlation

The Breusch-Godfrey serial correlation LM Test ('Breusch-Godfrey' n.d.) is a test for autocorrelation in the errors of a regression model. It uses the residuals from the model result and test if there is a serial correlation of the error term. Consider a linear regression of ADL model:

$$Y_t = \alpha + \delta\, t + \rho_1 Y_{t-1} + \ldots + \rho_p Y_{t-p} + \beta_0 X_t + \beta_1 X_{t-1} + \cdots + \beta_q X_{t-q} + u_t$$

where the residuals might follow an autoregressive scheme, as follows:

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \cdots + \rho_k u_{t-k} + \epsilon_t$$

The Breusch-Godfrey test to make sure the hypopaper of no first-order autocorrelation of the error term (u_t *depends on* $u_{t-1}, u_{t-2}, \ldots,$ *and* u_{t-k})

Prais-Winsten estimation

Jeffrey (2012) introduces Praise-Winsten method as a generalized least-squares (GLS) method to estimate the parameters in a linear regression model, in which the errors are serially correlated. Especially, Jeffrey assumes that the errors follow a first-order autoregressive process.

We summaries Prais-Winsten model and advantages/disadvantages ('Prais-Winsten' n.d.) as below:

$$y_t = \alpha + \beta X_t + u_t$$

Where y_t is the time series of dependent variable at time t, β is a vector of coefficients, X_t is a matrix of explanatory variables, and u_t is the error term. The error term can be serially correlated over times:

$$u_t = \rho u_{t-1} + e_t$$

When e_t is a white noise. The Cochrane-Orcutt procedure transformation is:

$$y_t - \rho y_{t-1} = \alpha(1-\rho) + \beta(X_t - \rho X_{t-1}) + e_t$$

For t=2,3,…,T, Prais-Winsten technique makes a reasonable transformation for t=1. Then the usual least squares estimation is done. However restrictions of Prais-Winsten estimation is that the error term still be restricted to an AR(1) type. If ρ is not known, a recursive procedure can be used to make the estimation feasible.

3.2 Econometric model

Firstly, the petroleum price is an independent variable and can be consider as an exogenous variable. Next, following the figures 1-3, we see some lag effect of petroleum price on CPI. From the figures, there are many time when the petroleum price increase, the CPI on the next month increase. So, we propose using a Finite Autoregressive Distributed Lags (ADL) Model to measure the relationship between petroleum retail price and CPI. This model allows us to determine what the effects are of a change in a policy variable. The following formula is our ADL model:

$$y_t = \beta_0 + \left(y_{t-1}\beta_{t-1}^{y} + \cdots y_{t-g}\beta_{t-g}^{y}\right) + \left(p_t\beta_t^{p} + p_{t-1}\beta_{t-1}^{p} + \cdots p_{t-k}\beta_{t-k}^{p}\right)$$

$$+ (e_t\beta_t^{e} + e_{t-1}\beta_{t-1}^{e}) + \sum_{i=1}^{11} D^i\beta_i^{D} + \epsilon_t$$

- Where:
  - y_t is the monthly change of CPI at time t which computed based on the last month
  - y_{t-g} is g-lagged of the monthly change of CPI
  - p_t is the changes of retail petroleum price at the month t
  - p_{t-k} is k-lagged of changes of retail petroleum price
  - e_t is the change of the exchange rate USD/VND at month t
  - D^i is the dummy variable denote if t is at the month i. We use dummy variables for January to November to remove seasonal effects.

- Notes:

- ADL models can be estimated by OLS with assuming that the number of data points sufficiently exceeds the number of lag weights. This assuming can be satisfied because we will collect monthly data from 2004 to 2013.
- Before estimating the ADL model by OLS, we need a strategy to find out the lag length of CPI and Petroleum price. It means we have to find out the value of k-lag and g-lag in the model. In this paper, I only consider model with k lag of CPI is 1 and g lag of petroleum price is from 1 to 3.
- After estimate the model, the short-run effect of Petroleum price is measured by the estimated β_t^p, and the long-run multiplier is:

$$\frac{\beta_t^p + \beta_{t-1}^p + \cdots \beta_{t-k}^p}{1 - \beta_{t-1}^y}$$

- Again, cause by petroleum price only depends on international prices, we can assume that there is no multicolliearity among lagged explainators β_t^p

- Steps to compute:
  - Test unit-root for stationary by using Dickey-Fuller test. If all variables are stationary, then the ADL model can be estimated using OLS. Econometric techniques are all standard
  - Run OLS regression for the model
  - From regression result, run Breusch-Godfrey Test to make sure the hypopaper of no first-order autocorrelation of the error term ($\epsilon_t \; depends \; on \; \epsilon_{t-1}$)
  - If there is serial correlation of the error term, we run the model again with GLS regression
  - See the result and check if control variables have expected signs
  - Compute long-run multiplier

4.3 Data sources

Monthly petroleum prices from January 2004 to December 2013 are collected from Vietnam National Petroleum Group's press releases for announcement of changing the prices. The changing often takes effect on the same day with the press releases. Some time the announcement is released one day before it actually happens.

There are four main kind of petroleum in Vietnam: Gasoline (RON), Diesel, Kerosene, and Mazut. There are four types of Gasoline: RON83, RON90, RON92, and RON95. In which the price of RON92 are often announced for changing the most. Diesel also has four types: Diesel 0.5S, Diesel 0.25S and Diesel 1%S. Diesel 0.5S is the one that changes almost all the time RON92 changes. And, Mazut similarly has four types: Mazut 3.0S, Mazut 3.5S, Mazut 380, and Mazut N2B. Mazut prices are not often changed.

Another important point: maybe there are more than one announcement of the price changes in one month. For example, on April 2013, there are three times the Vietnam National Petroleum Group (VNPG) released the notices. On April 09, 2013 VNPG reduced the Diesel 0.5S price from 21900 VND to 21450 VND. After 9 days, on 2013-04-19, VNPG reduced the price to 21350 VND. And in the 3rd time, on 2013-26-4, the Group reduced the price to only 21250 VND. Because our ADL model's purpose is to compute the effect of changing the price to CPI on several next months, so in those months have more than one times of changing the price, we will get the last price on the month. Hence, on April 2013, we consider as VNPG only changed the price to 21250 VND on 2013-26-4.

Monthly USD price indices from 2004 to December 2013 are collected from General Statistic Office of Vietnam (GSO) sources. The price index as the percent change based on the last month.

Monthly Consumer Price Index (CPI) from 2004 to December 2013 are collected from General Statistic Office of Vietnam (GSO) sources. From January 2004 to April 2006, CPI indices computed with the base year is 2000. In which there are 10 main kinds of CPI:

- CPI of food and foodstuff
- CPI of beverage and cigarette
- CPI of garment, footwear, and hat
- CPI of housing and construction materials (including rent, electricity, water, fuel and construction materials)
- CPI of household appliances and goods
- CPI of medicine and healthcare
- CPI of transportation and postal services (including telecommunication)
- CPI of education

- CPI of culture, entertainment and tourism
- CPI of other goods and services

From May 2006 to October 2009, the CPI is computed with the base year is 2005. However GSO still remains 10 main kinds of CPI as listed before. From November 2009 to December2013, GSO computed CPI with the new base year 2009. And GSO also changes CPI kinds to 11 main kinds by separating CPI of transportation and postal services to 2 kinds: CPI of transportation and CPI of postal services.

In our model, we use the CPI index as the percent change based on the last month. So we don't care if the base year to compute CPI is changed or not because we only concern if the CPI is different from the CPI on the last month.

5. EMPIRICAL FINDINGS

5.1 Results of Stationary Tests

Before measuring the impact of petroleum price changes on inflation, we run unit-root tests for all variables except dummy variables to make sure that they are stationary. By using Dickey Fuller Test for unit-root, we found that all variables are stationary. The following table summarizes the default Dickey-Fuller Test results for those variables. As we can see, for each test, MacKinnon approximate p-value for Z (t) is less than 5 percent value. After that, we can reject the unit-root hypopaper of existing unit-root. So we can apply the ADL model to all of them. Details of Dickey-Fuller Test results are listed in Appendix A.1.

Table 1 Summary of Dickey Fuller Tests for Unit Root

	Percent Change Petroleum Price	Total CPI change	Food CPI change	Beverage CPI change	Garment CPI change	Construction CPI change	Medicine CPI change	Telecomm -unication CPI Change	Transportation CPI change	Education CPI change	Entertainment CPI change	Service CPI change
Lag 1	-0.822***	-0.407***	-0.416***	-0.750***	-.505***	-0.415***	-0.543***	-0.995***	-0.636***	-0.783***	-0.840***	-0.814***
Constant	1.184***	41.050***	42.002***	75.420***	5.841***	41.825***	54.786***	99.114***	64.041***	78.830***	84.320***	82.037***
Z(t)	-9.038	-5.466	-5.54	-8.937	-6.356	-5.479	-6.599	-9.899	-7.386	-8.671	-9.2	-8.941
MacKinnon p-value for Z(t)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Number of observations	119	119	119	119	119	119	119	119	119	119	119	119

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5.2 Results of Regression

After running Dickey Fuller to test unit-root for all variables and reject the null hypopaper of unit-root, we can run the Ordinary Least Squares (OLS) for ADL models. In case there is a serial relationship of the model, we apply the Generalized Least Squares (GLS) to regress again. For each kind of CPI, we regress for the lag value changed from 1 to 3. We don't show regression for the lag value of petroleum variable greater than 3 because when the lag value of petroleum's variable is greater than 3, there isn't any additional significant result. In three results of lags from 1 to 3, we choose the best lag value to measure the impact of petroleum price changes on the CPI type. The final conclusion of this paper is based on the best models for each CPI kind.

The table 2 below summarizes the impacts of the petroleum variable on many kinds of CPI (does not display the results of some variables). Details of regression are on Appendix A.2. Column variables are the changes of CPI kinds which we need to evaluate the impacts of petroleum price changes.

From the table below, we can see that almost lag 1 of CPI kind is statistical at 1 percent significant level (except Transportation, Telecommunication and Construction CPI). Coefficient of change of petroleum price at current month is only significant at 5 percent level in models of Transportation CPI change and Service CPI change. Coefficient of change of petroleum at next month is significant at almost models except Telecommunication CPI model. On the next two months, the coefficients off petroleum price changes are weakly significant in Garment and Telecommunication models, and not significant on other models. There are two models which contain variables of the next three months of price changes: total CPI change and Food CPI change.

Table 2 Summary of Regression Results

Explanatory variables	Total CPI change	Food CPI change	Beverage CPI change	Garment CPI change	Construction CPI change	Transportation CPI change	Telecommunication CPI change	Entertainment CPI change	Service CPI change
Lag of Dependent Variable	0.6261***	0.6068***	0.6494***	0.4900***	0.3627***	0.0954	0.0486	0.4795***	0.5577***
	(0.0703)	(0.0669)	(0.0637)	(0.0777)	(0.0848)	(0.0633)	(0.1148)	(0.0877)	(0.0846)
Percent Change of Petroleum Price	0.0096	0.0095	-0.0014	0.0048	0.0237	0.0409**	0.0285	0.0077	0.0182**
	(0.0078)	(0.0128)	(0.0059)	(0.0046)	(0.0150)	(0.0186)	(0.0252)	(0.0083)	(0.0084)
Lag 1 of Percent Change of Petroleum Price	0.0484***	0.0466***	0.0141**	0.0086*	0.0724***	0.2169***	0.0110	0.0149*	0.0029
	(0.0082)	(0.0134)	(0.0061)	(0.0048)	(0.0153)	(0.0198)	(0.0246)	(0.0083)	(0.0087)
Lag 2 of Percent Change of Petroleum Price	-0.0074	0.0171		0.0093*			-0.0415*		
	(0.0092)	(0.0140)		(0.0048)			(0.0237)		
Lag 3 of Percent Change of Petroleum Price	0.0156*	0.0382***							
	(0.0081)	(0.0134)							

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Coefficients of variables of USD and months aren't displayed here. Please see details in Appendix A.2.

From the regression results, we can see that changes in petroleum prices have impacts immediately on transportation CPI and service CPI on current month. When the petroleum prices increase about 1 percent, the service CPI will increase 0.0182 percent and specially the transportation CPI will increase to 0.041 percent. After one month, almost every CPI suffers a large effect of petroleum price change. In which the transportation CPI suffers the most: it increases about 0.2169 percent. In the second order, the construction CPI suffers 0.0724 percent. The other CPIs increase with small amount of about 0.05 percent. On the next two month, the garment CPI increases about 0.0093 percent but the telecommunication CPI decreases -0.0415 percent. On the next three months, there are two kind of CPI still suffer the impact: total CPI and food CPI. In which the total CPI raises 0.0156 percent at 10 percent level of significant and the food CPI increases 0.0382 percent at 1 percent level of significant.

Those results are suitable with the fact that transportation price depends directly on petroleum price. Therefore when the petroleum price changes, it will affect immediately and largely to transportation CPI. We can explain the dependency of Service CPI on petroleum price with the same reason. However, the dependency of service CPI on the price changes is smaller than dependency of transportation CPI. On the next month, almost every CPI kind rises caused by the petroleum price rise. The most important reason is that because when the transportation price increases, almost goods and services' prices will change to deal with the rising of transportation price. So the changes in CPI in the first two month can understand as the first-round impact of petroleum price. Only total CPI and food CPI suffer the effect on the next three month.

There is one kind of CPI which doesn't suffer any impact of the energy changes: Medicine CPI. Their coefficients are not significant at any value level (1 percent to 10 percent value). That is suitable with the fact that the medicine industry totally does not depend on petroleum.

From regression results, we can compute the long-run multiplier:

$$\frac{\beta_t^p + \beta_{t-1}^p + \cdots \beta_{t-k}^p}{1 - \beta_{t-1}^y}$$

where the numerator in the formula is the total of coefficients of petroleum and lag petroleum price change variables, and β_{t-1}^y in the denominator in the formula is the coefficient of lag of the CPI variable. We graph the long-run multiplier results on the figure 5 below.

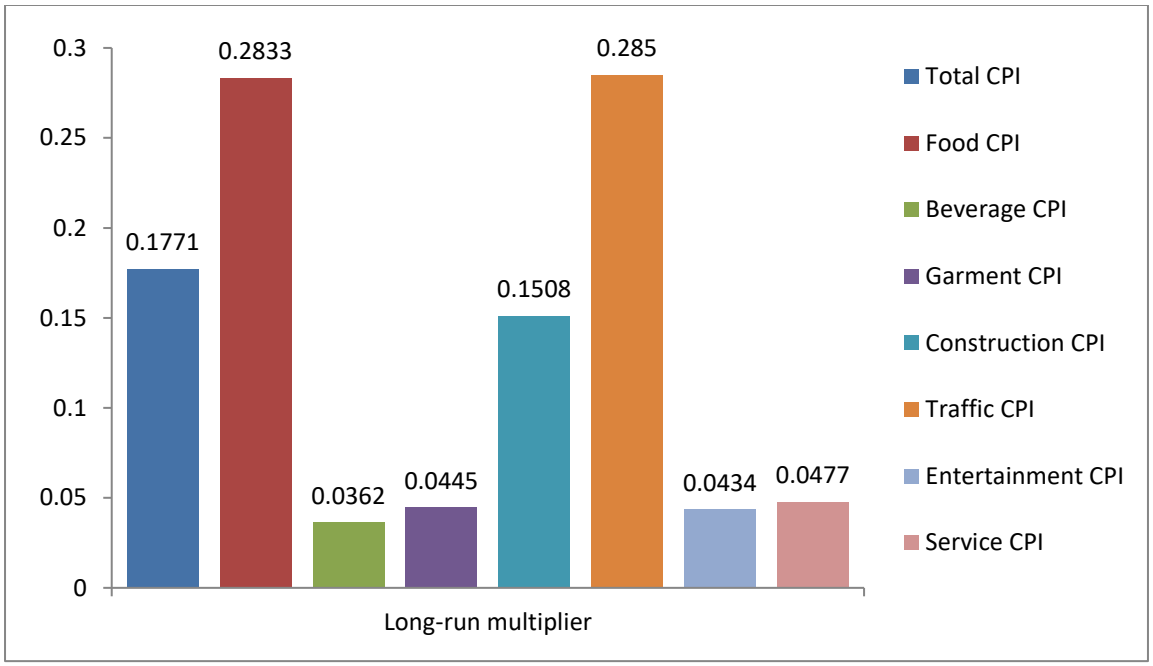

Figure 5 Long-run multipliers

From the results, there are eight kinds of CPI have the long-run relationship with petroleum price changes: total CPI, food CPI, beverage CPI, garment CPI, construction CPI, transportation CPI, entertainment CPI, and service CPI. The telecommunication CPI's long-run multiplier is too small. Food CPI and transportation CPI suffer the largest impact of petroleum price changes in the long-run. Long-run multiplier of food CPI is about 0.2833, and the one of transportation CPI is about 0.285. Total CPI and construction CPI's long-run multipliers are a litter smaller with the values are 0.1771 and 0.1508, respectively. Because medicine industry doesn't depend on petroleum price, therefore it doesn't have any short-run also long-run dependency with petroleum price.

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

This paper studies the impact of petroleum price on many kinds of CPI by using Autoregressive Distributed Lags Models. We use Ordinary Least Squares to regress the ADL model when there isn't any serial correlation in the model. Otherwise, we apply the Generalized Least Squares to

regress again. Average petroleum price was used as a proxy for petroleum prices because their prices often change together.

Regression results reveal that when petroleum price increases, it will impact immediately to transportation CPI and service CPI. In which the transportation CPI suffers the most with increasing about 0.041 percent on the month. On the next month, increasing petroleum price affects to almost every CPI kinds significantly. Transportation CPI still is the one suffers the largest impact with nearly 0.2169 percent increasing. Construction CPI is in the second order with 0.0724 percent increasing. The total CPI on the next month increases about 0.0484 percent.

Almost every kind of CPI has a long-run relationship with petroleum price except medicine CPI. In the long-run, food CPI and transportation CPI increase the most when the petroleum price increases. Long-run multiplier of food CPI is about 0.2833 and the one of transportation CPI is about 0.285.

In overall economy, we can see that the total impact of change in petroleum price on CPI is small (nearly zero) on current month, 4.84 percent during the next month, and 1.56 percent with a lag of 2 months. Long-run multiplier of total CPI is 0.1771.

First, it is found that public's memory on petroleum price change and inflation impact to inflation on current month. Memory about inflation in the last month impacts only lasts for one month. However, memory about petroleum price changes last for about one to three months. That implies that for studying the fluctuation of CPI when petroleum price changes, in order to forecast inflation/market, the economic researcher should consider at least one to three months finding correct impaction.

Second, we also can see that when petroleum prices increase, impacts on each CPI's change series are different, and it almost impacts on the next month. Therefore, in the circumstance of Vietnam, the government should try to support industries which suffer the impact the most. Especially, the government should have some policies to stable food CPI and transportation CPI.

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