Rice Price Transmission between Wholesalers and Retailers in the Philippines: Are Prices Integrated in Local Markets?

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ABSTRACT

Increasing attention has been given to raising commodity prices due to its negative effects on poverty and undernutrition. An example of this problem are the growing rice prices in Philippines, which are causing high living expenses to the population across the country. To assess the competitiveness of agro-food chains, price transmission has been used as an indicator of market integration. Using monthly data for the period 2000 to 2016, this study tests vertical price transmission between wholesale and retail prices and dynamic relationship between them in five local markets in Philippines. Results demonstrate that retail prices are granger caused by wholesale prices in all local markets. An autoregressive distributed lag (ARDL) model confirms that asymmetry in rice price transmission between wholesale and retail levels in Metro Manila and Davao. In addition, the ARDL model also confirms retail rice prices in all markets studied in Philippines depend on previous retail prices, contemporaneous wholesale prices and wholesale prices lagged one and two periods, depending on the location. Impulse Response Functions (IRFs) show the retail price response initiates almost immediately or at most one month later after shock, i.e. negative and positive change, on wholesale price, and the duration of full price adjustments

tend to be considerably longer in all five local markets in Philippines. [EconLit citations: C32, L11, Q13].

1. INTRODUCTION

Rice price in Philippines is higher in comparison with other major rice producing Asian countries such as Vietnam, Thailand and China. The largest sources of higher rice price in the Philippines are the costs for transportation, milling, packaging, working capital and import restriction (The Philippine Rice Research Institute (PhiRice), 2016). The PhiRice (2016) also said that the gross marketing margin (GMM) is higher at the different stages of rice supply chain in Philippines, and it is due to the high costs of marketing and the enormous returns to trade management. The rice prices in Philippines have fluctuated dramatically in the last decade, with consumers facing increasingly high prices that reached exceptional levels before falling during the financial crisis over the second half of 2007 and first half of the 2008 (FAO, 2016). According to FAO (2011), Zorya, Townsend and Delgado (2012) and Morales (2018), imperfections in price transmission are factors that have contributed to exacerbate price fluctuations of food commodities due to the lack of incentives transmitted to chain actors for markets adjust to shocks in supply and demand. The degree of market integration in agro-food chains is affected by variations in magnitude, delays and asymmetries in price transmission between positive and negative price shocks (Bunte, 2006; Aramyan and Kuiper, 2009; Swinnen and Vandeplas, 2014). In this context, market prices could be imperfect signals sent to actors, which could allocate suboptimal resources to production. Under this scenario, the quantity and quality of products offered in the market could be affected, with negative consequences for consumers and actors across the chain (Norwood and Lusk, 2008).

According to Rapsomanikis and Mugera (2011), imperfections in price transmission are considered as evidence of market failure and require policy interventions to control the level of market power of some actors in agro-food chains. Producers/wholesalers when increase prices, the retailers instantly and completely increase their prices to maintain their normal profit margins, but when producers/wholesalers decrease prices, the retailers keep constant their prices or takes time to reduce prices to capture higher profit margins (Schroeder, 1988; Vavra & Goodwin, 2005). Swinnen and Vandeplas (2014) argued that consumers in developing countries are hurt by increasing food prices, while producers are not benefiting from high prices for their products, increasing poverty and hunger. Meyer and von Cramon-Taubadel (2004) also claimed that the asymmetric price transmission (APT) possibly results on consumers not benefitting from price reductions at the producers' level, and producers might not benefit from price increases at the retail level. The asymmetric price transmission, in terms of magnitude and time delay in price adjustment mechanism, raised serious concerns in Philippines about market integration between wholesale and retail markets. Very few studies have been conducted on price transmission in the Philippines rice markets, and most of them were done before the global economic crisis in 2007-2008. Therefore, to our knowledge, this is the first study that investigates the dynamics of price adjustment and vertical price transmission between wholesale and retail prices of milled rice in local markets in Philippines. In this paper, we examine the causal relationships and empirically observe asymmetries in price transmission between wholesale and retail prices, and the dynamics of price adjustment in milled rice prices in rice markets in Philippines.

Market imperfections in agro-food markets are more prevalent in developing countries compared to developed countries (Morales, 2018). Imperfections in price transmission are due to several factors such as market power, processing and marketing costs, costs of transportation, government intervention, and product homogeneity and differentiation, in addition to market failure (Meyer and von Cramon-Taubadel, 2004). Frey and Manera (2005) stated that the main cause of imperfect transmission from wholesale to retail is that retailers allegedly try to maintain their "normal" profit margin by increasing retail prices when wholesale prices rise, but they try to capture the larger margins keeping constant the retail prices when wholesale prices fall, which results at least temporarily in APT. In the case of Philippines, in the context of a developing country, we expect market imperfections affecting rice markets.

Rice is the most consumed food across the Philippines, with a share of the total food consumption per person very high and increasing from 68.56% in 1999-2000 to 78.99% in 2008-2009 (Philrice, 2016). Growing rice prices in the Philippines represent high living expenses to the population across the country and more adverse effects on poverty, because the share of rice in total food consumption is high for poor peoples in Philippines which increases the expenditure for food consumption (Philrice, 2016). The historical data on rice consumption rate shows that it tends to increase over time, though the rice price rise, causing the rice consumption rate is inelastic to its price in the Philippines (Philrice, 2016 & FAO, 2016). The degree to which price shocks at one level of the rice chain are transmitted to other levels in local markets is often taken to be an important indicator of market power in supply chain. The high food prices to consumers and large marketing margins to traders at certain stages in supply chain, therefore the unbalanced marketing margins among traders are most important issues facing policy makers. Thus, deeper understanding about magnitude, speed and asymmetry to which wholesale prices are being transmitted to retailer prices is a key factor in designing appropriate policy measures to reduce the level of living expenses to individuals. Thus, the imperfections in rice markets could have serious economic impacts to households in the Philippines. Policy initiatives in this country indicate that market reform in rice market can lead to a reduction in the number of poor people in the country as it helps to reduce the food expenses for individuals (Cororaton, 2004), and to achieve such kind of benefits perfect price relationships between various market levels in rice supply chain in markets is an essential condition.

Previous studies on rice markets in the Philippines such as Reyes et al. (2009) analyzed the impact of changes in rice prices on poverty; Pede et al. (2013) investigated dynamics on rice prices, i.e. monthly rice prices changes over the period of January 1990 to December 2012 in 16 regions in Philippines at three market levels: farmgate, wholesale and retail; Jolejole-Foreman and Mallory (2011) analyzed the movement of Philippine rice price margins between farmgate and retail affected by government intervention measures; and Ramos, E. V. empirically tested the presence of seasonality in palay and rice price series from 1972 to 2008 and the speed of price transmission between farm, wholesale and retail levels on local markets in Philippines: Nueva Ecija, Illoilo and North Cotabato. But these above-mentioned studies did not conduct empirical test on asymmetries in price transmission between chain levels in local rice markets in the Philippines. Consequently, this study aims to explore whether there are price transmission imperfections in the Philippines rice markets and report its results and welfare implications to policy makers. Hence, this paper i) tests the causality directions of rice prices between wholesale and retail levels; ii) examines asymmetries in price transmission between wholesale and retail prices in different rice markets; and 3) assesses the dynamic relationships between wholesale and retail rice prices.

The remaining of this paper is organized as follows: Section 2 briefly review relevant literature about vertical price transmission analysis, Section 3 introduces the data which is used for the analysis, Section 4 describes the econometric methods for the vertical price transmission analysis and dynamics of price series, Section 5 presents the main findings and its discussions, and Section 6 provides the conclusions.

2. VERTICAL PRICE TRANSMISSION IN AGRO–FOOD CHAINS

Vertical price transmission has been studied to better understand the nature of price movements from one level to other in agro-food chains. Several methods have been used in previous studies, including von Cramon-Taubadel (1997), Conforti (2004), Varga (2007) Acosta and Valdes (2014), and Ahn and Lee (2015), to analyze the direction, magnitude and speed with which price changes are transmitted along the various stages of the agro-food chain. The price variations may reveal different kinds of asymmetries in intensity and nature depending upon the direction of price transmission in supply chain. Research and Consulting in Economics (Areté) (2012) argued that in agro-food supply chains, the increase in input prices are more rapidly (and often fully) transmitted to downstream along supply chain, but the reduction in input prices do not transmit or may take more time to be transmitted to the final market levels. The assessment of magnitude and speed of price movement through supply chain is often used as an indicator of the effectiveness and efficiency of the chain as well as the degree of competitiveness in food processing and distribution.

Vavra and Goodwin (2005), Commission of the European Communities (CEC) (2009) and Areté, (2012) stated that the assessment of vertical price transmission along the supply chain typically aims to address the issues: the magnitude, speed, and the asymmetry of price adjustment through the chain. In recent years, extensive studies have been done to examine market linkages among market levels such as: farm, wholesale and retail levels; and most of the literature on vertical price transmission refers to noncompetitive markets due to market imperfections, i.e. incomplete and time delay in price transmission (von Cramon-Taubadel & Loy, 1996; von Cramon-Taubadel, 1998; Conforti, 2004; Vavra & Goodwin, 2005; Capps & Sherwell, 2005; Acosta & Valdes, 2013; Ahn & Lee, 2015).

Developing appropriate models for analyzing price transmission and testing asymmetries is key to study market integration in agro-food chains. In the literature, there are econometric methods for testing APT in agricultural commodities markets which are still being used. In the very previous period, researchers have developed pre-cointegration approaches for testing APT. Tweeten and Quance (1969) introduced a dummy variable in the symmetric and linear price transmission model for estimating APT, and the dummy variables are split the prices into two parts: increasing and decreasing input prices. Wolffram (1971) proposed another empirical model that explicitly includes first differences of explanatory price series in the equation. Houck (1977) developed another model for testing APT, which is like Wolffram's model, and this model does not consider initial observations of price series data into account, because according to him the level of the first observation do not have power to cause dependent variable while considering differential effects. Ward (1982) modified the Houck's specifications by considering time lags on the explanatory variables. Meyer and von Cramon-Taubadel (2004), Frey and Manera (2005), and Hassouneh et al. (2012) have reviewed the existing empirical models for testing APT.

Granger and Newbold (1974) discovered that there could be spuriously significant results between non-stationary and highly autocorrelated stationary time series. To avoid a potential spurious regression, tests have been developed to identify non-stationarity and models to account for co-integration between time series i.e. the time series variables share similar stochastic trends and they never diverge too far from each other. Granger and Lee (1989) proposed a modeling for estimating asymmetric price transmission between co-integrated variables using an error correction model (ECM). Von Cramon-Taubadel and Loy (1996) suggested the empirical specification by splitting the explanatory variable into positive and negative components to allow for more complex dynamic effects. According to Frey and Manera (2005) some researchers also assume that the dependent variable depends on its own lags and on vector of explanatory variables, both contemporaneous and lagged. Thus, they applied an *Autoregressive Distributed Lag (ARDL)* model to incorporate asymmetries in price transmission by assuming that the explanatory variables have a different impact on dependent variable, according to whether it is increasing or decreasing.

In addition, vectors can be used instead of single equational specifications, i.e. multivariate extension of the uni-equational specification for estimating asymmetries in price transmission. The vector models such as *Vector Auto Regressive (VAR) and Vector Error Correction Model (VECM)* models are generalized from the standard single equation analysis of price asymmetries to system of equations to take account the potential interdependencies among time series data and other exogenous variables. Some studies such as Conforti (2004), Acosta and Valdés (2014), and Ahn and Lee (2015) among others, also tested the causality direction of price influences and lag distribution for adjustment of price transmission in agricultural commodity prices in different market levels.

Evidence of asymmetries in price transmission has been detected in several previous studies including producer and wholesaler pork prices in Northern Germany (von Cramon-Taubadel, 1998); producer, wholesaler and retailer for several agricultural product prices across Africa, Latin Ameraica and Asia (Conforti, 2004); beef, chicken and eggs in US farm (Vavra & Goodwin, 2005); farm and retail milk prices in US (Capps & Sherwell, 2005); pork and dairy products in EU (CEC, 2009); producer and wholesale milk prices in Panama (Acosta & Valdés, 2014); and shipping and terminal prices of fresh apples, table grapes and fresh peaches within Washington and California (Ahn & Lee, 2015).

3. DATA

Monthly wholesale and retail price time series of milled rice for the period January 2000 to March 2016 in five local markets in the Philippines were obtained from the "Food and Agriculture Organization of the United Nations – Food Price Monitoring and Analysis (FAO – FPMA) Tool". The price series in Philippines pesos per kilogram (PHP/kg) were obtained for five selected local rice markets in the Philippines, including Metro Manila, Cebu, Davao, Iloilo and South Cotabato, which are indicated in Figure 1.

[Figure 1 about here]

The series were deflated to the base year 2000 using the consumer price index (CPI) for the Philippines (Index Mundi, 2016). Table 1 provides a summary of statistics of wholesale and retail rice price series for the five selected market locations, where the wholesale and retail prices reached highest levels in ‘Davao’ than other market locations with high standard deviations in both markets, wholesale and retail, implying a high price variation. In contrast, the standard deviations for both wholesale and retail market prices are smaller in ‘Metro Manila’ than other markets.

[Table 1 about here]

Figure 2 shows that wholesale and retail price series fluctuated during the period under analysis, and they reached a peak in all markets during 2008, which is related to the global financial crisis. Though Philippines is an eight largest rice producer, it is also a rice deficit country that imports around 10 percent of the rice consumption to meet its demand which makes it a single largest rice importer in the world (FAO, 2016; Philippines Ricepedia, 2016). Being the largest rice importer, global rise in rice prices transmitted to the Philippines rice market and it caused high rice prices in domestic markets. After the peak value, the price series in all rice markets started to slightly decline. Figure 2 also demonstrates that the margin between wholesale and retail markets are comparatively higher in Metro Manila and Iloilo than the other three markets – Cebu, Davao and South Cotabato. This could be due the concretized relationship between large retailers and manufacturers in Metro Manila and Iloilo where manufacturers could deliver larger amount of product to the retailers’ own centralized warehouse (Dueñas-Caparas, 2005). The setup could help the retailer to internalize the wholesaling and transportation function into its own activities which could provide more market power to the retailers.

[Figure 2 about here]

4. ECONOMETRIC METHODS

This research tests asymmetry in vertical price transmissions of milled rice, i.e. transmission of price shocks between wholesale and retail rice prices in different local markets to investigate the extent of impact of shocks at one market level (wholesale or retail) to the other market level (retail or wholesale). Before developing the appropriate empirical modeling for price transmission between price series, the characteristics of price series and the causal direction between them must be confirmed at first. Therefore, in this study the first step was to determine whether the price series have a unit root or not. The Augmented Dickey-Fuller (ADF) (1979) test is usually carried out for testing the stationarity characteristics of price series data (Dickey & Fuller 1979; Frey & Manera 2005; Hill et al., 2012; Greb et al., 2012).

The reliability of unit root test is highly dependent on the inclusion of the intercept and time trend in the model equation. So, these terms are considered in the equation only if they appear significant in value. Sometimes ADF tests cannot capture the trend in time series data, therefore the Elliott, Rothenberg and Stock (ERS) (1996) and Ng-Perron (2001) tests were also performed to confirm the stationarity of time series price data. Rapach and Weber (2004) stated that ERS (1996) and Ng-Perron (2001) tests are more reliable because of its detrending data and size adjusted properties (Morales et al., 2017).

The tests found the price series do not contain unit root, so they are not conintegrated. The bivariate VAR model in matrix form, presented in equation (1), was used to determine the optimal lag orders and Granger Causality to assess the possible direction of the price transmission (Brooks 2014, p. 333; Ahn & Lee, 2015):

$$(1) \qquad \begin{bmatrix} P_{w,t} \\ P_{r,t} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \sum_{k=1}^{n} \begin{bmatrix} \beta_{11}(k) & \beta_{12}(k) \\ \beta_{21}(k) & \beta_{22}(k) \end{bmatrix} \begin{bmatrix} P_{w,t-k} \\ P_{r,t-k} \end{bmatrix} + \begin{bmatrix} \varepsilon_1(k) \\ \varepsilon_2(k) \end{bmatrix}$$

where $P_{w,(t)}$ and $P_{r,(t)}$ are rice price series at wholesale and retail levels, respectively, β_{ij} is the coefficient at kth lag and $\varepsilon_i(k)$ is a white noise residual with mean zero, $k = 1,2 \cdots n$, and 'n' is the optimal lags determined from equation (1). The optimal lag order is selected based on the Schwartz Bayesian Information Criterion (SBIC), minimum value criteria. *Granger causality* tests are performed based on the expressed individual equations from equation (1), i.e. $P_{w,t} = \alpha_1 + \sum_{k=1}^{n} \beta_{11}(k)\, P_{w,t-k} + \sum_{k=1}^{n} \beta_{12}(k)\, P_{r,t-k} + \varepsilon_1(k)$ *and* $P_{r,t} = \alpha_2 + \sum_{k=1}^{n} \beta_{21}(k)\, P_{w,t-k} + \sum_{k=1}^{n} \beta_{22}(k)\, P_{r,t-k} + \varepsilon_2(k)$, where the lags are specified using the findings on optimal lags. Therefore, to determine the causal direction between variables, all cross-lag coefficients or coefficient matrix, $M = \begin{bmatrix} \beta_{11}(k) & \beta_{12}(k) \\ \beta_{21}(k) & \beta_{22}(k) \end{bmatrix}$ where $k = 1,2 \cdots n$, can be tested by Wald Statistics. From this Granger causality tests, we can get four possible causal results between two price series $P_{w,t}$ and $P_{r,t}$: i) $P_{w,t}$ causes $P_{r,t}$ but $P_{r,t}$ does not cause $P_{w,t}$; ii) $P_{w,t}$ does not cause $P_{r,t}$ but $P_{r,t}$ causes $P_{w,t}$; iii) $P_{w,t}$ causes $P_{r,t}$ and $P_{r,t}$ also causes $P_{w,t}$; and iv) $P_{w,t}$ does not cause $P_{r,t}$ and $P_{r,t}$ also does not cause $P_{w,t}$.

In this research the rice price series $P_{w,t}$ and $P_{r,t}$ are used for estimating asymmetries in vertical price transmission between wholesale and retail levels in rice chains. The price transmission analyses were conducted separately on five different local markets across the

Philippines. As the unit root tests identified the $P_{r,t}$ and $P_{w,t}$ are stationary, i.e. *I(0)*, in all five markets, the Autoregressive Distributed Lag (ARDL) model with an *n* lag length determined by Lag Oder Choice based on SIC criteria, is applied for testing asymmetries in price transmission between these price series. For model specification, we considered $P_{r,t}$ depends on its own monthly lagged price and the current and monthly lagged of $P_{w,t}$, where the price series, $P_{r,t}$ and $P_{w,t}$, are *I(0)*, and the ARDL model can be represented as:

$$(2) \qquad P_{r,t} = \alpha + \sum_{i=1}^{n} \beta_i^+ P_{r,t-i}^+ + \sum_{i=1}^{n} \beta_i^- P_{r,t-i}^- + \sum_{i=0}^{n} \gamma_i^+ P_{w,t-i}^+ + \sum_{i=0}^{n} \gamma_i^- P_{w,t-i}^- + e_t$$

where $P_{r,t} = \begin{cases} P_{r,t}^+ & if\ \Delta P_{r,t-1} \geq 0 \\ P_{r,t}^- & Otherwise \end{cases}$, $P_{w,t} = \begin{cases} P_{w,t}^+ & if\ \Delta P_{w,t-1} \geq 0 \\ P_{w,t}^- & Otherwise \end{cases}$.

The tests of asymmetric price transmission are based on the parameter estimates, $\beta_i^+, \beta_i^-, \gamma_i^+, and\ \gamma_i^-$ in equation (2). For example, the hypothesis $H_0: \gamma_0^+ = \gamma_0^-$ provides an immediate test of asymmetry between contemporaneous prices, $P_{r,t}$ and $P_{w,t}$. If these coefficients are significantly different from each other, contemporaneous asymmetry exists. Estimating the effects of $P_{r,t}$ and $P_{w,t}$ is simple at the current period because of only one explanatory variable, $P_{w,t}$ exists. However, the period moves into the future, the effects of $P_{w,t}$ becomes less clear because the term $P_{w,t}$ entered as lagged terms in equation (2) at the future period which can influences the future $P_{r,t}$ directly as a lagged wholesale prices as well as indirectly through lagged retail prices. Thus, for the comprehensive analysis of price transmission, the dynamic multiplier approach requires which captures both the direct effects of $P_{w,t}$ and indirect effects that are realized through lagged retail prices over the multiple periods (Ahn & Lee, 2015). So, tracing all these effects, if

$\sum_{i=0}^{n}\gamma_i^{+}$ *and* $\sum_{i=0}^{n}\gamma_i^{-}$ are significantly different, asymmetry exists between two price series in long run.

In addition to usual test of asymmetry, the present study extends the test of asymmetry to dynamic multiplier effects by performing Impulse Response Functions (IRFs) to construct the dynamic relationships between wholesale and retail prices over the multiple periods in five local markets. The pattern of dynamic multiplier effects for each successive period gives insight about how the retail price adjusts in response to the initial shock in the wholesale price. Therefore, the comprehensive effect of initial shock can be obtained by summing up the dynamic multiplier effect at each period. These complete effects on retail price under the *nth* lag order can be expressed algebraically. For instance, the positive shock of wholesale price ($P_{w,t}$) under the *n*th lag order can be expressed as:

(3a) $$\hat{P}_{r,t} = (\gamma_0^{+}P_{w,t}),$$

(3b) $$\hat{P}_{r,t+1} = (\gamma_1^{+}P_{w,t}) + (\beta_1\hat{P}_{r,t}),$$

(3c) $$\hat{P}_{r,t+2} = (\gamma_2^{+}P_{w,t}) + (\beta_2\hat{P}_{r,t} + \beta_1\hat{P}_{r,t+1}),$$

$$\cdots\cdots \quad \cdots\cdots \quad \cdots\cdots \quad \cdots\cdots \quad \cdots\cdots,$$

(3d) $$\hat{P}_{r,t+n} = (\gamma_n^{+}P_{w,t}) + (\beta_n\hat{P}_{r,t} + \beta_{n-1}\hat{P}_{r,t+1} + \cdots + \beta_1\hat{P}_{r,t+n-1}).$$

The structural vector autoregressive (SVAR) model represented in equation (4) is also applied in this study to test the contemporaneous relationships between these price series in markets, where bi-directional causality found:

(4) $$AP_t = \gamma + BP_{t-1} + e_t$$

where, P_t is a vector of prices at time t, P_{t-1} is first month lag term of prices, A and B are 2×2 square matrices, and $\gamma\ and\ e_t$ are 2×1 column vector matrices.

The price transmission between the contemporaneous prices is estimated by imposing short-run restriction on the SVAR model equation (4) by creating matrix 'A' as lower-case matrix and matrix 'B' as diagonal matrix, i.e. $A = \begin{pmatrix} 1 & 0 \\ \alpha_{21} & 1 \end{pmatrix}$, $B = \begin{pmatrix} \beta_{11} & 0 \\ 0 & \beta_{22} \end{pmatrix}$. If the coefficients of contemporaneous price series (lower case in matrix A) are found significant, contemporaneous effects are existed in price transmission between price series. If the diagonal coefficients in matrix B are found significant, we can say that its lag term is significant in price transmission.

5. RESULTS AND DISCUSSIONS

Unit-Root Tests

The results of the unit root tests reported in Table 2, indicate that for the wholesale price ($P_{w,t}$) and retail price ($P_{r,t}$) there is sufficient evidence to reject the null hypothesis of unit roots, i.e. non-stationarity. The ADF (1979) tests show the sign of stationary for wholesale prices in markets – Cebu, Davao, Iloilo and South Cotabato, and for retail prices in markets – Cebu, Davao and South Cotabato. In contrast, the ADF (1979) test results indicate that both wholesale and retail prices in Metro Manila and retail price in Iloilo are non-stationary. Furthermore, the stronger unit root tests such as ERS (1996) and Ng-Perron (2001) tests result show the evidence of stationarity for wholesale and retail price series in all local markets. Therefore, the wholesale and retail price series in all local markets are stationary, i.e. integrated order zero *I(0)*. This is a similar outcome to those reported by

Ahn and Lee (2015). So, this study used the price series data at level for the model specification to estimate price transmission. But these unit root test results contrast with those reported by von Cramon-Taubadel (1998), Conforti (2004), Vavra and Goodwin (2005), Capps and Sherwell (2005), and Acosta and Valdés (2013), who identified unit roots in price series of agro-food products, and their first differences were stationary. Consequently, they used price series in first differences for estimating price transmission.

[Table 2 about here]

Lag Order Choice and Causality Tests

The test results of optimum lag order choice presented in Table 3, were based on the VAR model equation (1) and the optimum lag orders were selected using the Schwartz Information Criteria (SIC) – minimum value criteria.

[Table 3 about here]

The optimum lag orders were found one lag order for Cebu and Iloilo, and two lag orders for the Metro Manila, Davao and South Cotabato which are used for Granger Causality tests between $P_{r,t}$ and $P_{w,t}$ in all local markets. The price transmission models include two lags, as it is the length that is recommended in most of locations. The Granger Causality tests results shown in Table 4 confirmed the presence of causality between wholesale and retail prices in all five markets. In market locations – Metro Manila, Cebu and Iloilo, the results showed wholesale rice price granger causes retail rice price at the 1% level, but retail rice price do not granger cause wholesale rice price, i.e. there is uni-directional granger causality in these markets. This observed causality direction is comparable to that identified by Ahn and Lee (2015), i.e. the upstream prices Granger-cause downstream prices. The results also indicated that the retail price granger cause wholesale price at the 1% and 5% level in Davao and South Cotabato, respectively. Therefore, there is bi-directional causality between wholesale and retail prices in these markets. The Granger-causalities identified in this study are significant which are different from those reported by Conforti (2004), who found inconclusive Granger-causality within domestic markets in several agricultural products such as for pork meat in Costa Rica, wheat and bovine meat in Egypt, maize in Ethiopia, sorghum, palm oil and cassava in Ghana, and rice in Turkey.

[Table 4 about here]

Estimation Results of Price Transmission

We specified an ARDL model equation to assess the asymmetric relationship between the wholesale and retail price series in the five local markets. The results of the Granger causality test indicate that in the setting of ARDL, the current retail price series ($P_{r,t}$) is dependent variable and should be on the left-hand side. The estimation results of ARDL tests presented in Table 5, indicate that the current wholesale price ($P_{w,t}$) and one-month lagged retail price ($P_{r,t-1}$) have positive effects on the $P_{r,t}$, and their impact is significant at the 1% level in all local markets. This implies that changes in $P_{w,t}$ and $P_{r,t-1}$ caused changes in $P_{r,t}$ in same direction. In contrast, the one- month lagged wholesale price ($P_{w,t-1}$) has negative effect on the $P_{r,t}$, and the impact was also significant at the 1% level in locations – Metro Manila, Cebu and Davao, and significant at the 5% level in South Cotabato. This result suggests the $P_{r,t}$ changes in opposite direction with $P_{w,t-1}$ which implies that when wholesale price increase (decrease) caused the retail price decrease (increase) after one month. The ARDL outputs also suggests that the two-month lagged retail price ($P_{r,t-2}$) do not have significant impact on $P_{r,t}$ in all local markets implying that when shock comes on current retail price, it does not make any changes on retail price after two-months. But the two-month lagged wholesale price ($P_{w,t-2}$) has significant positive effect on $P_{r,t}$ in the markets Cebu and Davao at the 5% level, which means that the retail price increase (decrease) after two-months of wholesale price increase (decrease).

[Table 5 about here]

The vertical price transmission estimation results demonstrate that there is evidence of *asymmetry* in price transmission between wholesale and retail prices in the short and long run at 5% significance level in the markets, Metro Manila and Davao. This outcome indicates that rice price shocks at wholesale level do not fully transmit to the retail level in the short and long run. In contrast, the results corroborate that there is *symmetry* in price transmission between wholesale and retail prices in Iloilo and South Cotabato in the short and long run at 5% significance level. In Cebu, the estimated results demonstrate that there is *asymmetric price transmission* in the short run between wholesale and retail prices, but it is *symmetric* in the long run at 5% significance level. The vertical price transmission results in the rice markets of Cebu, Iloilo and South Cotabato in the Philippines are different than the results obtained in previous studies where asymmetry in price transmission was found in number of agro-food products along supply chains, including von Cramon-Taubadel (1998) for pork prices in northern Germany, Vavra and Goodwin (2005) for U.S. beef, chicken and egg markets, Acosta and Valdés (2014) for milk prices in Panama, Ahn and Lee (2015) for fresh fruits in the Western United States.

In addition, the results of the Granger causality tests indicated that there is bi-directional causality between wholesale and retail prices in Davao and South Cotabato. Hence, we estimated the contemporaneous relationships between these price series in these two markets using the SVAR model equations (4) imposing short-run restrictions.

The SVAR estimated results showed in Table 6 indicate the lower coefficients in matrix A^{-1} are statistically significant at 1% level in both locations, Davao and South Cotabato, implying that there are contemporaneous effects between wholesale and retail prices. This could be due to a reduced concentration of market power, which could be the consequence of more competitive conditions in these markets. The results also show the diagonal coefficients in matrix B are significant in 1% level, which implies both price series depend on its own first month lagged terms in both markets.

[Table 6 about here]

Dynamic Multiplier Effects

Based on the expressions (3a) – (3d) the dynamic multiplier effects and parameter estimates presented in table 5, we derive the responses of the retail prices to positive and negative impulses on the wholesale prices. We use the absolute value of one standard deviation (S.D.) as a magnitude of initial shocks of wholesale prices to represent a typical change in monthly wholesale price. The positive and negative shocks are prescribed simply by taking positive and negative change values of these price series.

[Figure 3 about here]

Figure 3 presents the resulting dynamic multiplier effects of retail prices and the lines corresponds to the retail price responses to the positive and negative shocks, equivalent to one S.D., in wholesale price. IRFs presented in figure 3 shows responses of retail prices in all five markets seems similar in terms of magnitude and duration in price transmission. First, IRFs demonstrate the impacts to retail price in second month due to shocks in wholesale price in all five markets; the dynamic multiplier effect and the duration of the full adjustment are long in all markets. Second, the response and the price transmission effect tend to be most intense after several months and its tend to be tamper with time. Third, the dynamic multiplier effect to retail price becomes strong in second and third months due to negative and positive changes on wholesale price respectively in South Cotabato, and the adjustment process is faster in South Cotabato than other four markets. Fourth, the adjustment process extends over many periods till 21st month for negative change and 36th month for positive change in South Cotabato but it spreads over more than 48 months for both negative and positive changes in Metro Manila, Cebu, Davao and Iloilo.

6. CONCLUSION

This study examines the asymmetry of price transmission between wholesale and retail monthly rice prices in five different markets in Philippines, Metro Manila, Cebu, Davao, Iloilo and South Cotabato. We tested the asymmetry by applying ARDL model and outlined the speed of adjustment of retail price response over multiperiod to a change in wholesale price that is differentiated by the direction of the change. This study also derived the dynamic multiplier effects of the retail price in response to the change in wholesale price based on IRFs.

The empirical results demonstrated asymmetry in price transmission between wholesale and retail prices in Metro Manila and Davao in long run, but the symmetric price transmission was found in Cebu, Iloilo and South Cotabato in long run. The price adjustment process was faster in South Cotabato than other markets, which took twenty-one months for full adjustment. But the IRFs showed the response for retail prices in Metro Manila, Cebu, Davao and Iloilo gradually tampered with time and it takes more than forty-eight months for full adjustment. Using monthly data enables us to find that the retail price response initiates almost immediately or at most one month later after the shock and that the full price adjustments tend to last a considerable time, more than forty-eight months except South Cotabato.

In this regard of price transmission, this study suggests that the different rice markets have distinct competitiveness in Philippines, and the policy makers require to pay close attention in designing mechanisms other than traditional transfer approaches from wholesale to retail level to increase the competitiveness in the rice markets in the supply chain. Therefore, it can reduce the food expenses to the all Filipinos and help to decrease a substantial number of poor peoples across the Philippines.

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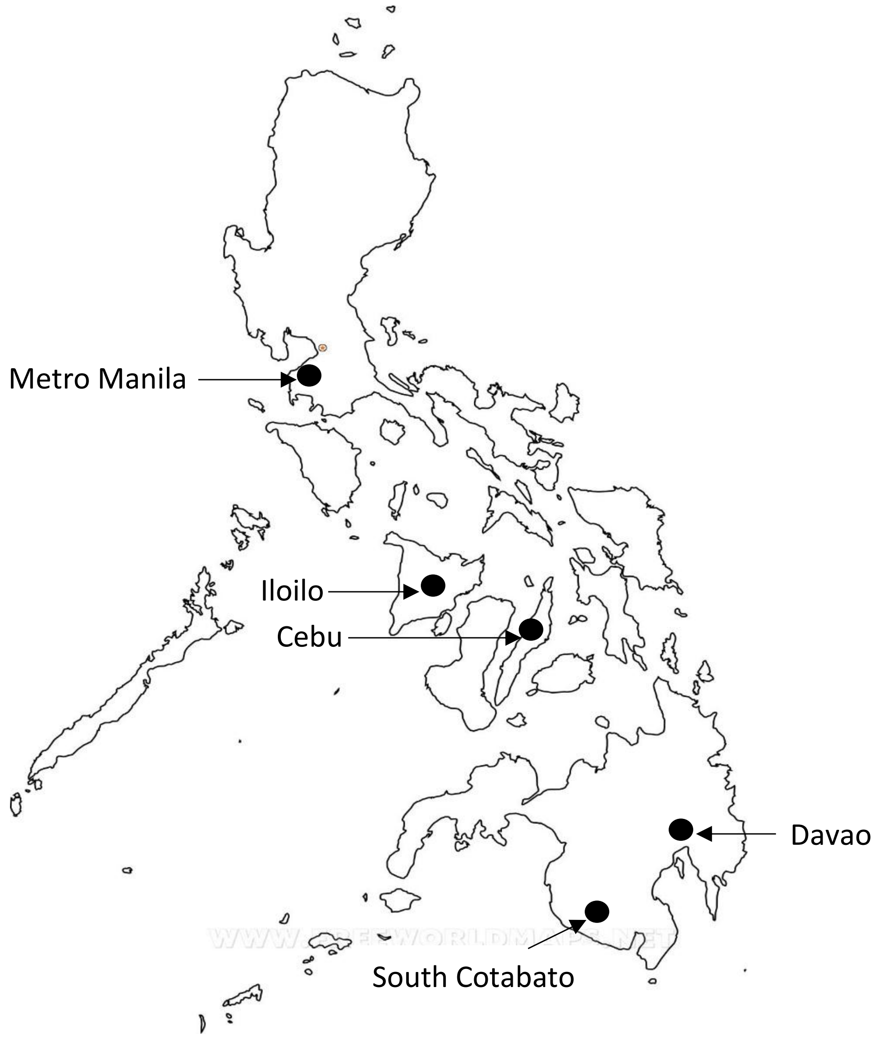

FIGURE 1 Locations of selected rice markets in Philippines

Source: Google

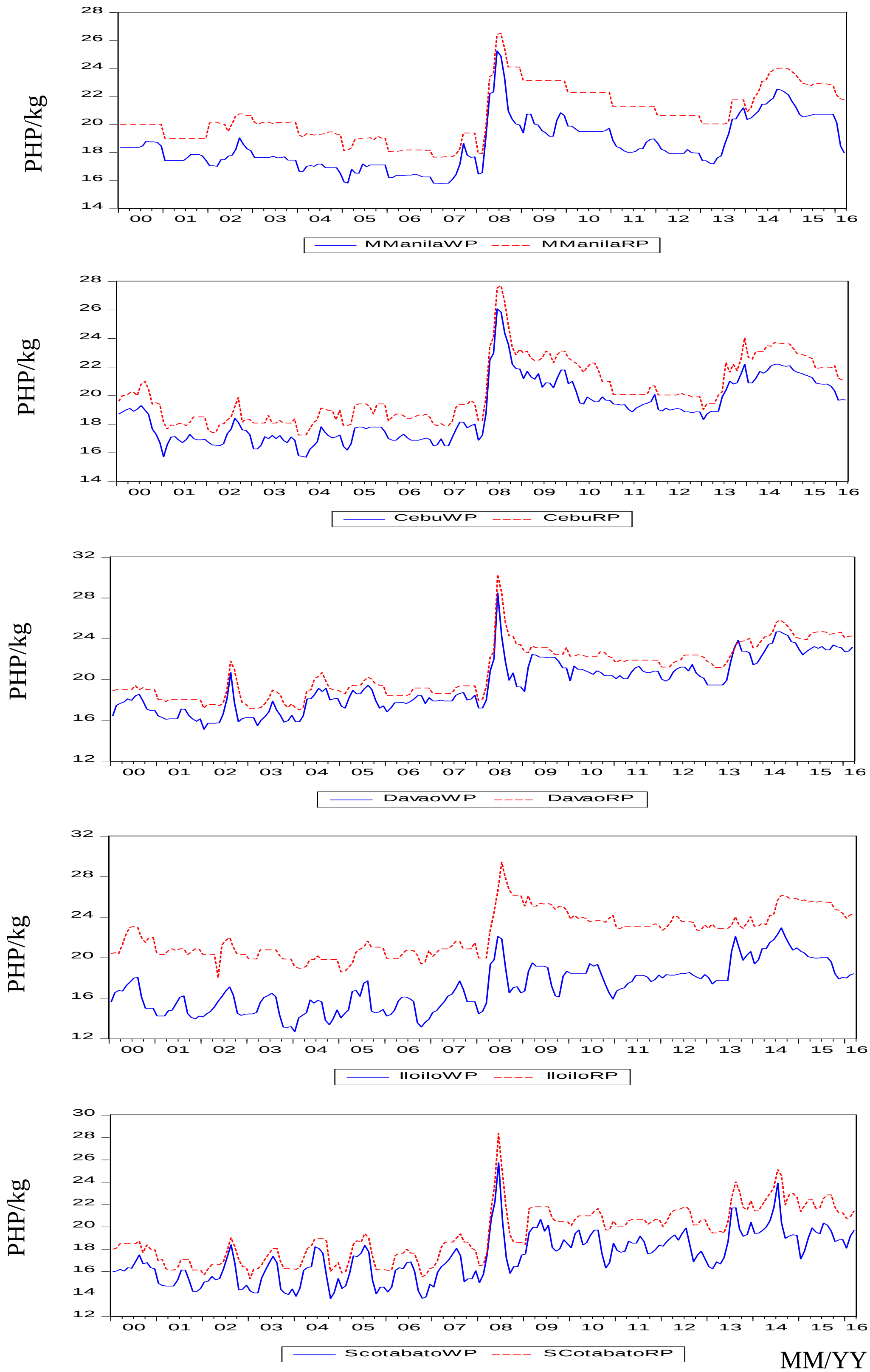

FIGURE 2 Wholesale (WP) and Retail (RP) monthly prices of milled rice in local markets in the Philippines, measured 'months' in X-axis and 'price (PHP/kg)' in Y-axis.
Source: FAO – FPMA

TABLE 1. Descriptive statistics of wholesale/retail prices from January 2000 to March 2016 – Philippine pesos per kilogram (PHP/kg) in base year 2000.

Wholesale prices (WP) – (PHP/kg)

Location	Mean	Median	SD	Min.	Max.
Metro Manila	18.52	18.05	1.80	15.78	25.25
Cebu	18.90	18.86	2.06	15.68	26.08
Davao	19.49	19.28	2.53	15.11	28.50
Iloilo	17.04	16.85	2.28	12.69	22.95
South Cotabato	17.30	17.33	2.13	13.58	25.75

Retail prices (RP) – (PHP/kg)

Location	Mean	Median	SD.	Min.	Max.
Metro Manila	20.70	20.14	1.90	17.65	26.51
Cebu	20.27	19.93	2.12	17.24	27.71
Davao	20.87	21.02	2.57	17.02	30.29
Iloilo	22.38	22.70	2.20	18.02	29.43
South Cotabato	19.30	19.01	2.39	15.36	28.37

Source: FAO – FMPA

TABLE 2 Unit root test results of wholesale and retail rice prices in the Philippines

Variable	t-statistics		
	ADF	ERS	Ng–Perron (MZt)
Metro Manila:			
Wholesale	– 1.79	– 3.07***	– 3.07***
Retail	– 2.34	– 2.21**	– 2.22**
Cebu:			
Wholesale	– 3.43*	– 2.85*	– 2.84*
Retail	– 3.30*	– 2.98**	– 2.95**
Davao:			
Wholesale	– 5.42***	– 4.74***	– 4.25***
Retail	– 4.60***	– 4.11***	– 4.02***
Iloilo:			
Wholesale	– 5.71***	– 5.11***	– 4.94***
Retail	– 2.96	– 2.93*	– 2.81*
South Cotabato:			
Wholesale	– 7.14***	– 6.72***	– 6.40***
Retail	– 6.45***	– 1.75	– 1.48

Null Hypothesis H_0: Series has unit root → Non-Stationary.

ADF = Augmented Dickey-Fuller (1979); ERS = Elliott, Rothenberg, and Stock (1996); and Ng-Perron = Ng and Perron (2001).

(***), (**) and (*) indicate statistical significant at the 1%, 5% and 10% level respectively.

TABLE 3 Lag order choice based on SIC – minimum value criteria

Location	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
Metro Manila	2.1531	2.1451*	2.2307	2.2848	2.3626
Cebu	2.5320*	2.5369	2.6308	2.7305	2.8191
Davao	3.7643	3.7326*	3.8265	3.8968	3.9968
Iloilo	4.1945*	4.2034	4.2744	4.3262	4.3813
South Cotabato	4.1827	4.1636*	4.2684	4.3597	4.3525

*Minimum value that determines the optimal Lag Order Choice.

TABLE 4 VAR Granger Causality test results between wholesale and retail rice prices

Location	Causality	Chi^2 Test Statistics	d.f.	*p*-values
Metro Manila	H_0: Wholesale do not cause Retail	13.88638***	2	0.0010
	H_0: Retail do not cause Wholesale	0.936402	2	0.6261
Cebu	H_0: Wholesale do not cause Retail	29.59543***	1	0.0000
	H_0: Retail do not cause Wholesale	1.779629	1	0.1822
Davao	H_0: Wholesale do not cause Retail	24.47100***	2	0.0000
	H_0: Retail do not cause Wholesale	12.78076***	2	0.0017
Iloilo	H_0: Wholesale do not cause Retail	21.77164***	1	0.0000
	H_0: Retail do not cause Wholesale	1.091724	1	0.2961
South Cotabato	H_0: Wholesale do not cause Retail	32.37150***	2	0.0000
	H_0: Retail do not cause Wholesale	7.612101**	2	0.0222

(***), (**) and (*) indicate statistical significant at the 1%, 5% and 10% level respectively.

TABLE 5 Estimation results for testing vertical price transmission in local markets in the Philippines

		Metro Manila		Cebu		Davao		Iloilo		South Cotabato	
Regressor	Coefficient	Coeff. Est.	Std. Er.	Coeff. Est.	Std. Er.	Coeff. Est.	Std. Er.	Coeff. Est.	Std. Er.	Coeff. Est.	Std. Er.
	α	0.0107	0.2307	0.4084	0.2515	0.2842	0.2393	1.1837***	0.4338	−0.7522***	0.2772
$P^{+}_{r,t-1}$	β^{+}_{1}	0.8891***	0.0781	0.5190***	0.0790	0.9840***	0.0761	0.8776***	0.0828	0.6739***	0.0757
$P^{-}_{r,t-1}$	β^{-}_{1}	0.8891***	0.0790	0.5178***	0.0803	0.9854***	0.0769	0.8865***	0.0852	0.6796***	0.0770
$P^{+}_{r,t-2}$	β^{+}_{2}	−0.0507	0.0729	0.1362*	0.0836	−0.2131***	0.0750	−0.0728	0.0812	−0.0648	0.0657
$P^{-}_{r,t-2}$	β^{-}_{2}	−0.0502	0.0732	0.1395*	0.0837	−0.2121***	0.0746	−0.0664	0.0812	−0.0640	0.0653
$P^{+}_{w,t}$	γ^{+}_{0}	0.7759***	0.0444	0.8790***	0.0548	0.8242***	0.0381	0.3912***	0.0604	0.7136***	0.0404
$P^{-}_{w,t}$	γ^{-}_{0}	0.7833***	0.0459	0.8860***	0.0569	0.8386***	0.0402	0.3926***	0.0643	0.7204***	0.0442
$P^{+}_{w,t-1}$	γ^{+}_{1}	−0.6116***	0.0943	−0.2921***	0.1097	−0.6456***	0.0869	−0.1116	0.0963	−0.2026**	0.0797
$P^{-}_{w,t-1}$	γ^{-}_{1}	−0.6089***	0.0956	−0.2911***	0.1111	−0.6482***	0.0885	−0.1015	0.0986	−0.1989**	0.0815
$P^{+}_{w,t-2}$	γ^{+}_{2}	0.0111	0.0729	−0.2420**	0.0941	0.0460***	0.0722	−0.1041	0.0710	−0.0402	0.0646
$P^{-}_{w,t-2}$	γ^{-}_{2}	0.0142	0.0731	−0.2449**	0.0945	0.0475***	0.0728	−0.1012	0.0708	−0.0336	0.0651
Null Hypothesis		F- Stat. (df)	Pr(|F| > c)	F- Stat. (df)	Pr(|F| > c)	F- Stat. (df)	Pr(|F| > c)	F- Stat. (df)	Pr(|F| > c)	F- Stat. (df)	Pr(|F| > c)
$\gamma^{+}_{0} = \gamma^{-}_{0}$		6.5906	0.0111	4.3969	0.0374	16.2504	0.0001	0.0492	0.8246	1.6217	0.2045
$\sum_{i=0}^{n} \gamma^{+}_{i} = \sum_{i=0}^{n} \gamma^{-}_{i}$		12.4591	0.0005	0.9018	0.3436	4.8975	0.0281	2.0945	0.1496	3.1117	0.0794
		(1, 181)		(1, 181)		(1, 181)		(1, 181)		(1, 181)	

(***), (**) and (*) indicate statistical significant at the 1%, 5% and 10% level respectively.

Table 6. Coefficients Cholesky decomposition imposing short-run restrictions

		Coefficients Matrix A^{-1}		Coefficients Matrix B	
		Retail	Wholesale	Retail	Wholesale
Davao	Retail	1.0000	0.0000	0.7467***	0.0000
	Wholesale	0.9989***	1.0000	0.0000	0.4469***
South Cotabato	Retail	1.0000	0.0000	0.8017***	0.0000
	Wholesale	1.0835***	1.0000	0.0000	0.5179***

(***), (**) and (*) indicate statistical significant at the 1%, 5% and 10% level respectively.

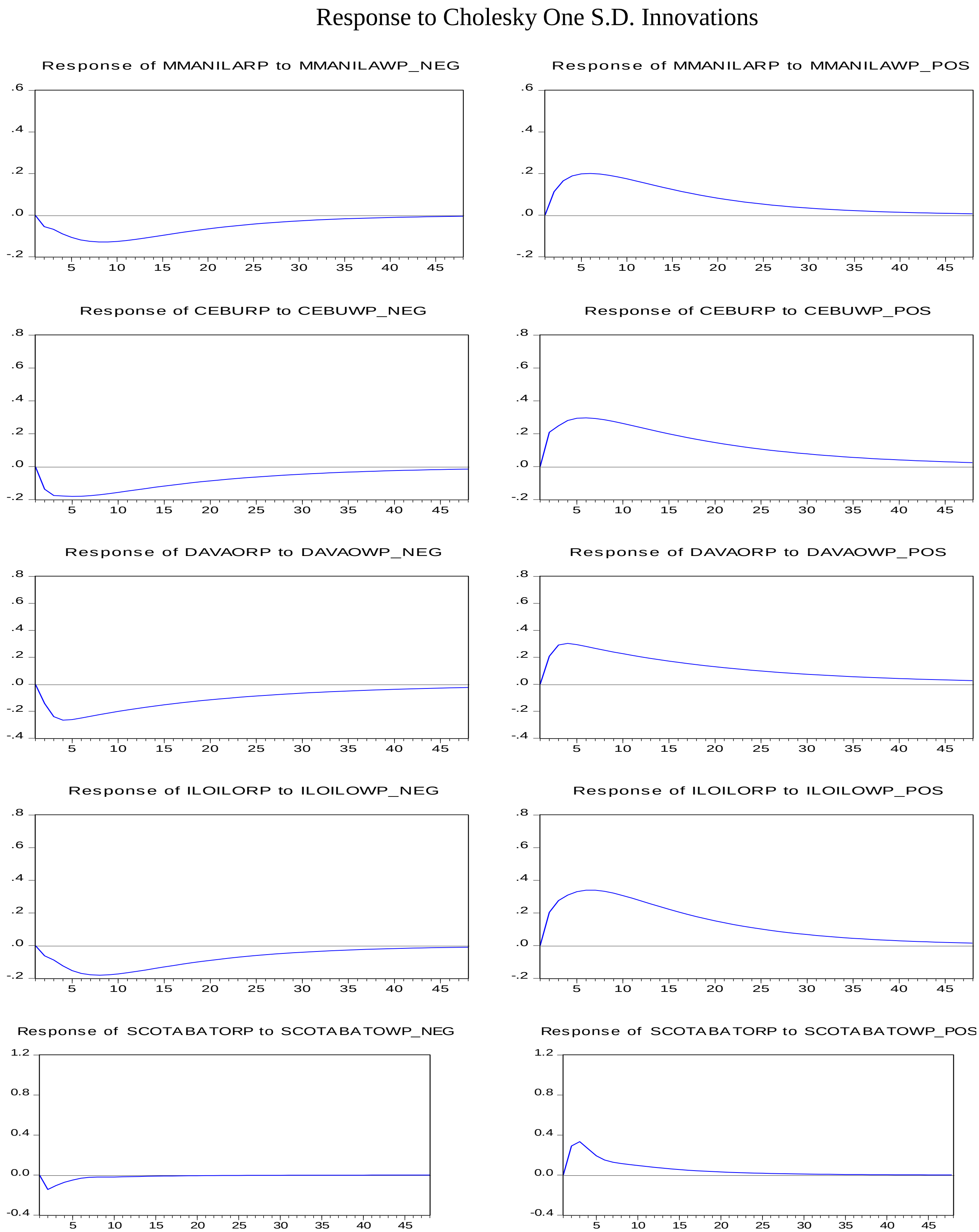

Figure 3 Responses of Retail Price to Positive and Negative Shocks in Wholesale Price by One Standard Deviation; measured 'month' in X-axis and 'price (PHP/kg)' in Y-axis.
Source: FAO – FPMA