

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search http://ageconsearch.umn.edu aesearch@umn.edu

Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.

1	Rice Price Transmission between Wholesalers and Retailers in the
2	Philippines: Are Prices Integrated in Local Markets?
3 4	Bijay Chaudhary ¹ , L. Emilio Morales ¹ and Renato Villano ¹
5	¹ UNE Business School, University of New England, Australia.
6 7	ABSTRACT

8 Increasing attention has been given to raising commodity prices due to its negative effects 9 on poverty and undernutrition. An example of this problem are the growing rice prices in 10 Philippines, which are causing high living expenses to the population across the country. 11 To assess the competitiveness of agro-food chains, price transmission has been used as an 12 indicator of market integration. Using monthly data for the period 2000 to 2016, this study 13 tests vertical price transmission between wholesale and retail prices and dynamic 14 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 15 16 distributed lag (ARDL) model confirms that asymmetry in rice price transmission between 17 wholesale and retail levels in Metro Manila and Davao. In addition, the ARDL model also 18 confirms retail rice prices in all markets studied in Philippines depend on previous retail 19 prices, contemporaneous wholesale prices and wholesale prices lagged one and two 20 periods, depending on the location. Impulse Response Functions (IRFs) show the retail 21 price response initiates almost immediately or at most one month later after shock, i.e. 22 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].

25 1. INTRODUCTION

26 Rice price in Philippines is higher in comparison with other major rice producing Asian 27 countries such as Vietnam, Thailand and China. The largest sources of higher rice price in 28 the Philippines are the costs for transportation, milling, packaging, working capital and 29 import restriction (The Philippine Rice Research Institute (PhiRice), 2016). The PhiRice 30 (2016) also said that the gross marketing margin (GMM) is higher at the different stages 31 of rice supply chain in Philippines, and it is due to the high costs of marketing and the 32 enormous returns to trade management. The rice prices in Philippines have fluctuated 33 dramatically in the last decade, with consumers facing increasingly high prices that reached 34 exceptional levels before falling during the financial crisis over the second half of 2007 35 and first half of the 2008 (FAO, 2016). According to FAO (2011), Zorya, Townsend and 36 Delgado (2012) and Morales (2018), imperfections in price transmission are factors that 37 have contributed to exacerbate price fluctuations of food commodities due to the lack of 38 incentives transmitted to chain actors for markets adjust to shocks in supply and demand. 39 The degree of market integration in agro-food chains is affected by variations in magnitude, 40 delays and asymmetries in price transmission between positive and negative price shocks 41 (Bunte, 2006; Aramyan and Kuiper, 2009; Swinnen and Vandeplas, 2014). In this context, 42 market prices could be imperfect signals sent to actors, which could allocate suboptimal 43 resources to production. Under this scenario, the quantity and quality of products offered 44 in the market could be affected, with negative consequences for consumers and actors 45 across the chain (Norwood and Lusk, 2008).

46 According to Rapsomanikis and Mugera (2011), imperfections in price transmission are considered as evidence of market failure and require policy interventions to control the 47 48 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 49 50 normal profit margins, but when producers/wholesalers decrease prices, the retailers keep 51 constant their prices or takes time to reduce prices to capture higher profit margins 52 (Schroeder, 1988; Vavra & Goodwin, 2005). Swinnen and Vandeplas (2014) argued that 53 consumers in developing countries are hurt by increasing food prices, while producers are 54 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 55 (APT) possibly results on consumers not benefitting from price reductions at the producers' 56 57 level, and producers might not benefit from price increases at the retail level. The 58 asymmetric price transmission, in terms of magnitude and time delay in price adjustment 59 mechanism, raised serious concerns in Philippines about market integration between wholesale and retail markets. Very few studies have been conducted on price transmission 60 in the Philippines rice markets, and most of them were done before the global economic 61 62 crisis in 2007-2008. Therefore, to our knowledge, this is the first study that investigates the 63 dynamics of price adjustment and vertical price transmission between wholesale and retail 64 prices of milled rice in local markets in Philippines. In this paper, we examine the causal 65 relationships and empirically observe asymmetries in price transmission between wholesale and retail prices, and the dynamics of price adjustment in milled rice prices in 66 67 rice markets in Philippines.

68 Market imperfections in agro-food markets are more prevalent in developing countries compared to developed countries (Morales, 2018). Imperfections in price transmission are 69 70 due to several factors such as market power, processing and marketing costs, costs of 71 transportation, government intervention, and product homogeneity and differentiation, in 72 addition to market failure (Meyer and von Cramon-Taubadel, 2004). Frey and Manera 73 (2005) stated that the main cause of imperfect transmission from wholesale to retail is that 74 retailers allegedly try to maintain their "normal" profit margin by increasing retail prices 75 when wholesale prices rise, but they try to capture the larger margins keeping constant the 76 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 77 affecting rice markets. 78

79 Rice is the most consumed food across the Philippines, with a share of the total food 80 consumption per person very high and increasing from 68.56% in 1999-2000 to 78.99% in 81 2008-2009 (Philrice, 2016). Growing rice prices in the Philippines represent high living 82 expenses to the population across the country and more adverse effects on poverty, because 83 the share of rice in total food consumption is high for poor peoples in Philippines which 84 increases the expenditure for food consumption (Philrice, 2016). The historical data on rice 85 consumption rate shows that it tends to increase over time, though the rice price rise, 86 causing the rice consumption rate is inelastic to its price in the Philippines (Philrice, 2016 87 & FAO, 2016). The degree to which price shocks at one level of the rice chain are 88 transmitted to other levels in local markets is often taken to be an important indicator of 89 market power in supply chain. The high food prices to consumers and large marketing 90 margins to traders at certain stages in supply chain, therefore the unbalanced marketing 91 margins among traders are most important issues facing policy makers. Thus, deeper 92 understanding about magnitude, speed and asymmetry to which wholesale prices are being 93 transmitted to retailer prices is a key factor in designing appropriate policy measures to 94 reduce the level of living expenses to individuals. Thus, the imperfections in rice markets 95 could have serious economic impacts to households in the Philippines. Policy initiatives in 96 this country indicate that market reform in rice market can lead to a reduction in the number 97 of poor people in the country as it helps to reduce the food expenses for individuals 98 (Cororaton, 2004), and to achieve such kind of benefits perfect price relationships between 99 various market levels in rice supply chain in markets is an essential condition.

100 Previous studies on rice markets in the Philippines such as Reyes et al. (2009) analyzed 101 the impact of changes in rice prices on poverty; Pede et al. (2013) investigated dynamics 102 on rice prices, i.e. monthly rice prices changes over the period of January 1990 to December 103 2012 in 16 regions in Philippines at three market levels: farmgate, wholesale and retail; 104 Jolejole-Foreman and Mallory (2011) analyzed the movement of Philippine rice price 105 margins between farmgate and retail affected by government intervention measures; and 106 Ramos, E. V. empirically tested the presence of seasonality in palay and rice price series 107 from 1972 to 2008 and the speed of price transmission between farm, wholesale and retail 108 levels on local markets in Philippines: Nueva Ecija, Illoilo and North Cotabato. But these 109 above-mentioned studies did not conduct empirical test on asymmetries in price 110 transmission between chain levels in local rice markets in the Philippines. Consequently, 111 this study aims to explore whether there are price transmission imperfections in the 112 Philippines rice markets and report its results and welfare implications to policy makers. 113 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.

122 2. VERTICAL PRICE TRANSMISSION IN AGRO–FOOD CHAINS

123 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 124 in previous studies, including von Cramon-Taubadel (1997), Conforti (2004), Varga 125 126 (2007) Acosta and Valdes (2014), and Ahn and Lee (2015), to analyze the direction, 127 magnitude and speed with which price changes are transmitted along the various stages of 128 the agro-food chain. The price variations may reveal different kinds of asymmetries in 129 intensity and nature depending upon the direction of price transmission in supply chain. 130 Research and Consulting in Economics (Areté) (2012) argued that in agro-food supply 131 chains, the increase in input prices are more rapidly (and often fully) transmitted to 132 downstream along supply chain, but the reduction in input prices do not transmit or may 133 take more time to be transmitted to the final market levels. The assessment of magnitude 134 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 foodprocessing and distribution.

137 Vavra and Goodwin (2005), Commission of the European Communities (CEC) (2009) 138 and Areté, (2012) stated that the assessment of vertical price transmission along the supply 139 chain typically aims to address the issues: the magnitude, speed, and the asymmetry of 140 price adjustment through the chain. In recent years, extensive studies have been done to 141 examine market linkages among market levels such as: farm, wholesale and retail levels; 142 and most of the literature on vertical price transmission refers to noncompetitive markets 143 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 & 144 145 Goodwin, 2005; Capps & Sherwell, 2005; Acosta & Valdes, 2013; Ahn & Lee, 2015).

146 Developing appropriate models for analyzing price transmission and testing 147 asymmetries is key to study market integration in agro-food chains. In the literature, there 148 are econometric methods for testing APT in agricultural commodities markets which are 149 still being used. In the very previous period, researchers have developed pre-cointegration 150 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 151 152 variables are split the prices into two parts: increasing and decreasing input prices. 153 Wolffram (1971) proposed another empirical model that explicitly includes first 154 differences of explanatory price series in the equation. Houck (1977) developed another 155 model for testing APT, which is like Wolffram's model, and this model does not consider 156 initial observations of price series data into account, because according to him the level of 157 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.

162 Granger and Newbold (1974) discovered that there could be spuriously significant 163 results between non-stationary and highly autocorrelated stationary time series. To avoid a 164 potential spurious regression, tests have been developed to identify non-stationarity and 165 models to account for co-integration between time series i.e. the time series variables share 166 similar stochastic trends and they never diverge too far from each other. Granger and Lee 167 (1989) proposed a modeling for estimating asymmetric price transmission between co-168 integrated variables using an error correction model (ECM). Von Cramon-Taubadel and 169 Loy (1996) suggested the empirical specification by splitting the explanatory variable into 170 positive and negative components to allow for more complex dynamic effects. According 171 to Frey and Manera (2005) some researchers also assume that the dependent variable 172 depends on its own lags and on vector of explanatory variables, both contemporaneous and 173 lagged. Thus, they applied an Autoregressive Distributed Lag (ARDL) model to incorporate 174 asymmetries in price transmission by assuming that the explanatory variables have a 175 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.

185 Evidence of asymmetries in price transmission has been detected in several previous studies including producer and wholesaler pork prices in Northern Germany (von Cramon-186 187 Taubadel, 1998); producer, wholesaler and retailer for several agricultural product prices 188 across Africa, Latin Ameraica and Asia (Conforti, 2004); beef, chicken and eggs in US 189 farm (Vavra & Goodwin, 2005); farm and retail milk prices in US (Capps & Sherwell, 190 2005); pork and dairy products in EU (CEC, 2009); producer and wholesale milk prices in 191 Panama (Acosta & Valdés, 2014); and shipping and terminal prices of fresh apples, table 192 grapes and fresh peaches within Washington and California (Ahn & Lee, 2015).

193 **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.

200 [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.

208 [Table 1 about here]

209 Figure 2 shows that wholesale and retail price series fluctuated during the period under 210 analysis, and they reached a peak in all markets during 2008, which is related to the global 211 financial crisis. Though Philippines is an eight largest rice producer, it is also a rice deficit 212 country that imports around 10 percent of the rice consumption to meet its demand which 213 makes it a single largest rice importer in the world (FAO, 2016; Philippines Ricepedia, 214 2016). Being the largest rice importer, global rise in rice prices transmitted to the 215 Philippines rice market and it caused high rice prices in domestic markets. After the peak 216 value, the price series in all rice markets started to slightly decline. Figure 2 also 217 demonstrates that the margin between wholesale and retail markets are comparatively 218 higher in Metro Manila and Iloilo than the other three markets – Cebu, Davao and South 219 Cotabato. This could be due the concretized relationship between large retailers and 220 manufacturers in Metro Manila and Iloilo where manufacturers could deliver larger amount 221 of product to the retailers' own centralized warehouse (Dueñas-Caparas, 2005). The setup 222 could help the retailer to internalize the wholesaling and transportation function into its 223 own activities which could provide more market power to the retailers.

224 [Figure 2 about here]

4. ECONOMETRIC METHODS

226 This research tests asymmetry in vertical price transmissions of milled rice, i.e. 227 transmission of price shocks between wholesale and retail rice prices in different local 228 markets to investigate the extent of impact of shocks at one market level (wholesale or 229 retail) to the other market level (retail or wholesale). Before developing the appropriate 230 empirical modeling for price transmission between price series, the characteristics of price 231 series and the causal direction between them must be confirmed at first. Therefore, in this 232 study the first step was to determine whether the price series have a unit root or not. The 233 Augmented Dickey-Fuller (ADF) (1979) test is usually carried out for testing the 234 stationarity characteristics of price series data (Dickey & Fuller 1979; Frey & Manera 235 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):

247 (1)
$$\begin{bmatrix} P_{w,t} \\ P_{r,t} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \sum_{k=1}^n \begin{bmatrix} \beta_{11}(k) & \beta_{12}(k) \\ \beta_{21}(k) & \beta_{22}(k) \end{bmatrix} \begin{bmatrix} P_{w,t-k} \\ P_{r,t-k} \end{bmatrix} + \begin{bmatrix} \varepsilon_1(k) \\ \varepsilon_2(k) \end{bmatrix}$$

where $P_{w,(t)}$ and $P_{r,(t)}$ are rice price series at wholesale and retail levels, respectively, β_{ij} 248 is the coefficient at kth lag and $\varepsilon_i(k)$ is a white noise residual with mean zero, $k = 1, 2 \cdots n$, 249 250 and 'n' is the optimal lags determined from equation (1). The optimal lag order is selected 251 based on the Schwartz Bayesian Information Criterion (SBIC), minimum value criteria. 252 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 253 $P_{r,t} = \alpha_2 + \sum_{k=1}^n \beta_{21}(k) P_{w,t-k} + \sum_{k=1}^n \beta_{22}(k) P_{r,t-k} + \varepsilon_2(k)$, where the lags 254 are 255 specified using the findings on optimal lags. Therefore, to determine the causal direction between variables, all cross-lag coefficients or coefficient matrix, $M = \begin{bmatrix} \beta_{11}(k) & \beta_{12}(k) \\ \beta_{21}(k) & \beta_{22}(k) \end{bmatrix}$ 256 where $k = 1, 2 \cdots n$, can be tested by Wald Statistics. From this Granger causality tests, we 257 can get four possible causal results between two price series $P_{w,t}$ and $P_{r,t}$: i) $P_{w,t}$ causes 258 $P_{r,t}$ 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) $P_{w,t}$ 259 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 260 cause $P_{w,t}$. 261

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:

271 (2)
$$P_{r,t} = \alpha + \sum_{i=1}^{n} \beta_i^+ P_{r,t-i}^+ + \sum_{i=1}^{n} \beta_i^- P_{r,t-i}^- + \sum_{i=0}^{n} \gamma_i^+ P_{w,t-i}^+ + \sum_{i=0}^{n} \gamma_i^- P_{w,t-i}^- + e_t$$

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

273 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 274 immediate test of asymmetry between contemporaneous prices, $P_{r,t}$ and $P_{w,t}$. If these 275 276 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 277 278 one explanatory variable, $P_{w,t}$ exists. However, the period moves into the future, the 279 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 280 prices as well as indirectly through lagged retail prices. Thus, for the comprehensive 281 282 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 283 284 prices over the multiple periods (Ahn & Lee, 2015). So, tracing all these effects, if 285 $\sum_{i=0}^{n} \gamma_i^+$ and $\sum_{i=0}^{n} \gamma_i^-$ are significantly different, asymmetry exists between two price 286 series in long run.

287 In addition to usual test of asymmetry, the present study extends the test of asymmetry 288 to dynamic multiplier effects by performing Impulse Response Functions (IRFs) to 289 construct the dynamic relationships between wholesale and retail prices over the multiple 290 periods in five local markets. The pattern of dynamic multiplier effects for each successive 291 period gives insight about how the retail price adjusts in response to the initial shock in the 292 wholesale price. Therefore, the comprehensive effect of initial shock can be obtained by 293 summing up the dynamic multiplier effect at each period. These complete effects on retail 294 price under the *nth* lag order can be expressed algebraically. For instance, the positive 295 shock of wholesale price $(P_{w,t})$ under the *n*th lag order can be expressed as:

296 (3a) $\hat{P}_{r,t} = (\gamma_0^+ P_{w,t}),$ 297 (3b) $\hat{P}_{r,t+1} = (\gamma_1^+ P_{w,t}) + (\beta_1 \hat{P}_{r,t}),$ 298 (3c) $\hat{P}_{r,t+2} = (\gamma_2^+ P_{w,t}) + (\beta_2 \hat{P}_{r,t} + \beta_1 \hat{P}_{r,t+1}),$ 299,,,,, 300 (3d) $\hat{P}_{r,t+n} = (\gamma_n^+ P_{w,t}) + (\beta_n \hat{P}_{r,t} + \beta_{n-1} \hat{P}_{r,t+1} + \dots + \beta_1 \hat{P}_{r,t+n-1}).$

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:

304 (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 γ 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.

314 5. RESULTS AND DISCUSSIONS

315 Unit-Root Tests

316 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 317 roots, i.e. non-stationarity. The ADF (1979) tests show the sign of stationary for wholesale 318 prices in markets – Cebu, Davao, Iloilo and South Cotabato, and for retail prices in markets 319 320 - Cebu, Davao and South Cotabato. In contrast, the ADF (1979) test results indicate that 321 both wholesale and retail prices in Metro Manila and retail price in Iloilo are non-322 stationary. Furthermore, the stronger unit root tests such as ERS (1996) and Ng-Perron 323 (2001) tests result show the evidence of stationarity for wholesale and retail price series in 324 all local markets. Therefore, the wholesale and retail price series in all local markets are 325 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.

332 [Table 2 about here]

333 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.

337 [Table 3 about here]

338 The optimum lag orders were found one lag order for Cebu and Iloilo, and two lag orders 339 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 340 341 lags, as it is the length that is recommended in most of locations. The Granger Causality 342 tests results shown in Table 4 confirmed the presence of causality between wholesale and 343 retail prices in all five markets. In market locations - Metro Manila, Cebu and Iloilo, the 344 results showed wholesale rice price granger causes retail rice price at the 1% level, but 345 retail rice price do not granger cause wholesale rice price, i.e. there is uni-directional 346 granger causality in these markets. This observed causality direction is comparable to that 347 identified by Ahn and Lee (2015), i.e. the upstream prices Granger-cause downstream 348 prices. The results also indicated that the retail price granger cause wholesale price at the 349 1% and 5% level in Davao and South Cotabato, respectively. Therefore, there is bi-350 directional causality between wholesale and retail prices in these markets. The Granger-351 causalities identified in this study are significant which are different from those reported 352 by Conforti (2004), who found inconclusive Granger-causality within domestic markets in 353 several agricultural products such as for pork meat in Costa Rica, wheat and bovine meat 354 in Egypt, maize in Ethiopia, sorghum, palm oil and cassava in Ghana, and rice in Turkey.

355 [Table 4 about here]

356 Estimation Results of Price Transmission

357 We specified an ARDL model equation to assess the asymmetric relationship between the 358 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 359 dependent variable and should be on the left-hand side. The estimation results of ARDL 360 tests presented in Table 5, indicate that the current wholesale price $(P_{w,t})$ and one-month 361 lagged retail price $(P_{r,t-1})$ have positive effects on the $P_{r,t}$, and their impact is significant 362 at the 1% level in all local markets. This implies that changes in $P_{w,t}$ and $P_{r,t-1}$ caused 363 changes in $P_{r,t}$ in same direction. In contrast, the one- month lagged wholesale price 364 365 $(P_{w,t-1})$ has negative effect on the $P_{r,t}$, and the impact was also significant at the 1% level 366 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 367 implies that when wholesale price increase (decrease) caused the retail price decrease 368

369 (increase) after one month. The ARDL outputs also suggests that the two-month lagged 370 retail price $(P_{r,t-2})$ do not have significant impact on $P_{r,t}$ in all local markets implying that 371 when shock comes on current retail price, it does not make any changes on retail price after 372 two-months. But the two-month lagged wholesale price $(P_{w,t-2})$ has significant positive 373 effect on $P_{r,t}$ in the markets Cebu and Davao at the 5% level, which means that the retail 374 price increase (decrease) after two-months of wholesale price increase (decrease).

375 [Table 5 about here]

376 The vertical price transmission estimation results demonstrate that there is evidence of 377 asymmetry in price transmission between wholesale and retail prices in the short and long 378 run at 5% significance level in the markets, Metro Manila and Davao. This outcome 379 indicates that rice price shocks at wholesale level do not fully transmit to the retail level in 380 the short and long run. In contrast, the results corroborate that there is *symmetry* in price 381 transmission between wholesale and retail prices in Iloilo and South Cotabato in the short 382 and long run at 5% significance level. In Cebu, the estimated results demonstrate that there 383 is asymmetric price transmission in the short run between wholesale and retail prices, but 384 it is symmetric in the long run at 5% significance level. The vertical price transmission 385 results in the rice markets of Cebu, Iloilo and South Cotabato in the Philippines are different 386 than the results obtained in previous studies where asymmetry in price transmission was 387 found in number of agro-food products along supply chains, including von Cramon-388 Taubadel (1998) for pork prices in northern Germany, Vavra and Goodwin (2005) for U.S. 389 beef, chicken and egg markets, Acosta and Valdés (2014) for milk prices in Panama, Ahn 390 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.

402 [Table 6 about here]

403 **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.

410 [Figure 3 about here]

411 Figure 3 presents the resulting dynamic multiplier effects of retail prices and the lines 412 corresponds to the retail price responses to the positive and negative shocks, equivalent to 413 one S.D., in wholesale price. IRFs presented in figure 3 shows responses of retail prices in 414 all five markets seems similar in terms of magnitude and duration in price transmission. 415 First, IRFs demonstrate the impacts to retail price in second month due to shocks in 416 wholesale price in all five markets; the dynamic multiplier effect and the duration of the 417 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. 418 419 Third, the dynamic multiplier effect to retail price becomes strong in second and third 420 months due to negative and positive changes on wholesale price respectively in South 421 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 422 change and 36th month for positive change in South Cotabato but it spreads over more than 423 424 48 months for both negative and positive changes in Metro Manila, Cebu, Davao and Iloilo.

425 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, lloilo 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.

433 The empirical results demonstrated asymmetry in price transmission between wholesale 434 and retail prices in Metro Manila and Davao in long run, but the symmetric price 435 transmission was found in Cebu, Iloilo and South Cotabato in long run. The price 436 adjustment process was faster in South Cotabato than other markets, which took twenty-437 one months for full adjustment. But the IRFs showed the response for retail prices in Metro 438 Manila, Cebu, Davao and Iloilo gradually tampered with time and it takes more than forty-439 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 440 441 the full price adjustments tend to last a considerable time, more than forty-eight months 442 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.

449

450

451

452

453

454 **REFERENCES**

- 455 Acosta, A. & Valdés, A. (2014). Vertical price transmission of milk prices: Are small dairy
- 456 producers efficiently integrated into markets? *Agribusiness*, *30*(*1*), 56–63.
- 457 Ahn, Byeong-il, & Lee, H. (2015). Vertical price transmission of perishable products: The
- 458 case of fresh fruits in the western United States. *Journal of Agricultural and Resource*
- 459 *Economics*, 40(3), 405–424.
- 460 Aramyan, L., Kuiper, M., 2009. Analyzing price transmission in agri-food chains: An
 461 overview. *Measuring Business Excellence 13(3)*, 3–12.
- 462 Areté Research & Consulting in Economics. (2012). Study on price transmission in the
- 463 sugar sector. European Commission, DG Agriculture and Rural Development,
 464 TENDER Nº AGRI 2011 EVAL 03.
- Brooks, C. (2014). Introductory econometrics for finance (4th ed.). Cambridge University
 Press.
- 467 Bunte, F., 2006. Pricing and performance in agri-food supply chains, in C.J.M Ondersteijn,
- J.H.M. Wijnands, R.B.M. Huirne, O. van Kooten (eds.), Quantifying the agri-food
 supply chain. Springer, Dordrecht, pp. 37–45.
- 470 Capps, O., & Sherwell, P. (2005, May). Spatial Asymmetry in Farm-Retail Price
 471 Transmission Associated with Fluid Milk Products. Paper presented at the annual
- 472 meeting of American Agricultural Economics Association, Rhode Island, USA.
- 473 Conforti, P. (2004). Price transmission in selected agricultural markets. FAO Commodity
- and Trade Policy Research Working Paper No.7.

- 475 Commission of the European Communities. (2009). Analysis of price transmission along
 476 the food supply chain in the EU. Brussels, 28.10.2009, Commission Staff Working
 477 Document.
- 478 Cororaton, Caesar B. (2004). Rice Reforms and Poverty in the Philippines: A CGE
 479 Analysis. ADB Institute Research Paper 57.
- 480 Department of Agriculture, Philippines Rice Research Institute (DA–Philrice) (2016).
 481 Accessed 20 October 2017 from http://www.philrice.gov.ph/.
- 482 Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive
- time series with a unit root. *Journal of the American Statistical Association*, 74(366),
 484 427–431.
- 485 Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time
 486 series with a unit root. *Econometrica*, 49(4), 1057–1072.
- 487 Dueñas-Caparas, Ma. T. (2005). State of Competition in the Wholesale and Retail Sector.
- 488 Philippine Institute for Development Studies. Discussion Paper Series No. 2005–05.
- Elliott, G., Rothenberg, T. J., & Stock, J. H. (1996). Efficient tests for an autoregressive
 unit root. *Econometrica*, 64, 813–836.
- Food and Agriculture Organization of the United Nations (FAO). (2011). The state of food
 insecurity in the world. How does international price volatility affect domestic
 economies and food security? FAO Publishing Policy and Support Branch, Rome,
 Italy. Accessed 18 January 2018 from http://www.fao.org/docrep/014/i2330e/
 i2330e.pdf.

- 496 Food and Agriculture Organization of the United Nations (FAO), (2016). Food price
 497 monitoring analysis tool (FPMA). Accessed 10 January 2017 from
 498 www.fao.org/giews/food-prices/en/.
- 499 Frey, G., & Manera, M. (2007). Econometric models of asymmetric price transmission.

500 *Journal of Economic Surveys*, 21(2), 349–415.

- Google (2016). Map of selected rice markets in Philippines. Accessed 10 December 2016
 from http://www.freeworldmaps.net/asia/philippines/philippines-outline-
- 503 Granger, C. W. J. & Newbold, P. (1974). Spurious regressions in econometrics. Journal of
- 504 *Econometrics*, 2(2), 111–120.
- 505 Granger, C. W. J., & Lee, T. H. (1989). Investigation of production, sales and inventory
- relationships using multicointegration and non-symmetric error correction models. *Journal of Applied Econometrics*, *4*, S145–S159.
- 508 Greb, F., Jamora, N., Mengel, C., von Cramon-Taubadel, S., & Wurriehausen (2012, 30
- 509 October 02 November). Cereal price transmission from international to domestic
- 510 markets in Africa. Paper prepared for the African Economic Conference, Kigali,511 Rwanda.
- 512 Hassouneh, I., Cramon-Taubadel, S. v., Serra, T., & Gil, J. M. (2012). Recent
- 513 Developments in the Econometric Analysis of Price Transmission. Working Paper No.
- 514 2, Transparency of Food Pricing TRANSFOP.
- 515 Hill, R. C., Griffths, W. E., & Lim, G. C. (2018). Principles of econometrics (5th ed.).
- 516 Wiley, Haboken, United States.
- 517 Houck, P. J. (1977). An approach to specifying and estimating non-reversible functions.
- 518 *American Journal of Agricultural Economics*, 59(3), 570–572.

- 519 Index Mundi (2016). Consumer price index, Philippines. Accessed 15 December 2017
 520 from http://www.indexmundi.com/facts/philippines/consumer-price-index.
- Joleiole-Foreman, Maria Christina and Mallory, Mind L. (2011, July). Analyzing price
 margins, government intervention and weather shocks for rice market in the
 Philippines. Paper presented at the annual meeting of Agricultural & Applied
 Economics Associations, Pittsburgh.
- Meyer, J., & von Cramon-Taubadel, S. (2004). Asymmetric price transmission: A survey. *Journal of Agricultural Economics*, *55*(*3*), 581–611.
- 527 Morales, L. E., Hoang, N., & Stuen, E. (2017). Spatial price premium transmission for
- Meat Standards Australia-graded cattle: The vulnerability of price premiums to outside
 shocks. *Australian Journal of Agricultural and Resource Economics*, *61(4)*, 590–609.
- 530 Morales, L. E. (2018). The effects of international price volatility on farmer prices and
- 531 marketing margins in cattle markets. International Food and Agribusiness
- 532 Management Review. Accessed 18 January 2018 from:
- 533 <u>http://www.wageningenacademic.com/doi/abs/10.22434/IFAMR2017.0020</u>.
- Ng, S. & Perron, P. (2001). Lag length selection and the construction of unit root tests with
 good size and power. *Econometrica*, 69(6), 1519–1554.
- Norwood, F. B., Lusk, J. L., 2008. Agricultural marketing and price analysis. Pearson,
 Prentice Hall, New Jersey.
- 538 Pede, Valerien O., Valera, Harold Glenn A., Alam, Mohammad J. and Mckenzie, Andrew
- 539 M. (2013, August). Nonlinearities in regional rice prices in the Philippines: Evidence
- 540 from a smooth transition autoregressive (STAR) approach. Paper presented at the
- 541 annual meeting of Agricultural & Applied Economics Associations, Washington DC.

542	Rapach, D. E. & Weber, C. E. (2004). Are real interest rates really nonstationary? New
543	evidence from tests with good size and power. Journal of Macroeconomics, 26(3),
544	409-430.

- 545 Rapsomanikis, G., & Mugera, H. (2011). Price transmission and volatility spillovers in
- food markets of developing countries, in Piot-Lepetit, I. and M'Barek, R. (eds.)
- 547 *Methods to Analyse Agricultural Commodity Price Volatility.* Springer, Dordrecht, pp.
- 548 165–179.
- 549 Reyes, C. M., Sobrevinas, A. B., Bancolita, J. & Jesus, J. de (2009). Analysis of the Impact
- of Changes in the Prices of Rice and Fuel on Poverty in the Philippines. Philippine

551 Institute for Development Studies, Discussion Paper Series No. 2009–07.

- 552 Schroeder, Ted C. (1988). Price linkages between wholesale and retail pork cuts.
 553 Agribusiness, 4(4), 359–369.
- 554 Swinnen, J., & Vandeplas, A. (2014). Price transmission and market power in modern
- agricultural value chains. LICOS Discussion Paper Series 347/2014. Accessed 12
- January 2017 from <u>https://feb.kuleuven.be/drc/licos/publications/dp/dp347</u>.
- The Philippines Rice Research Institute (Philrice) (2016). Why is per capita rice
 consumption increasing? Rice Science Decision Makers. Vol. 3 No. 1. ISSN 2094–
 8409.
- The Philippine Rice Research Institute (PhilRice) and The International Rice Research
 Institute (IRRI). (2016). Competitiveness of Philippine Rice in Asia.
- 562 Tweeten, L. G., & Quance, L. (1969). Positivistic measures of aggregate supply elasticities:
- some new approaches. *American Journal of Agricultural Economics*, 51(2), 342–352.

- Vavra, P., & Goodwin, B. K. (2005). Analysis of price transmission along the food chain.
- 565 OECD Food, Agriculture and Fisheries Working Papers, No. 3, OECD Publishing.
- Accessed 15 January 2017 from <u>http://www.oecd.org/Agriculture/Agricultural-</u>
 policies/40459642.Pdf.
- von Cramon-Taubadel, S. (1998). Estimating asymmetric price transmission with the error
- 569 correction representation: An application to the German pork market. *European*570 *Review of Agricultural Economics*, 25, 1–18.
- von Cramon-Taubadel, S. & Loy, J. P. (1996). Price asymmetry in the international wheat
- 572 market: Comment. *Canadian Journal of Agricultural Economics*, 44(3), 311–317.
- Ward, R. W. (1982). Asymmetry in retail, wholesale, and shipping point pricing for fresh
 vegetables. *American Journal of Agricultural Economics* 62(2), 205–212.
- Wolffram, R. (1971). Positivistic measures of aggregate supply elasticities: Some new
 approaches: Some critical notes. *American Journal of Agricultural Economics*, 53(2),
- 577 356–359.
- Zorya, S., R. Townsend and C. Delgado. 2012. Transmission of global food prices to
 domestic prices in developing countries: why it matters, how it works, and why it
- 580 should be enhanced. Working Paper 71268. World Bank, Washington, WA, USA.
- 581 Accessed 18 January 2018 from: <u>http://tinyurl.com/yb2lqtnn</u>.
- 582
- 583
- 584



- 586 FIGURE 1 Locations of selected rice markets in Philippines
- 587 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

600	2016 – Philippine	2016 – Philippine pesos per kilogram (PHP/kg) in base year 2000.							
601	Wholesale prices (WP) – (PHP/kg)								
602	Location	Mean	Median	SD	Min.	Max.			
603	Metro Manila	18.52	18.05	1.80	15.78	25.25			
604	Cebu	18.90	18.86	2.06	15.68	26.08			
605	Davao	19.49	19.28	2.53	15.11	28.50			
606	Iloilo	17.04	16.85	2.28	12.69	22.95			
607	South Cotabato	17.30	17.33	2.13	13.58	25.75			
608	Retail prices (RP)	– (PHP/kg)							
609	Location	Mean	Median	SD.	Min.	Max.			
610	Metro Manila	20.70	20.14	1.90	17.65	26.51			
611	Cebu	20.27	19.93	2.12	17.24	27.71			
612	Davao	20.87	21.02	2.57	17.02	30.29			
613	Iloilo	22.38	22.70	2.20	18.02	29.43			
614	South Cotabato	19.30	19.01	2.39	15.36	28.37			
615	Source: FAO – FMPA	L							
616									
617									
618									
619									
620									
621									
622									

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

624	Variable		t-statistics			
625		ADF	ERS	Ng-Perron (MZt)		
626	Metro Manila:					
627	Wholesale	- 1.79	- 3.07***	- 3.07***		
628	Retail	- 2.34	-2.21**	- 2.22**		
629	Cebu:					
630	Wholesale	- 3.43*	-2.85*	- 2.84*		
631	Retail	- 3.30*	-2.98**	- 2.95**		
632	Davao:					
633	Wholesale	- 5.42***	-4.74***	- 4.25***		
634	Retail	- 4.60***	-4.11***	- 4.02***		
635	Iloilo:					
636	Wholesale	- 5.71***	- 5.11***	- 4.94***		
637	Retail	- 2.96	- 2.93*	- 2.81*		
638	South Cotabato:					
639	Wholesale	- 7.14***	- 6.72***	- 6.40***		
640	Retail	- 6.45***	- 1.75	- 1.48		
641	Null Hypothesis H ₀ : Ser	ries has unit root \rightarrow Non-S	tationary.			
642	ADF = Augmented Dicl	key-Fuller (1979); ERS = E	Illiott, Rothenberg, and S	Stock (1996); and Ng-Perron = Ng		
643	and Perron (2001).					
644	(***), (**) and (*) indic	cate statistical significant at	the 1%, 5% and 10% lo	evel respectively.		
645						
646						
647						

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

Location	Lag 1 Lag 2		Lag 3	Lag 4	Lag
Metro Manila	2.1531 2.1451*		2.2307	2.2848	2.36
Cebu	2.5320*	2.6308	2.7305	2.81	
Davao	3.7643 3.7326*		3.8265	3.8968	3.99
Iloilo	4.1945*	4.2034	4.2744	4.3262	4.38
South Cotabato 4.1827 4.1636 ³		4.1636*	4.2684	4.3597	4.35
*Minimum value	e that determines the optim	nal Lag Order	Choice.		
TABLE 4	VAR Granger Causal	lity test resu	lts between whole	sale and	retail rice pr
Location	Causality		Chi ² Test Statistic	es d.f.	<i>p</i> -values
Metro Manila	H ₀ : Wholesale do not c	cause Retail	13.88638***	2	0.0010
Metro Manila	H ₀ : Wholesale do not c H ₀ : Retail do not cause	cause Retail e Wholesale	13.88638*** 0.936402	2 2	0.0010
Metro Manila Cebu	H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c	cause Retail e Wholesale cause Retail	13.88638*** 0.936402 29.59543***	2 2 1	0.0010 0.6261 0.0000
Metro Manila Cebu	H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause	cause Retail e Wholesale cause Retail e Wholesale	13.88638*** 0.936402 29.59543*** 1.779629	2 2 1 1	0.0010 0.6261 0.0000 0.1822
Metro Manila Cebu Dayao	H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause	cause Retail e Wholesale cause Retail e Wholesale	13.88638*** 0.936402 29.59543*** 1.779629 24.47100***	2 2 1 1 2	0.0010 0.6261 0.0000 0.1822 0.0000
Metro Manila Cebu Davao	H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c	cause Retail e Wholesale cause Retail e Wholesale cause Retail	13.88638*** 0.936402 29.59543*** 1.779629 24.47100*** 12.78076***	2 2 1 1 2 2 2	0.0010 0.6261 0.0000 0.1822 0.0000
Metro Manila Cebu Davao	H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause	cause Retail e Wholesale cause Retail e Wholesale cause Retail e Wholesale	13.88638*** 0.936402 29.59543*** 1.779629 24.47100*** 12.78076***	2 2 1 1 2 2 2	0.0010 0.6261 0.0000 0.1822 0.0000 0.0017
Metro Manila Cebu Davao Iloilo	H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Retail do not cause	cause Retail e Wholesale cause Retail e Wholesale cause Retail e Wholesale cause Retail	13.88638*** 0.936402 29.59543*** 1.779629 24.47100*** 12.78076*** 21.77164***	2 2 1 1 2 2 2 1	0.0010 0.6261 0.0000 0.1822 0.0000 0.0017 0.0000
Metro Manila Cebu Davao Iloilo	H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause	cause Retail e Wholesale cause Retail e Wholesale cause Retail e Wholesale cause Retail e wholesale	13.88638*** 0.936402 29.59543*** 1.779629 24.47100*** 12.78076*** 21.77164*** 1.091724	2 2 1 1 2 2 2 1 1 1	0.0010 0.6261 0.0000 0.1822 0.0000 0.0017 0.0000 0.2961
Metro Manila Cebu Davao Iloilo South Cotabate	H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause H ₀ : Wholesale do not c H ₀ : Retail do not cause	cause Retail e Wholesale cause Retail e Wholesale cause Retail e Wholesale cause Retail e Wholesale cause Retail	13.88638*** 0.936402 29.59543*** 1.779629 24.47100*** 12.78076*** 21.77164*** 1.091724 32.37150***	2 2 1 1 2 2 2 1 1 1 2	0.0010 0.6261 0.0000 0.1822 0.0000 0.0017 0.0000 0.2961 0.0000

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

 $\overline{(***)}, (**)$ and (*) indicate statistical significant at the 1%, 5% and 10% level respectively.

671			Metro M	Manila	(Cebu	Ι	Davao	Iloilo		South Co	otabato
672	Regressor	Coefficient	Coeff. Est.	Std. Er.								
673		α	0.0107	0.2307	0.4084	0.2515	0.2842	0.2393	1.1837***	0.4338	- 0.7522***	0.2772
674	$P_{r,t-1}^{+}$	β_1^+	0.8891***	0.0781	0.5190***	0.0790	0.9840***	0.0761	0.8776***	0.0828	0.6739***	0.0757
675	$P_{r,t-1}^{-}$	β_1^-	0.8891***	0.0790	0.5178***	0.0803	0.9854***	0.0769	0.8865***	0.0852	0.6796***	0.0770
676	$P_{r,t-2}^{+}$	β_2^+	- 0.0507	0.0729	0.1362*	0.0836	- 0.2131***	0.0750	- 0.0728	0.0812	- 0.0648	0.0657
677	$P_{r,t-2}^{-}$	β_2^-	- 0.0502	0.0732	0.1395*	0.0837	- 0.2121***	0.0746	- 0.0664	0.0812	- 0.0640	0.0653
678	$P_{w,t}^+$	γ_0^+	0.7759***	0.0444	0.8790***	0.0548	0.8242***	0.0381	0.3912***	0.0604	0.7136***	0.0404
679	$P_{w,t}^-$	γō	0.7833***	0.0459	0.8860***	0.0569	0.8386***	0.0402	0.3926***	0.0643	0.7204***	0.0442
680	$P_{w,t-1}^+$	γ_1^+	- 0.6116***	0.0943	- 0.2921***	0.1097	- 0.6456***	0.0869	- 0.1116	0.0963	- 0.2026**	0.0797
681	$P_{w,t-1}^{-}$	γ_1^-	- 0.6089***	0.0956	- 0.2911***	0.1111	- 0.6482***	0.0885	- 0.1015	0.0986	- 0.1989**	0.0815
682	$P_{w,t-2}^+$	γ_2^+	0.0111	0.0729	- 0.2420**	0.0941	0.0460***	0.0722	- 0.1041	0.0710	- 0.0402	0.0646
683	$P_{w,t-2}^{-}$	γ_2^-	0.0142	0.0731	- 0.2449**	0.0945	0.0475***	0.0728	- 0.1012	0.0708	- 0.0336	0.0651
684 685	Null Hypothesi	S	F- Stat. (df)	$\Pr(F > c)$								
686	$\gamma_0^+ = \gamma_0^-$		6.5906	0.0111	4.3969	0.0374	16.2504	0.0001	0.0492	0.8246	1.6217	0.2045
687	$\sum_{i=0}^{n} \gamma_i^+ = \sum_{i=0}^{n}$	$_{\rm D}\gamma_i^-$	12.4591	0.0005	0.9018	0.3436	4.8975	0.0281	2.0945	0.1496	3.1117	0.0794
688			(1, 181)		(1, 181)		(1, 181)		(1, 181)		(1, 181)	

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

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

	Coefficient		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	Retail	1.0000	0.0000	0.8017***	0.0000
Cotabato	Wholesale	1.0835***	1.0000	0.0000	0.5179***

690 Table 6. Coefficients Cholesky decomposition imposing short-run restrictions



Figure 3 Responses of Retail Price to Positive and Negative Shocks in Wholesale Price by One Standard

- 722 Deviation; measured 'month' in X-axis and 'price (PHP/kg)' in Y-axis.
- 723 Source: FAO FPMA