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THE ASYMMETRIC EFFECT OF GASOLINE PRICE ON CONSUMER PRICES: AN EVIDENCE FROM THE VIETNAMESE MARKET

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Gasoline price is closely related to macroeconomic variables. This relationship has been interested in over the last decades by policymakers. So far, there have been many studies on the linear relationship between gasoline price and consumer prices, but little is known regarding the nonlinear interactions between them. The objective of this paper is to analyze the asymmetric effect of petrol prices on consumer prices in the Vietnamese market. The theoretical basis is developed from the theory of asymmetric price transmission (APT). The quarterly data is collected between Q1/2008 and Q4/2019, and the nonlinear autoregressive distributed lag (NL-ARDL) model is used as an analytical tool. The research results indicate that the gasoline price in the Vietnam market disproportionately affects consumer prices in both the short-run and long-term.

Keywords: *Gasoline price, asymmetric price transmission, nonlinear autoregressive distributed lag model.*

JEL Classification: *C14; C31.*

1. Introduction

Broadly speaking, consumer prices are measured by the Consumer Prices Index (CPI), which is calculated by determining the list of popular consumer goods and services. This is a relative indicator reflecting the trend and level of fluctuations in retail prices over time of consumer goods and daily services in the life of residents and households. On the other hand, the CPI plays a pivotal role to help organizations and individuals in making important decisions such as the interest rate policy of the state bank, bases for adjusting the salary in enterprises, the individual investors make a decision to allocate investment capital. If there is a change in the CPI it means that there are changes in prices of goods and services on the market. Consequently, it will surely affect other economic indicators of the economy such as securities, inflation, unemployment. Gasoline is, also, one of the inputs of production and consumption activities in society. Therefore, the adjustment of gasoline prices will certainly directly affect the production costs of most industries and economic activities. When the price of gasoline goes up, it will lead to an increase in the cost of goods and services constituting "output" products. As a result, It is the root of inflation that has a negative impact on other macro variables. Therefore, it can be affirmed that petroleum is the main input that decides the entire price system and consumer price index of the economy.

In fact, a short time ago, gasoline prices have fluctuated strongly and the tendency of price fluctuations was "increase a lot, reduce a little; up fast, slow down" (asymmetry). This not only directly

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affects the psychology and interests of consumers but also hinders the competitiveness of the economy in the global context. Theoretically, this topic has been analyzed by a number of domestic and foreign authors in many different aspects. However, previous studies often assess the impact of petrol prices on macroeconomic variables of the economy, very few studies have analyzed the effects of gasoline price fluctuations on consumer prices adequately. In terms of methodology, most previous studies have estimated linear models (the hypothesis that the effect of gasoline prices is symmetrical). However, short-term and long-term fluctuations in petrol prices can be asymmetric and nonlinear (Chou & Lin, 2013; Du et al., 2010; Mork, 1989). Starting from the research gap as mentioned above, the purpose of the article is to study the asymmetric effect of gasoline price on consumer prices in the Vietnamese market: The nonlinear autoregressive distributed lag model approach. Thereby, Based on research results suggest appropriate policies to stabilize the valuing market, contributing to macroeconomic stability to promote efficient and sustainable growth.

2. Literature review

2.1. Types of APT

Asymmetric price transmission (APT) is the phenomenon of market reactions at different levels to the price increase (decrease) of goods (Meyer & von Cramon-Taubadel, 2004). APT is classified by magnitude, speed, or a combination of both.

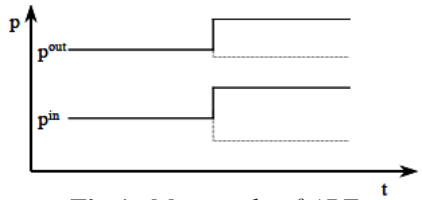

Fig 1: *Magnitude of APT*

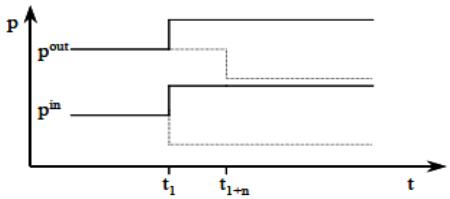

Fig 2: *Speed of APT*

In both cases, the change in the output price (pout) of the goods depends on the direction (increase/decrease) of the input price (pin). Fig. 1 shows the amplitude of APT appears when a change of pout and pin occurs at the same time. The speed of APT comes out when the change of pout and pin occurs at different times (Fig. 2). In some cases, APT also occurs when there are two simultaneous cases.

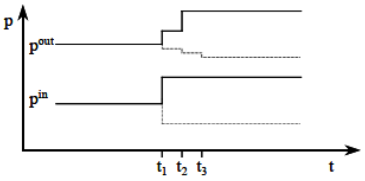

Fig 3: *Magnitude and speed of APT*

The illustration in Figure 3 shows that if the input price (pin) increases, the output price (pout) fully receives after two-point of time (amplitude). If the input price (pin) falls, the output price (pout) is fully received after three-point of time (amplitude and speed). According to Peltzman (2000) , APT is divided into two types such as negative APT and positive APT.

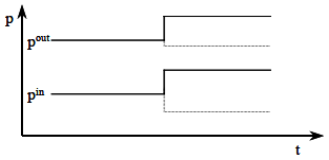

Fig 4: *Positive APT*

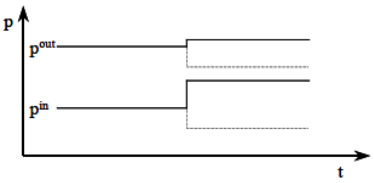

Fig 5: *Negative APT*

A positive APT is a phenomenon in which pout responds quickly and fully in the case of an increase of input price rather than when the decrease of input price. Conversely, a negative APT is a phenomenon in which pout responds quickly and fully rather than in the case of decline of input price rather than when

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the rise of input price. In addition, APT can also be classified vertically based on supply chains or spatially between markets with geographically distant locations.

2.2. Cause of APT

Up to now, most studies suggest that there are three main causes of APT. First, market power that is the influence of one or a group of firms on the determination of market prices, for a specific product or industry as a whole is the main reason (Amonde et al., 2009). On the structure of non-competitive market, the market power is revealed clearly. For this reason, it is often expected to lead to a positive APT case (Kinnucan & Forker, 1987; Miller & Hayenga, 2001). However, Ward (1982) argued that market power may also be a cause of negative APT because monopolies may be reluctant to raise market prices due to fear of risk of losing market share. Another similar argument of Frey & Manera (2007) is the case of implicit collusion in monopoly markets. While the whole price rises, companies inform competitors by quickly raising prices to show they are complying with the tacit agreement. However, companies tend to adjust slowly because of concerns about reducing profits when market prices fall.

Secondly, the other cause of APT depends on the adjustment cost that is the cost that a company incurs when the quantity and/or price of inputs and/or outputs change. If costs are related to price changes, then such adjustment costs are called menu costs (Menu cost) (Meyer & von Cramon-Taubadel, 2004). Menu costs include nominal price changes, catalog printing, inflation costs, and dissemination of price changes information. So that costs may be disproportionate to the increase or decrease of prices (Ball & Mankiw, 1994). Third, another factor causing price asymmetry is the role of government intervention. This is evident in the administrative intervention in the form of price support in the agricultural sector, which is mainly referred to as floor prices (Kinnucan & Forker, 1987).

2.3. Determining retail gasoline price in Vietnam

According to Decree 83/ND-CP/2014 about petroleum trading, the government decides the base price to develop retail prices in the petroleum market. The base price formula of actual petroleum products is based on the following principles: (1) The minimum required gasoline reserve is 30 days of supply, based on the average daily domestic consumption output of the previous adjacent year. (2) The retail price of gasoline does not exceed the base price determined every 15 days. Base price is calculated by the following formula:

Base price = {CIF price + Import tax + Special consumption tax} x Currency exchange + Value-added tax + Standard business expenses + deduction for price valorization fund + Norm profit + Environment protection tax + Other taxes, fees and other deductions as prescribed by current law.

Table 1: *Composition of fundamental price gasoline*

Base price = CIF import price	gasoline	Diesel oil	Oil	Mazut oil
+ Import tax	10%	0.85%	0.13%	3.04%
+ Special consumption tax	10%	8%		
+ Value-added tax	10%	10%	10%	10%
+ Standard business expenses	1.050đ/l 1.250đ/l (E_5, E_{10})	950đ/l	950đ/l	600đ/l
+ Price valorization fund	300đ/l	300đ/l	300đ/l	300đ/l
+ Norm profit	300đ/l	300đ/l	300đ/l	300đ/l
+ Environment protection tax	4.000đ/l	2.000đ/l	1.000đ/l	2.000đ/l
+ Other taxes, fees	If yes	If yes	If yes	If yes

Source: Ministry of Industry and Trade

Regarding the formula and calculation of base price, there are 9 factors that are very clear and

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transparent. However, each factor in the formula is determined how properly, objectively, and transparently under the market mechanism, asymptotic to world prices is a matter of much debate.

3. Methods

3.1. Econometrics model

The research model developed from the Phillips curve model has the following form:

$$pr_t = \beta(L)pr_{t-i} + \gamma Un_t + \zeta(L)op_t + \varepsilon_t \qquad (1)$$

where: prt: consumer price index, Un_t: the difference between unemployment rate and natural unemployment rate, op_t: Gasoline price, L: lag operator, ε_t : error term. According to Okun's Law (1962), Unt can be replaced by the difference between the output level (yt) and the potential output ($\tilde{y}_t$), denoted as $g_t = y_t - \tilde{y}_t$. Then equation (1) is rewritten

$$pr_t = \beta(L)pr_{t-i} + \gamma g_t + \zeta(L)op_t + \varepsilon_t \qquad (2)$$

So equation (1) shows the long-run equilibrium between consumer prices pr_t, g_t and op_t. According to the cointegration theory (Engle, 1982; Engle et al., 1987), if first-order integrated series and cointegration exist, dynamic relationships can be analyzed based on the error correction model (ECM). However, Pesaran, M. H., Shin (1999) argue that time series in the economy are often integrated at 0 or 1 order and have cointegration, then the dynamic relationship is analyzed by ARDL model (Autoregressive Distributed Lag. Especially this model is suitable for small samples. Therefore, if pr_t, g_t and op_t have an integrated degree of I(0) or I (1) and cointegration present, the Equation (1) has the form:

$$\Delta pr_t = \alpha_1 + \alpha_2 pr_{t-1} + \alpha_3 op_{t-1} + \alpha_4 g_{t-1} + \sum_{i=1}^{m}\varphi_i \Delta pr_{t-i} + \sum_{i=0}^{n}\tau_i \Delta op_{t-i} + \sum_{i=0}^{k}\gamma_i \Delta g_{t-i} + \varepsilon_t \qquad (3)$$

From Equation (3) can explain the relationship between oil prices and consumer prices in the short and long term. However, the approaches of Equation (1) and (2) are based on the assumption that the effect of the independent variable on the dependent variable is symmetric.

In reality, it is not suitable because of the fluctuations in gasoline prices are asymmetric to consumer prices. Therefore, Shin et al. (2013) developed a nonlinear ARDL model based on equation (3) to analyze this situation as follows:

$$\Delta pr_t = \alpha_1 + \alpha_2 pr_{t-1} + \theta^+ op^+_{t-1} + \theta^- op^-_{t-1} + \alpha_3 g_{t-1} + \sum_{i=1}^{m}\varphi_i \Delta pr_{t-i} + \sum_{i=0}^{n}(\tau^+_i \Delta op^+_{t-i} + \tau^-_i \Delta op^-_{t-i}) + \sum_{i=0}^{k}\gamma_i \Delta g_{t-i} + \varepsilon_t \qquad (4)$$

$$op^+_t = \sum_{j=1}^{t}\Delta op^+_j = \sum_{j=1}^{t}\max(\Delta op_j, 0)\ ;\ op^-_t = \sum_{j=1}^{t}\Delta op^-_j = \sum_{j=1}^{t}\min(\Delta op_j, 0)$$

Where, and are partial sum processes of positive and negative changes in pt, m, n, k is the lags of the dependent and independent variables respectively. Equation (4) infers to that is the transmission level when gasoline prices rise to consumer prices, that is the transmission level when gasoline prices reduce to consumer prices. If it is symmetric in long-term. Contrarily, it is asymmetric. Similarly, in short term, the symmetric effect is when the following condition is satisfied:

$$\sum_{i=0}^{n}\tau^+_i = \sum_{i=0}^{n}\tau^-_i \qquad \text{với i =1, 2, 3,…, n.}$$

If a short-run or a long-run (or both) asymmetry relationship is confirmed in the NARDL model, we can derive and trace the positive and negative cumulative dynamic multiplier effects of a unit change in and on pt, respectively.

$$\sum_{i=0}^{n}\tau^+_i = \sum_{i=0}^{n}\tau^-_i \qquad \text{với h = 0, 1, 2, 3, …}$$

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It called asymmetric cumulative effect when op^+_t, op^-_t change 1%. When $h \to \infty$ then $m^+_h = L^+ = -\theta^+/\alpha_2$ and $m^-_h = L^- = -\theta^-/\alpha_2$.

3.2. Data gathering procedures

To examine the impact of gasoline prices on consumer prices, this study uses time series data (from Q1/2008 to Q4/2019). Macroeconomic variables are reported quarterly from the General Statistics Office (GSO) and the Ministry of Industry and Trade (MIT). In particular, the variables are defined as follows: the price index variable is the CPI of the last month of the quarter (%), the price of gasoline is the average selling price in each quarter (1000VND/liter), the potential GDP growth (%) is estimated from Hodrick-Prescott-Filter technique.

Table 2: *Research variables*

N_0	Symbol	Variable	Unit	Source
1	pr	CPI	%	GSO
2	op	Gasoline prices	1000VND/liter	MIT
3	op^+	Increase in gasoline prices	1000VND/liter	Own calculation
4	op^-	Decrease in gasoline prices	1000VND/liter	Own calculation
5	g	$g_t = y_t - \tilde{y}_t$ output gap	%	Own calculation

Source: Authors'elaboration.

4. Results and discussion

4.1. Descriptive statistics

The results in Tab. 3 show that sample has 48 observations (from Q1/2008 to Q4/2019). During this period, the lowest consumer price index was 0.99%, the highest was 27.91% and the average was 7.53 (%). The average gasoline price is 19.16 (1,000VND/liter), the average increase is 0.313 (1,000VND/liter), the average decrease is 0.368 (1,000VND/liter). The output gap (g) has the lowest value of -3.37 (%), the highest is 1.44 (%) and the average is -0.097 (%), indicating that GDP growth has not reached its potential. Except for the petrol price (op) and (g) that have a left distribution (because of the negative skewness), the remaining variables have the right distribution (because of the positive skewness)

On the other hand, the output gap variable (g) has the smallest variation (the coefficient of variation is -8.168) and the price increase of gasoline has the largest variation (the coefficient of variation is 1.780). The result of Jarque-Bera (JB) statistics indicates that gasoline price variable has standard distribution.

4.2. Stationary tests and order of integration

Nelson & Plosser, (1982) argue that most time series are non-station at order zero (I (0)), So, it is necessary to test whether time-series station or not. The station of time-series is critical to the efficiency of the estimation method used. If the time series does not station, the assumption of the OLS (Ordinary Least Square) method does not satisfy. Accordingly, t or F tests are not valid (Brooks, 2008). Two common methods employed to examine time-series stationarity are the Augment Dickey-Fuller (ADF) and Phillips-Perron (PP) tests.

Tab. 4 illustrates the results of station tests by two methods of ADF and PP. Indeed, only gasoline price variable is not station at level (according to ADF). In contrast, according to the PP method, the consumer price indexes and gasoline prices variables are not station, the remaining time-series are station at the level. For a first-order differential series, both test methods show that all series are station with at significance level of 1%. So the results

Table 3: *Data description*

Variables	pr	op	op^+	op^-	g
Observation	48	48	48	48	48
Mean	7.53	19.16	0.313	0.386	-0.097
Standard deviation	7.027	3.671	0.557	0.669	0.791
Coefficient of variation	0.993	0.192	1.780	1.733	-8.168
Min	0.99	11.5	0	0	-3.370
Max	27.91	25.05	2.29	2.55	1.440
Skewness	1.468	-0.217	2.335	2.053	-1.428
Kurtosis	4.168	2.305	7.863	6.244	7.913
Jarque-Bera (JB)	4.6e-05	0.510	1.8e-20	1.3e-12	9.4e-15

Source: Output from Stata.

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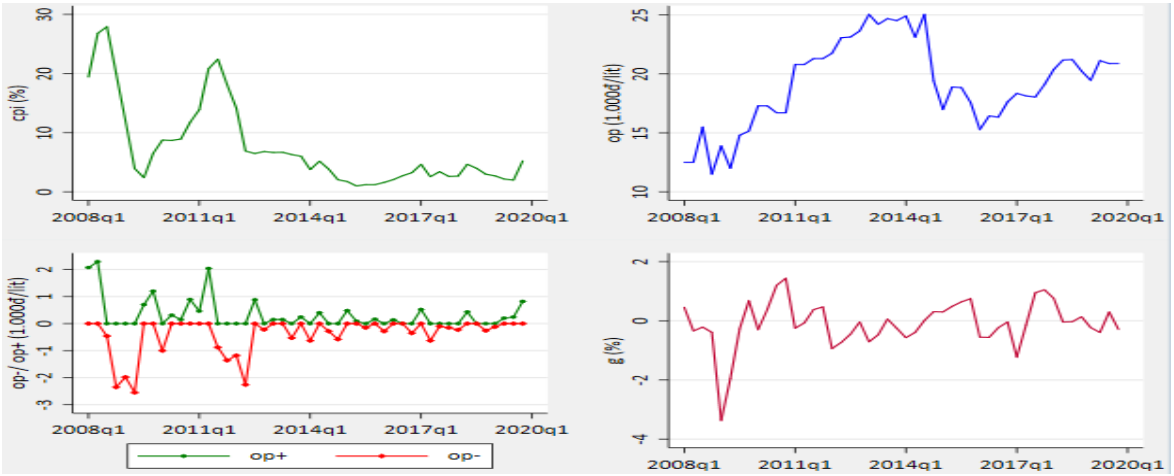

Fig 6: *Data series*

Table 4: *Results of stationary tests*

Variables	lags	Levels		First-order difference	
		ADF	PP	ADF	PP
pr	2	-4,112***	-2,562	-5,032***	-4,690***
op	1	-1,07	-1,832	-4,940***	-8,729***
op^+	0	-5,985***	-5,985***	-10,342***	-10,342***
op^-	1	-4,132***	-4,805***	-5,507***	-9,021***
g	2	-3,278*	-4,232***	-5,596***	-7,291***

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

Source: Output from Stata.

of the stationarity test indicate that the integrated research variables are at level 1 or level 0, which is a prerequisite for applying the ARDL model.

4.3. Nonlinear ARDL model

In the nonlinear ARDL regression model, the bounds test is to test the relationship between variables in the long term Pesaran, M. H., Shin (1999), with the hypothesis H0: "Does not exist at cointegration" and H1:" Opposite ".

Tab.5 reveals that the computed F valued is equal to 30.573 greater than 5.61 at the significance level of 1%. So, the hypothesis H0 is rejected, it means that the existence of cointegration between variables (single cointegration).

Tab.6 interprets the results of estimating the nonlinear ARDL regression model. The coefficient of the Wald test is statistically significant at 5%. It means that, in the long run, if the gasoline price increases by 100 (VND/liter), the consumer price index (CPI) will increase by an average of 4.163% (Assuming other factors remain unchanged). Similarly, if the gasoline price decreases by another 100 (VND/liter), the price of consumer goods (CPI) will decrease by an average of 1.575% (Assuming other factors remain unchanged). Also, both WLR (long-term asymmetric test) and WSR (short-term asymmetric test) are statistically significant at 1%. This means that the effect of gasoline prices on consumer prices is

Table 5: *Results of cointegration tests-Bounds test*

Variables: pr, op^+, op^-, g; k=3		
	Computed F-valued: 30.573	
	Critical value F-statistic	
Significant level	Lower bounds	Upper bounds
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

Source: Output from Stata.

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Table 6: *Estimation of nonlinear ARDL model*

Variables	Coef.	Std. Err.	t	P>|t|
pr_{t-1}	-0.138*	0.068	-2.04	0.050
op^{+}_{t-1}	5.754***	0.801	7.18	0.000
op^{-}_{t-1}	-2.177*	1.073	-2.03	0.051
g_{t-1}	0.157	0.395	0.40	0.693
Δpr_{t-1}	0.097	0.156	0.62	0.583
Δpr_{t-2}	0.036	0.129	0.28	0.781
Δop^{+}_{t}	3.487***	0.464	7.51	0.000
Δop^{-}_{t}	-1.365**	0.507	-2,69	0.011
Δop^{-}_{t-1}	0.502	0.535	0.94	0.354
Δg_{t}	0.0.31	0.273	0.11	0.910
Δg_{t-1}	0.197	0.245	0.80	0.428
Δg_{t-2}	0.058	0.264	0.22	0.827
Constant	0.092	0.242	0.38	0.707
Transmission effect				
$L_{op^{+}}$	41.63**			0.023
$L_{op^{-}}$	-15.75**			0.028
Asymmetric test				
W_{LR}	19.53***			0.000
W_{SR}	44.97***			0.000
Diagnostic test				
R-squared	0.9316			
JB	1.366			0.505
χ^2_{sc}	0.333			0.855
χ^2_{Het}	45.00			0.423
CUSUM				Stable

**** p<0.01, ** p<0.05, * p<0.1; JB: Normality test; : Breusch–Godfrey LM test for serial autocorrelation; : Breusch-Pagan test for heteroskedasticity; CUSUM: Stable test model.*

Source: Output from Stata.

asymmetric both in the short and long term. In the short term, if the price of gasoline increases by 100 (VND/liter), the consumer price index (CPI) increases by an average of 0.3487% (Assuming other factors remain unchanged). If the gasoline price decreases by 100 (VND/liter), the consumer price index (CPI) will decrease by an average of 0.1365% (Assuming other factors remain unchanged). On the other hand, the diagnostic test reveals that the model overcomes the basic assumptions of the regression model. The determinant coefficient (R2) is 0.9316 and the statistical significance of 5% level. It means that 93.16% of CPI volatility is explained by the independent variables. Furthermore, this study uses the CUSUMSQ method to examine whether the research model is stable or not. The test results in Figure 7 show that the research model is stable (Brown et al., 1975).

5. Conclusions

The research results of asymmetric effect of gasoline price on consumer prices, evidence from the Vietnamese market, has confirmed that, in the short and long term, gasoline prices have an asymmetric effect on consumer prices. It means that the policy of operating petrol prices recently has revealed limitations and shortcomings that have not assuage consumers' expectations. To overcome this problem, the author sug-

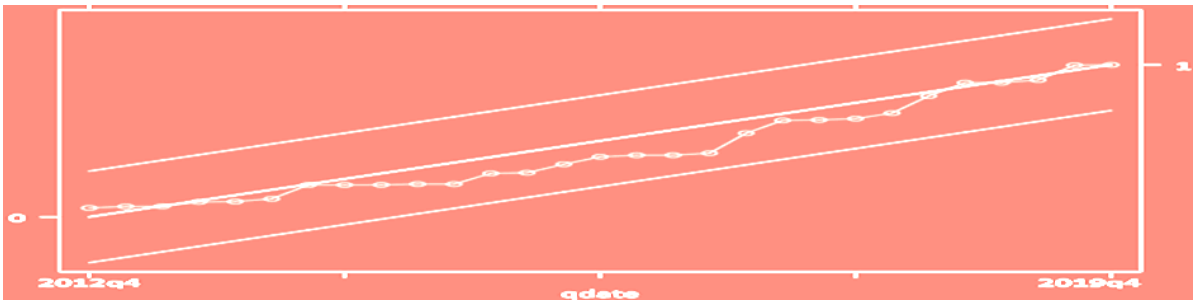

Fig 7: *CUSUMSQ test*

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gests a number of major solutions. The operating policies for petrol prices are as follows:

Firstly, Acceptation on the viewpoint that the management of petrol and oil prices should be ensured according to the market principles, to be competitive, transparent and to break the monopoly over the distribution market. Government needs to enact laws to encourage more businesses to participate in distribution channels to increase competitiveness and reduce monopoly.

Secondly, for the Price Stabilization Fund, in order to harmonize the state management and the interests of consumers, it is recommended that the Government should only deduct the Price Stabilization Fund when prices fall to keep prices stable (stabilize prices) and create sources for funds, when the price increase is not deducted (so as not to increase the price to achieve the goal of price stabilization) and the stabilization fund will be used to compensate when the fund is insufficient, then the price will increase.

Thirdly, for the frequency of gasoline price adjustment, the government should consider shortening the frequency of adjusting gasoline prices appropriately, so that domestic retail prices are increasingly closer to world prices, avoiding world prices falling, domestic prices rising, and the opposite.

Finally, for the norm profit, the current policy stipulates that the norm of profit for petrol and oil retail enterprises is 300 VND/liter. This shows that the provision is not marketable because it has to make a profit and has losses, as with the norm of profit norm, the leading petroleum business enterprise will never lose. Therefore, the government needs to study and improve this policy in accordance with the market mechanism, ensuring fair and fair competition.◆

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Summary

Giá xăng dầu có mối liên hệ mật thiết với các biến kinh tế vĩ mô. Mối quan hệ này đã được các nhà hoạch định chính sách quan tâm trong nhiều thập kỷ qua. Cho đến nay, đã có nhiều nghiên cứu về mối quan hệ tuyến tính giữa giá xăng dầu và giá tiêu dùng nhưng còn rất ít các nghiên cứu tiếp cận mối quan hệ này theo phương diện phi tuyến. Mục tiêu của bài viết này là phân tích ảnh hưởng bất cân xứng của giá xăng dầu đến giá tiêu dùng tại thị trường Việt Nam. Cơ sở lý thuyết được phát triển từ lý thuyết truyền dẫn giá bất cân xứng. Dữ liệu phân tích được thu thập theo quý trong khoảng thời gian từ quý 1 năm 2005 đến quý 4 năm 2019 và mô hình tự hồi quy phân phối trễ phi tuyến được sử dụng để làm công cụ phân tích. Kết quả nghiên cứu chỉ ra rằng giá xăng dầu tại thị trường Việt Nam ảnh hưởng bất cân xứng đến giá tiêu dùng trong ngắn hạn và dài hạn.

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