

QUALITY GRADING IN THE SUPPLY CHAIN: THE CASE OF VEGETABLES IN SOUTHERN PHILIPPINES¹

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ABSTRACT

This paper examines the role of quality grades or standards in the supply chain. A model is employed which shows that quality grading provides information that lower search cost of buyers. Thus, when such standards are inadequate, information is distorted which results to asymmetric price transmission. The model is applied in the vegetable industry in Southern Philippines using primary and secondary data. A price asymmetry marketing margin model is estimated using secondary data for cabbage and onion. Results show that price transmission is symmetric for cabbage and asymmetric for onion. Asymmetry in price transmission implies that marketing information are not effectively transmitted in the food chain and that establishing quality grades or standards is necessary to improve efficiency in the supply chain.

1.0 Introduction

Quality attributes desired by buyers or consumers should be reflected or intrinsic in the standards or grades. These quality requirements are market information that should be effectively and efficiently transmitted from downstream to upstream industries. Simply put, requirements of ultimate consumers of vegetables should be known to farmers and all the players in the marketing system so that production can accurately respond to market signals. Farmers, agents, traders, wholesalers and retailers should be able to produce or deliver what consumers want.

However, distortion in the quality grading system may exist which garbles marketing information. Whether deliberate or not, this breeds inefficiency. Deliberate distortion of quality grading system such as inconsistency in the application of the bases of grading opens the door to opportunistic behavior. This implies not only inefficiency in the system, but redistribution of benefits or income gained from productive activities among players in the marketing chain. When traders take advantage of farmers by controlling the grading standards as they know the market better and may under-price farmer's

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produce, they extract rents or benefits from farmers. This compounds the high poverty incidence in the rural sector as farmers continue to receive lower prices for their produce.³ On the other hand, distortions that are not deliberate basically refer to the inadequacy of the quality grading system. When the system is inadequate, farmers are not able to meet consumer requirements. This yields overproduction or underproduction yielding post-harvest losses, low price of produce and hence, low profitability.

The inadequacy or lack of quality grading system also contributes to high marketing costs of farmer's produce. Majority of farmers in Mindanao complain about high transportation costs particularly shipping costs. They complain that shipping companies form a cartel, controlling increases in shipping rates. Shipping companies, on the other hand, argue that shippers including farmers do not avail of volume discounts by using larger container vans since they do not consolidate. One of the reasons why shippers or farmers do not consolidate is the lack of grading system.

This paper examines the role of quality grading standards in the supply chain of selected vegetable industries in Southern Philippines in order to identify issues and explore policy implications. By gaining a deeper understanding of the quality grading system in the vegetable industry, one will be able to effectively map out interventions to improve production and marketing systems of vegetables. Grades or standards are critical marketing information that must be communicated well among the various players in the food chain. Farmers need to know this information to synchronize their production and be able to respond to market needs. Aside from minimizing production losses, an effective grading system minimizes opportunistic behavior and in general, reduces marketing costs. However, there is a dearth of research studies in the area of grading and standards in the Philippines particularly in Mindanao.

2.0 The Model

The food chain involves a number of intermediaries from the farm to retail. The typical food chain entails a link between farmer, wholesaler and retailer. In the case of the vegetable industry in Southern Philippines, the food chain links the farmer to the karyador⁴, agent, buyer, warehouse owner, wholesaler and retailer in that order. However, an agent negotiates with the buyer and farmer and sometimes the farmer negotiates directly with a buyer who sells to the wholesaler.

2.1 *The farm-trader-retailer linkage*

For simplicity, it assumed here that the players in the chain are farmers, traders and retailers. To model this linkage and characterize the price setting behavior of firms, consider N firms for each of the three levels.⁵ The farm sector is denoted by f , and the trader and wholesaler by t and r respectively. Assume n profit maximizing farms face the

³ In the Philippines particularly the southern part, approximately half of the population mostly in the rural areas engaged in agriculture are below the poverty threshold level.

⁴ Handles the transportation of produce from the farm to the trading area through the use of horse (See Murray-Prior, et. al 2003).

⁵See Azzam (1992)

same farm price p^f and input prices. Each farm's technology can be represented by the dual cost function $C_i^f(Q_i^f, F)$ for $i = 1, 2, \dots, n$ where F is a vector of input prices used in the production of the quantity Q_n^f . It should be noted that inputs include the grading activities done by farmers. This will be discussed further in section 2.2.

The profit maximizing condition for farm i is:

$$p^f = \frac{\partial C_i^f(Q_i^f, F)}{\partial Q_i^f} \quad (1)$$

Equation (1) indicates that for farm i to maximize profit, it equates the price received from selling its output to the wholesaler or processor, to its marginal cost of production.

To aggregate over firms, the cost functions of the individual firms are assumed to be of the polar form, $C_i^f(Q_i^f, F) = g^f(Q_i^f)C^f(F)$, which yields the aggregate industry cost function $C^f(Q^f, F)$.⁶ The industry analogue of equation (1) becomes:

$$p^f = \frac{\partial C^f(Q^f, F)}{\partial Q^f} = G^f(Q^f, F) \quad (2)$$

The trader, on the other hand, combines the farm output Q^f or raw material in fixed proportion to his/her output Q^t but not between the marketing inputs provided by the trader T .⁷

$$Q^t = \min[Q^f / k^t, m(T)] \quad (3)$$

where k^t is the constant amount of raw material (Q^f) used to produce a unit of trader's product (Q^t). T is a vector of input prices.

The indirect cost function is given by:

$$C^t(Q^f, p^f, T) = p^f k^t Q^f + C^t(Q^f, T) \quad (4)$$

Assuming that wholesalers are price takers, their marginal cost is derived by differentiating (4) with respect to Q^f and equating it to the trader's price which gives the following profit maximizing condition:

$$p^t = k^t p^f + \frac{\partial C^t(Q^f, T)}{\partial Q^f} \quad (5)$$

⁶ If $Q^f = \sum Q_i^f$ then g must be linear, that is, $g = a + bQ$.

⁷This is similar to Brorsen, B. W., J. P. Chavas, et al. (1985).

Further assume that the retailer has a production technology similar to the trader which requires fixed proportion of raw material sourced from the wholesaler but not between the retailing inputs R . The indirect cost function is given as:

$$C^r(Q^f, p^t, R) = p^t k^r Q^f + C^r(Q^f, R) \quad (6)$$

where k^r is the amount of raw material required to produce one unit of wholesale output. Differentiating equation (6) with respect to Q^f will yield the marginal cost:

$$MC = p^t k^r + \frac{\partial C^r(Q^f, R)}{\partial Q^f} \quad (7)$$

Assuming $k^r = k^t = k = 1$, the profit for retailer's can now be specified as follows:

$$\pi^r = (p^r - p^t)Q^f - C^r(Q^f, R) \quad (8)$$

Retailers maximize profit when:

$$p^r = p^t + \frac{\partial C^r(Q^f, R)}{\partial Q^f} \quad (9)$$

The last term in equation (9) is the mark-up to cover the services provided by the retailer. These services provided by retailers to consumers include grading, assurance of product delivery at the desired time and in the desired form, information that increase costs to farmers and traders but reduce costs to consumers. This shifting of costs between farmers and wholesalers, wholesalers and retailers or retailers and consumers is explored in the model below.

2.2 Grading

The grades or standards are market information necessary to coordinate production of vegetables. Grades provide information to minimize search cost or transaction costs. Like brands, they carry information on quality attributes and therefore minimize uncertainty of quality levels. This implies that a trader is willing to pay a premium on grading quality standards. At this point, it is useful to introduce the concept of full price. For simplicity we consider only one node in the supply chain: the farmer-trader node.

2.2.1 Full price

A rational trader minimizes full price in purchasing products from the farmer.⁸ This full price is defined as:

⁸ This is similar to that applied by Ratchford and Stoops (1988) in the retail industry which was based on Erlich and Fisher (1982). Both Betancourt and Gautschi (1988) and Erlich and Fisher (1982) derived their models from a household production framework. These models looked at the issue of advertising and retail services.

$$B_{ft} = P_t + T_t(M_{ft}(G_f, q_{ft}, D_{ft})) \quad (10)$$

where P_t = trader's price;

T_t = cost of trader's time per hour; and

M_{ft} = the time involved in searching or acquiring the good by trader t from farmer f which is affected by the amount purchased q_{ft} , the quality grading done by the farmer is G_f , and the knowledge acquired by the trader from sources other than the one provided by farmer f is D_{ft} .

The raw material or vegetable bought by the trader from the farmer and the grading services are complementary implying that wholesalers or those consumers buying from the traders are willing to pay for the grading services which come bundled with the raw material because these services reduce the cost of acquiring the product directly from the farmer or supplier of raw materials. The difference between full price and trader price equal to $T_t M_{ft}$ which is the value of acquiring the product from farmer f . This difference exists because of imperfect information about the products in the market (Erllich and Fisher, 1982, p. 367). Note that the time involved in acquiring the product M_{ft} is affected by both traders and farmers. The amount purchased by the consumer q_{ft} is expected to decrease M_{ft} since buying more will save him the time of going back to the farmer to buy the vegetable and therefore lowers the cost involved per transaction. Traders' knowledge about the product D_{ft} depends not only on his education, experience and length of stay in the area, but also on his investment of knowledge to minimize the total of all the components of the time cost of the commodity (Ehrlich, 1982).⁹ Grading is assumed to affect the opportunities under which graded products can be acquired. It is argued that grading affects demand because it lowers the search costs of traders and therefore lowers the gap between the price received by the seller and the full price borne by the buyer. A gap exists because the buyer incurs the costs of obtaining information about the characteristics of the varieties of vegetables and the costs of mistakes in buying vegetables.

To derive the equilibrium condition between the interaction of trader and the farmer, it is assumed that M_{ft} is only a function of grading G_f . Thus, (10) becomes:

$$B_{ft} = P_t + T_t(M_{ft}(G_f)) \quad (11)$$

First, the trader minimizes the full price or the price paid for the graded commodity which yields:

$$\frac{\partial P_t}{\partial G_f} = -T_t \frac{\partial M_{ft}}{\partial G_f} \quad (12)$$

⁹ Knowledge is considered as durable and hence the problem of its optimal accumulation is similar to the problem of optimal accumulation of physical capital of an irreversible nature. For details, see (Ehrlich, 1982, pp. 368-369).

Since $\frac{\partial M_{ft}}{\partial G_f} < 0$ because grading reduces search cost hence $\frac{\partial P_t}{\partial G_f} > 0$. This implies that the trader is willing to pay a higher price due to grading equal to the cost of time reduced due to grading. Similarly, he/she is also willing to pay a higher price due to labor services up to the amount equal to the marginal reduction in the cost of time due to labor services.

2.2.2 Profit maximization

The decision problem of the farmer is to determine the optimal output in order to maximize profit, thus:

$$\text{Max } \Pi = (P_f - c)Q_f - w_g G_f \quad (13)$$

where c = unit cost of Q

$Q_f = n_t q_f = f(P_f(G_f))$ = total sales of the farmer;

n_t = number of traders;

q_f = volume of vegetable purchased;

w_g = per unit cost of grading.

Profit is maximized when:

$$\begin{aligned} \frac{\partial \Pi}{\partial G_f} &= Q_f \frac{\partial P_t}{\partial G_f} + P_t \frac{\partial Q_f}{\partial G_f} - c \frac{\partial Q_f}{\partial G_f} - w_g = 0 \\ &= Q_f \frac{\partial P_t}{\partial G_f} + \frac{\partial Q_f}{\partial G_f} (P_t - c) - w_g = 0 \end{aligned} \quad (14)$$

If the trader is at the minimum full price:

$$\frac{\partial Q_f}{\partial G_f} = 0 \text{ since } \frac{\partial Q_f}{\partial G_f} = \frac{\partial Q_f}{\partial B_{ft}} \frac{\partial B_{ft}}{\partial G_f} \text{ and } \frac{\partial B_{ft}}{\partial G_f} = 0$$

This implies that the middle term in (14) is equal to zero which reduces to:

$$\frac{\partial P_f}{\partial G_f} = \frac{w_g}{Q_f} \quad (15)$$

In addition, given (12), it implies that the marginal contribution of grading to profit equals the marginal reduction in the cost of buyers or consumers in acquiring the good. This equilibrium condition yields the following solution to (14):

$$\frac{w_g}{Q_f} = -T_t \frac{\partial M_{ft}}{\partial G_f} \quad (16)$$

Equation (16) implies that the trader is willing to pay the farmer or agent to provide the optimum level of grading. That is, the grading cost should be recovered by the time saved in search costs or minimizing transaction costs. These services are reflected in the margin charged by farmers. The above model implies that quality grades or standards provide information to lower search costs of traders or buyers including consumers. When quality standards desired by buyers and consumers are not relayed to the producers or farmers, inefficiency occurs. This happens when opportunistic behavior occurs emanating from any of the players in the supply chain – farmers, traders, agents, wholesalers or retailers. Because of the lack of market information provided by the grades or standards, transmission of information and prices is asymmetric.

3.0 Empirical Analysis

The empirical analysis utilizes both primary and secondary data. The primary data came from a survey of 207 vegetable farm households in Kapatagan, Davao del Sur located in the southern part of the Philippines which accounts for 12% of the total households in the area. Approximately 80% of the total farm households are into farming. The survey data provide evidence that not all farmers grade their vegetables although graded vegetables command higher price in the market. Hence, price transmission may not be symmetric.

Secondary data were used to test whether market information is transmitted effectively in the supply chain or whether price transmission is symmetric. A price asymmetry model was estimated using secondary data for cabbage and onion to examine price responses to changes in marketing costs which includes grading. Cabbage was chosen as it accounts for about 35% of the total volume of vegetables produced by the farmers surveyed. However, due to limited data to run the model using survey data, only secondary industry monthly data from January 1988 to December 1998 were used. Onion was included as data to run the model were available and it also provides a contrast to cabbage in terms of perishability.

3.1 A price asymmetry model

The price asymmetry model estimated uses the Houck procedure to segment changes in costs particularly wholesale price into decreases and increases. This model was based on the work by Tweeten and Quance (1969) which was modified later by Wolfram (1971) and Houck (1977) and is now dubbed as the Wolfram-Houck asymmetry model (von Cramon Taubadel 1998). One of the criticisms of these time series models is that most studies that apply them do not provide the theoretical foundation of estimating these models. In this paper, the theoretical basis of estimating these models has been discussed in the previous section. That is, whether equation (5) holds or whether price equals marginal costs. Markets are efficient when price transmission is symmetric or when the changes in costs including the cost of grading and the changes in prices which include the premium for quality attributes or standards are symmetric.

To implement the theoretical model in equation (9) empirically, a functional form for $C^r(Q^f, R)$ was assumed. The generalized cost function of Diewert (1974) was applied for this purpose specified as follows:

$$C^r(Q^f, R) = Q^f \sum_i \sum_j \psi_{ij} (R_i R_j)^{1/2} + (Q^f)^2 \sum_i \phi_i R_i \quad (17)$$

Further, the cost function of each firm in the wholesale industry was assumed to be of the polar form $C_n^r(Q_n^f, K) = g^r(Q_n^f) C^r(R)$ which yields the aggregate cost function $C^r(Q^f, R)$. It should be noted that due to inadequacy of data at the farm level, wholesale and retail data were used instead of farm and wholesale data. However, the model discussed in the previous section is general enough to cover any node in the supply chain i.e. farm to agent, farm to wholesaler, wholesale to retailer and so forth. Based on the initial survey, wholesalers also grade the vegetables. But whether wholesalers grade or not, any distortion in the supply chain such as the absence or inadequacy of grading system regardless of where it emanates will affect the transmission of prices in the entire supply chain.

Given $\alpha_{ij} = \alpha_{ji}$, $\chi_{ij} = \chi_{ji}$, and $\psi_{ij} = \psi_{ji}$, and $i, j=1, 2$, the following is obtained:

$$\begin{aligned} \sum_{i=1}^t \Delta p_i^r = & \alpha_0 + \sum_{i=0}^t \theta_{1,i} p_{1-t-i}^w + \sum_{i=0}^t \theta_{2,i} p_{2-t-i}^w + \psi_{11} \sum_{i=1}^t \Delta R_{1i} + \psi_{22} \sum_{i=1}^t \Delta R_{2i} + \\ & \psi_{12} \sum_{i=1}^t \Delta 2(R_{1i} R_{2i})^{1/2} + \phi_1 \sum_{i=1}^t \Delta(2Q^f R_{1i}) + \phi_2 \sum_{i=1}^t \Delta(2Q^f R_{2i}) + \varepsilon_t \end{aligned} \quad (18)$$

where p_i^w = increases in wholesale prices;
 p_D^w = decreases in wholesale prices;
 R_{1i} = wage rate;¹⁰
 R_{2i} = cost index for light and power; and
 Q^f = quantity of product.

The wholesale prices were segmented into increases and decreases via the Houck procedure. All variables in equation (18) except the segmented wholesale prices are expressed as deviations from their initial value which is equivalent to summing their changes over the period.¹¹ One can also segment other cost variables in the model but this becomes impractical due to limited degrees of freedom particularly in the firm level data as this will include lagged variables. Moreover, wholesale prices or the cost of raw materials account for the bulk of the costs in retailing and are usually the only ones segmented in previous price asymmetry studies (for example, Kinnucan and Forker 1987, Pick et al 1991, Fabiosa 1995). Moreover, with the semi-fixed proportions technology adopted in the model, specification of cost variables in the model is not straightforward. Hence, other cost variables were not segmented to maintain a more parsimonious model. Finally, the model was also estimated considering cointegration of variables. Two empirical specifications of this model were used depending on the cointegration test results. These are the error correction (ECM) and the Wolfram-Houck (WHM) models.

¹⁰ The generator Δ denotes discrete or periodic change in the variable.

¹¹ For details of this procedure, see Houck (1977).

Based on the cointegration results, the error correction version of the Wolfram-Houck price asymmetry model was used. Various diagnostic tests were conducted to test for validity of results.

4.0 Results and Discussion

4.1 Vegetable Grading in Kapatagan, Davao del Sur

Of the 207 vegetable farmers surveyed in Kapatagan, Davao del Sur, 134 or 65% grade their vegetables before selling (Table 1). Grading appears to be more important in vegetables like potatoes, tomatoes, carrots and cabbage.¹² Around 113 or 84 % of the total farmers who grade their vegetables are accounted for by these four commodities. More than half or around 53% of the vegetable farmers said they get a higher price for grading their vegetables (Table 2). It should be noted, however, that 43% did not provide any answer while only 4% said they did not receive higher price for grading their vegetables. Around 96 of the 109 or approximately 88% of farmers who said they get higher price for their graded vegetables were those farmers who sold the aforementioned four major commodities.

It is worthwhile noting that answers to the question on whether the farmers get a higher price for grading may be considered as perceptions of the farmers. However, actual data on the price received by the farmers particularly for cabbage, carrots, potatoes and tomatoes show a substantial difference in prices between graded and ungraded price (Table 3). Prices between these two prices for cabbage and tomatoes range from twice or four times the price for vegetables without grading. Considering the four major vegetables, price difference range from 31% to 341% higher than the vegetables without grading. The extent of price difference appears to differ in terms of the perishability of the product. Cabbage and tomatoes are relatively perishable than carrots and potatoes. Thus for first grade cabbage, the price difference is around 341% compared to carrots of only 44% (Table 3).

While grading significantly increases the price of vegetables, there are also costs involved with it. Table 4 shows the grading costs for the key vegetables covered in the survey. The average grading cost per kilogram is approximately 0.30 pesos or Aus\$ 0.01 at one Australian dollar 1 to 30 pesos. The highest cost of grading is tomatoes while the lowest is chayote.

Finally, it is also interesting to note that functions of the buyers of the farmers' produce and the distribution of types of buyers for the various vegetables covered in the survey (Table 5). These buyers are either agents, buyers or wholesalers, bodega or warehouse owner. While the number of buyers depends on the volume of transaction, it is worthwhile noting that cabbage has the most number of buyers with various functions. This point may help explain the results in the price asymmetry model estimated using industry data.

¹² See Concepcion and Montiflor (2003) for the basis of grading or the quality attributes used by farmers such as size, appearance, color, etc.

4.2 *Price Asymmetry Model*

Before the cointegration test was applied, price and costs variables were graphed to check for outliers and existence of non-stationarity. Cointegration test results indicate that variables for cabbage and onion are cointegrated. A Wolfram-Houck specification was estimated for these products but results appear unacceptable based on the diagnostic tests conducted which includes autocorrelation (Durbin h), specification (RESET) and heteroskedasticity (B-P-G) tests. The lack of cointegration among these products is mainly due to the presence of a stationary variable in the model. As other variables are non-stationary or integrated of order 1, variables are expected to be not cointegrated. However, Hansen and Joselius (1995) argue that stationary variables can be included in an error correction framework. What is required is at least two non-stationary variables in the model (Purcell 1999). Thus, an error correction model was used. For cabbage and onion, on the other hand, cointegration results for the trend and no trend models show that the coefficient of the lagged residuals are significantly different from zero rejecting the null hypothesis of no cointegration. Hence, an error correction model was also estimated.

Distributed lags

As in Kinnucan and Forker (1987), a lower degree polynomial was assumed as it is unlikely for retailers' response to changes in prices and costs to have a distributed lag structure with a degree of polynomial higher than cubic.

The lag for onion was one month while for cabbage, both wholesale and retail prices were lagged two months. This difference in the length of lag between retail and wholesale prices is expected, as the former is relatively rigid compared to the latter. On the other hand, a second degree polynomial was used for cabbage. No polynomial specification was imposed on the coefficients of the lagged variables for onion.

In general, lagged retail cost variables other than for the raw material (wholesale price) were insignificant. This indicates the importance of the cost of raw material in retail pricing. The majority of studies using the Wolfram-Houck price asymmetry model including its error correction version (von Cramon Taubadel 1998), include only the cost of raw materials in the model (for example, Kinnucan and Forker 1987, Pick et al 1991, Fabiosa 1995).

Exogeneity test

Tests of exogeneity with respect to the long-run and short-run parameters were conducted following Borentein, Cameron, et. al (1997). Results show that the unsegmented and segmented error correction terms are insignificant for all products. Similarly, tests of exogeneity with respect to the short-run parameters were also conducted via a variable addition test of the residuals. It was found that the coefficient of the residual variable was insignificant, confirming the argument that wholesale prices were weakly exogenous (Table 6.6). There appears to be no problem with autocorrelation as shown by the values of the Durbin-h statistic. The Durbin Watson statistic was not used since a lagged dependent variable is included in the model. The battery of heteroskedasticity tests that

Shazam generates also shows that errors are homoskedastic, although only the result of the Breusch-Pagan-Godfrey (B-P-G) test is presented (Table 6.6).¹³

Symmetry test

The formal test of asymmetry shows that price transmission is symmetric for all products except onion. This implies that, generally, increases and decreases in costs (particularly the cost of raw materials) are fully reflected in retail prices (Table 6).

For onion, however, increases in costs are reflected in retail prices more than decreases. The coefficient of the contemporaneous variable of wholesale price is relatively large at 0.91 compared to other products (Table 6.6). A unit increase in wholesale price increases retail price by 0.91, which reduces margin by 0.09 units. This error is adjusted asymptotically by 0.04 units. Similarly, a decrease in the wholesale price increases the margin by 0.09 units and adjusted by 0.48 units. This shows that when margins are squeezed, retailers do not adjust the cost as much as when it is in excess. This is perhaps indicative of the competition in the industry and the nature of the product. Onions are sold by many retailers in low volumes particularly in wet markets. Alternatively, as argued by Ward (1982) in his study of vegetable products, retailers transmit decreases in costs faster than increases to avoid a decrease in demand resulting in higher costs due to spoilage.

Generally, the coefficient of the contemporaneous variable for wholesale price is less than unity for onion but not for cabbage, indicating that changes in wholesale prices are generally transmitted within one month (Table 6).¹⁴ A unit increase in the cabbage wholesale price increases retail price by 1.47 units which increases margin by 0.47. This error or ‘overpricing’ is corrected asymptotically by 1.49 while an “underpricing” is adjusted by 1.66 unit each month. The coefficients for both are expected to be negative because when the margin is low in the previous period, the retailer is expected to increase price in the present period. On the other hand, when the margin is high in the previous period, the retailer is expected to decrease the price in the present period. Thus, both coefficients are negative. While price transmission is symmetric, the adjustment in margins is lower when retail price is less than the long-run equilibrium value compared to when it is higher. This result is consistent with that of Ward (1982) who argued that due to perishability of vegetables, retailers are reluctant to increase price when costs increase as this may result in excessive inventory leading to higher costs due to spoilage. The insignificance of the difference in transmission of increases and decreases in costs, however, may be attributed to the fact that in the Philippines, most of the cabbages are sold by very small retailers in very low volumes. Thus, perhaps due to competition, increases and decreases in costs are reflected symmetrically in retail prices. The study by

¹³ B-P-G test addresses the weaknesses in other heteroskedasticity tests such as Goldfeld-Quandt test which depends on the number of central observations to be discarded and on identifying the correct independent variable with which to order the observations (Gujarati 1995, p. 377). Other similar tests that Shazam generates show that the errors are homoskedastic (eg. Glejser test).

¹⁴ While the coefficient of the contemporaneous wholesale price in cabbage exceeds unity, implying that weekly or daily data may be more appropriate, testing for price asymmetry is not necessarily invalid. Lye and Sibly (1994) conducted a Monte Carlo experiment and concluded that price rigidity still exists even when more frequent observations are aggregated (p.246).

Ward, however, used aggregate data for vegetables and was done in the United States where vegetables are sold mostly by large food retailers.

Diagnostic tests

The models appear to be well-specified as indicated by the RESET test results, implying that the addition of a squared estimated dependent variable does not significantly increase R^2 . Autocorrelation and heteroskedasticity are not present in the final models as shown by the value of the Durbin-h and Breusch-Pagan-Godfrey (B-P-G) statistics respectively (Table 6).¹⁵

Price asymmetry implies that changes in costs are not fully reflected in retail prices. A negative difference between increases and decreases in costs (or residuals in error correction models) implies that cost decreases are passed on more quickly than increases. A positive difference, on the other hand, implies that decreases in costs are not as fully reflected in retail prices as increases. However, this difference may not be statistically significant. In such cases, it is concluded that price transmission is symmetric. Notwithstanding a conclusion of symmetry, a seemingly insignificant difference implies that changes in costs are not fully reflected in retail prices. Thus, a decrease or savings in the costs of raw materials, for example, although statistically insignificant, is not fully passed on to consumers. When it is concluded that price transmission is asymmetric, it is because the difference between increases and decreases in costs is statistically significant. That is, retail prices are significantly above or below the long-run equilibrium price.

5.0 Concluding comments

The primary data show that two thirds of the farmers survey grade their vegetables primarily because they get higher price for doing such marketing function. While there are costs involved, the benefits in terms of higher price outweigh them. As argued in the grading model presented, grading provides benefits to buyers by lowering their search and transaction costs. There are anecdotal evidences that those who do not conduct grading packed their vegetables by putting the high quality ones on the top of a sack or packaging material and the low quality ones at the bottom. With grading, the uncertainty or risks of getting low quality vegetables are minimized.

While two thirds grade their vegetables, possibly a third still do not grade their vegetables despite the benefits of receiving higher prices.¹⁶ Apparently, there are various reasons why this is so. One is the inadequacy in the quality grading system. In effect, the basis of grading is quite arbitrary and hence application of standards or attributes to determine grades may not be consistent. This becomes a disincentive for farmers to grade which may explain why some farmers do not grade their products. In a wider scale, this distorts market information in the supply chain, breaking the flow of information from consumers to producers thus yielding inefficiency in the system. Thus, establishing an adequate quality grading system is necessary to improve the performance or enhance the efficiency of the food chain.

¹⁵ Autocorrelation is addressed by determining the optimum lags and degree of polynomial.

¹⁶ There are respondents who did not provide answers to the question

The price asymmetry model provides an indication of the magnitude of this inefficiency. It should be noted, however, that this inefficiency should not be solely attributed to the inadequacy of the grading system as there are many factors involved including market power, poor infrastructure facilities and so on.

Table 1. Farm households grading their produce before selling by type of vegetables

Vegetables	Farm Households Grading Vegetable Produce						Total
	Grading	%	Not Grading	%	No answer	%	
Not Specified	6	2.90	64	30.92	2	0.97	72
Cabbage	20	9.66	2	0.97	1	0.48	23
Carrots	26	12.56					26
Chinese Cabbage	6	2.90					6
Kentucky Beans	4	1.93					4
Potatoes	34	16.43			1	0.48	35
Chayote	2	0.97					2
Tomatoes	32	15.46			3	1.45	35
Bell Pepper	2	0.97					2
Onion	1	0.48					1
Eggplant & Okra	1	0.48					1
Total	134	64.73	66	31.88	7	3.38	207

Source: Survey of Vegetable Farm Households, Kapatagan Davao del Sur (2002)

Table 2. Perceptions of farmers' impact of grading on prices received

Vegetable	Farmers Getting Higher Price by Grading						Total
	Higher Price	%	No Higher Price	%	No Answer	%	
No particular	4	1.93	7	3.38	68	32.85	79
Cabbage	14	6.76	1	0.48	5	2.42	20
Carrots	21	10.14			3	1.45	24
Chinese Cabbage	3	1.45			1	0.48	4
Kentucky Beans	3	1.45			3	1.45	6
Potatoes	32	15.46			2	0.97	34
Chayote	1	0.48					1
Tomatoes	29	14.01			6	2.90	35
Bell Pepper	1	0.48			1	0.48	2
Onion		0.00			1	0.48	1
Eggplant	1	0.48					1
Total	109	52.66	8	3.86	90	43.48	207

Source: Survey of Vegetable Farm Households, Kapatagan Davao del Sur (2002)

Table 3. Graded and ungraded price of vegetables

Vegetables	Prices (PhP)			% Difference between Graded and Ungraded Prices	
	Ungraded (A)	First Grade (B)	Second Grade (C)	B-A	C-A
Cabbage (per kilo)	4.50	19.83	13.50	340.67	200.00
Carrots (per kilo)	12.00	17.33	16.44	44.42	36.98
Potatoes (per kilo)	13.75	20.93	18.00	52.22	30.91
Tomatoes (in crates)	49.31	125.71	103.16	154.96	109.21

Source: Survey of Vegetable Farm Households, Kapatagan Davao del Sur (2002)

Table 4. Costs of Grading Vegetables, by type

Vegetables*	Costs (Pesos)	
	Average Cost/Unit (PhP)*	Average Cost/kg
Cabbage	10.00	0.15
Carrots	19.23	0.30
Chinese Cabbage	8.33	0.13
Kentucky Beans	5.00	0.08
Potatoes	22.13	0.34
Chayote	5.00	0.08
Tomatoes	41.67	1.19
Bell Pepper	10.00	0.15
Average	15.17	0.30

*Unit of measurement are sacks (65 kilograms) except for tomatoes which are expressed in crates (35 kilograms)

Source: Survey of Vegetable Farm Households, Kapatagan Davao del Sur (2002)

Table 5. Function of buyers of vegetables

Crops	Agent	Buyer	Bodega*	Others	Total
Bell Pepper	2	1			3
Cabbage	16	51	1	4	72
Carrots	6	17		2	25
Chayote	2	5		1	8
Chinese Cabbage	2	11			13
Corn	1				1
Eggplant & Okra				1	1
Kentucky Beans	2	4			6
Onion		1			1
Potatoes	6	12	8	2	28
Tomatoes	3	30	1		34
Total	40.00	132.00	10.00	10.00	192.00

*warehouse or storage room

Source: Survey of Vegetable Farm Households, Kapatagan Davao del Sur (2002)

Table 6. Price Transmission with Cointegrated Variables for Selected Vegetables

Variable	Cabbage		Onion	
	Coeff.	T-ratio	Coeff.	T-ratio
Dependent				
Difference in retail price				
Independent				
Difference in wholesale price	1.47	22.68**	0.91	24.11**
		*		*
Decreases in residuals	-1.49	-	-0.04	-0.18
		2.77***		
Increases in residuals	-1.66	-	-0.48	-2.09**
		2.95***		
Lagged residuals				
Difference in retail prices lagged 1 period	1.23	2.28**	0.13	0.71
Difference in retail prices lagged 2 periods	-0.22	-2.48**		
Difference in retail prices lagged 3 periods				
Difference in retail prices lagged 4 periods				
Difference in wholesale price lagged 1 period	-1.98	-2.21**	0.09	0.43
Difference in wholesale price lagged 2 periods	0.50	3.39***		
Difference in fuel, light and water cost index	-0.32	-2.01**	-3.10	-
				5.30***
Difference in wage rate	-0.05	-0.72	2.24	5.59***
Diff in sq. root of the product of cost index & wage rate	0.13	1.56	0.01	0.77
Diff in cost index multiplied by production volume	0.05	1.75*	0.32	5.08***
Diff in wage rate multiplied by production volume	-0.03	-1.87*	-0.22	-
				5.46***
Constant	0.00	0.51	0.00	1.43
Adjusted R-squared	0.84		0.92	
Durbin-H	-1.48		0.06	
Asymmetry test	0.41[$\sim\chi^2(1)$]		4.97[$\sim\chi^2(1)$]**	
RESET test	0.00[$\sim F(1,117)$]		0.71[$\sim F(1,120)$]	
Heteroskedasticity test (B-P-G test)	16.47 [$\sim\chi^2(12)$]		9.29[$\sim\chi^2(10)$]	
Test of exogeneity	0.13[$\sim F(1,120)$]		0.05 [$\sim F(1,120)$]	

***significant at 1 per cent level **significant at 5 per cent level *significant at 10 per cent level

References

Azzam, A. (1992). "Testing the Competitiveness of Food Price Spreads" *Journal of Agricultural Economics* 42 : 248-256.

Betancourt, R. and Gautschi, D. (1988). "The Economics of Retail Firms" *Managerial and Decision Economics* 9 : 133-144.

Borenstein, S., Cameron, C. A. and Gilbert, R. (1997). "Do Gasoline Prices Respond Asymmetrically to Crude Oil Price Changes?" *The Quarterly Journal of Economics* 112 (1): 305-339.

Brorsen, B. W., Chavas, J. P., Grant, W. R. and Schnake, L. D. (1985). "Marketing Margins and Price Uncertainty: The Case of the US Wheat Market" *American Journal of Agricultural Economics* 67 (August): 521-528.

Concepcion, S. B and Montiflor, M. O. (2003). "Perceptions of Southern Mindanao Farmers on the Quality of Temperate Vegetables" contributed paper 4th Australian Agricultural and Resource Economics Society Conference, Fremantle, Western Australia, February 12-14, 2003.

Diewert, W. E. (1974). "Applications of Duality Theory" In Intrilligator, M. D. and Kendrick, D. A. (Eds.) *Frontiers of Quantitative Economics*, 2. North Holland, Amsterdam, pp. 106-199.

Dy, R. T. and Medina, M. T. (1995). Mindanao 2010: Agriculture and Agro-Industry Sectors Framework Plan, Institute for Agribusiness and Development and Policy and Office of the President for Mindanao, Pasig, pp. 171.

Ehrlich, I. and Fisher, L. (1982). "The Derived Demand for Advertising: A Theoretical and Empirical Investigation" *American Economic Review* 72 (3): 366-388.

Fabiosa, J. F. (1995). "Price Asymmetry in the Rice Marketing Channel: Is There Evidence of Market Power?" *Journal of Agricultural Economics and Development* 30 : 66-85.

Gujarati, D. N. (1995). *Basic Econometrics*, McGraw Hill Inc., New York.

Houck, J. P. (1977). "An Approach to Specifying and Estimating Nonreversible Functions" *American Journal of Agricultural Economics* 59 (August): 570-572.

Kinnucan, H. W. and Forker, O. D. (1987). "Asymmetry in Farm-Retail Price Transmission for Major Dairy Products" *American Journal of Agricultural Economics* 69 (2): 285-292.

Lantican, F. A. (1989). "Vegetable Marketing in the Philippines: Status, Problems and Policy Directions" *Philippine Cooperative Review* : 17-28.

Lantican, F. A., Licardo, K. E., Cabebe, L. R., Dumayas, E. E. and Harder, D. S. (1996). Commercial Crops Subsector: Fruits, Vegetables and Ornamentals, Congressional Commission on Agricultural Modernization and Agricultural Policy Research and Advocacy Assistance Program.

Murray-Prior, R, et. al. "A Pluralistic Methodology for Analyzing Supply Chains, contributed paper 4^{7th} Australian Agricultural and Resource Economics Society Conference, Fremantle, Western Australia, February 12-14, 2003.

Lye, J. N. and Sibly, H. (1994). "Testing for Pricing Asymmetries in Customer Markets" *Australian Economic Papers* 33 (63): 239-252.

Patalinghug, E. E. (1997). *Competition Policy, Technology Policy and Philippine Industrial Competitiveness*, University of the Philippines, College of Business Administration, Quezon City.

Pick, D. H., Karrenbrock, J. and Carman, H. F. (1991). "Price Asymmetry and Marketing Margin Behavior: An Example for California-Arizona Citrus" *Agribusiness* 6 (1): 75-84.

Purcell, T. (1999). *Forecasting Marketing Margins in the Australian Pig Industry*, Christchurch, New Zealand.

Ratchford, B. T. and Stoops, G. T. (1988). "A Model and Measurement Approach for Studying Retail Productivity" *Journal of Retailing* 64 (3): 241-263.

Ravallion, M. (1986). "Testing Market Integration" *American Journal of Agricultural Economics* 68 (1): 102-109.

Tweeten, L. G. and Quance, L. C. (1969). "Positive Measures of Aggregate Supply Elasticities: Some New Approaches" *American Journal of Agricultural Economics* 51 : 342-352.

Umali, D. L. (1990). "Rice Marketing and Prices Under Philippine Government Rice Stabilisation" *Journal of Agricultural Economics and Development* 20 : 1-43.

Von Cramon-Taubadel, S. (1998). "Estimating asymmetric price transmission with the error correction representation: An application to the German pork market" *European Review of Agricultural Economics* 25 : 1-18.

Von Cramon-Taubadel, S. and Loy, J. P. (1996). "Price Asymmetry in the International Wheat Market: Comment" *Canadian Journal of Agricultural Economics* 44 : 311-317.

Ward, R. W. (1982). "Asymmetry in Retail, Wholesale, and Shipping Point Pricing for Fresh Vegetables" *American Journal of Agricultural Economics* 64:205-212.

Wolffram, R. (1971). "Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches - Some Critical Notes" *American Journal of Agricultural Economics* 53: 356-59.

