4. Asymmetric Price Transmission And Consumer Costs In The Taiwanese Rice Market

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Abstract

Rice is a staple food in Taiwan, fluctuation in the retail price of milled rice has considerable influence on the costs of consumer. Unlike the numerous previous studies, this study analyses asymmetry in farm-retail price transmission in the Taiwanese rice market, using the asymmetric error correction model with threshold cointegration. We found that retail price of milled rice adjustments to negative price deviations from long-run equilibrium are faster than adjustments to the positive ones with a null threshold. We also showed that over the short run, the adjustments of retail price of milled rice react more strongly to positive shocks in paddy rice price. The asymmetric price transmission in the Taiwanese rice market also implies that the benefit of a fall in the paddy rice price is not transmitted to the consumers. In other words, the shocks in paddy rice price inflate consumer costs, and entities involved in the production-to-sales process are earning supernormal profit. This uneven spreading of surplus between the consumers and noncompetitive sellers displays a market failure. Instead of monitoring prices and interfering in the market, the policy makers should be adopting right intervention.Such as facilitate transparent pricing data or subsidize milling equipment for farmers, would be more effective in improving the competitiveness and efficiency of the rice market, potentially discouraging price asymmetry.

Keyword: Paddy Rice Prices, Retail Prices of Milled Rice, Market Power, Asymmetric ECM, Taiwan

JEL Classification: D43, L11, Q10

1. Introduction

Rice is a staple food in Taiwan, which means that fluctuations in the price of rice have considerable influence on the costs of consumer. Asymmetric price transmission in the producer-retail rice market can mean that either consumers do not benefit from production

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cost reduction, or producers do not profit from retail price increase (Meyer and von Cramon-Taubadel, 2004; Fiamohe et al., 2013). A phenomenon of price asymmetry services as a key element in evaluating welfare effects of market failure. An understanding of the price asymmetric transmissions between the retail prices of milled rice and paddy rice prices helps the government to adopt appropriate policies.

Although price transmission in the rice markets of developing nations has recently received considerable attention from researchers, there are still a number of research gaps. We aim to discuss this topic in-depth through our case study of the Taiwanese rice market. First, rice is a staple food in Taiwan, accounting for approximately 92.58% of the volume (Food Supply and Utilization of Taiwan, 2018) and 80.60% of the value (Basic Agricultural Statistics of Taiwan, 2018) of grain crops. Taiwan exports only 4.77% of its rice and imports 7.94%. Its food self-sufficiency ratio in relation to rice exceeds 120.10% (Food Supply and Utilization of Taiwan, 2018). Therefore, the Taiwanese rice market is not susceptible to the influence of global rice markets. Domestic rice prices are more vulnerable to fluctuations in paddy rice price. Although many previous studies have focused on market integration (such as the world-domestic market, central-local market, local-local market, or wholesale-retail market) (see, for example, Abdulai, 2000; Sanogo and Amadou, 2010; Fiamohe et al., 2013; Baquedano et al., 2011; Coxhead et al., 2012; John, 2013; Baquedano and Liefert, 2014; Zakari et al., 2014), we emphasize asymmetry in farm-retail price transmission. This is because rice is different from most fresh produce as it cannot be consumed directly but requires complex processing before it goes to retail, which is performed by a small number of intermediaries (such as rice millers). These intermediaries, who wield considerable market power, can asymmetrically transmit the positive or negative cost impacts of paddy rice prices to consumers.

Second, a number of studies have demonstrated price asymmetry in rice markets; however, modelling limitations meant that they were only able to determine that positive/negative price deviations converge at different speeds towards long-run equilibrium, but neglected the characteristics of price asymmetry in the short run (see, for example, Sanogo and Amadou, 2010; Fiamohe et al., 2013; Korale Gedara et al., 2015). Previous research on price asymmetry has been more concerned with whether positive/negative cost impacts have an asymmetric effect on short-term prices (see, for example, Bettendorf et al., 2003; Galeotti et al., 2003; Chen et al., 2005; Grasso and Manera, 2007). In our study, we focus on whether the various types of price asymmetry (both in the short run and the long run) exist in the Taiwanese rice market.

Third, in countries where rice is a staple food, fluctuation in the retail price of milled rice has a significant effect on consumer cost. The decisions of policymakers are often driven by the need to stabilize prices. Although Taiwan has transitioned into a developed nation, the government still regulates and interferes with the market to a considerable degree. For example, the government in Taiwan closely monitors price fluctuations and releases public stock to stabilize retail prices. Price asymmetry prevents price signals from enabling the robust operation of markets. It can lead to market participants either incurring loss or obtaining an unfair advantage from price variation, leading the government to reallocate resources (Korale Gedara et al., 2015). Price asymmetry in the rice market is not only an indication of market failure but also provides an argument in favor of government intervention in the market (Meyer and von Cramon-Taubadel, 2004; Fimaohe et al., 2013). This study discusses how price asymmetry and the price shocks of paddy rice affect consumer cost. We hope that studying a nation in economic transition like Taiwan will produce results that not only improve local allocation of resources but also offer learnings to other countries.

With the premise that paddy rice prices and the retail prices of milled rice are integrated of order one, we confirmed that a threshold cointegration relationship exists between paddy rice prices and the retail prices of milled rice. The concept of threshold cointegration captures the essence of nonlinear adjustment processes toward a long-run cointegrating relationship (Balke and Fomby, 1997). Engle and Granger (1987) indicated that the short-term dynamics and long-term equilibrium among any cointegration series can be linked using error correction. Thus, error correction models (ECMs) are standard methods to investigate the dynamic adjustments of prices (Bettendorf et al. 2003; Bachmeier and Griffin 2003). Von Cramon-Taubaded (1998) also advocated that only ECMs are suitable for testing asymmetric price adjustments. Thus, this paper proposes asymmetric error correction models (asymmetric ECMs) using threshold cointegration to establish reduced forms of the dynamic adjustment relationships between retail prices of milled rice and paddy rice prices. This study attempted to clarify the transmission mechanisms from price changes of paddy rice in Taiwan to the retail prices of milled rice. This study focused on the major agricultural regions of Taiwan, and found that retail price adjustments to negative price deviations from long-run equilibrium are faster than adjustments to the positive ones with a null threshold. The results for asymmetric ECMs and impulse response functions indicated that over the short run, retail prices react more strongly to positive shocks in paddy rice price. Furthermore, the results of various price asymmetry tests support the view that price asymmetry is a widespread phenomenon. According to the asymmetrical pricing model of Taiwanese rice market, shocks in paddy rice prices inflate consumer costs and indicate that entities involved in the production-to-sales process are earning supernormal profit. The Taiwanese government monitors and often regulates market supply-demand in order to stabilize prices. However, improving the competitiveness of the rice market, for example by facilitating transparent pricing data or subsidizing milling equipment for farmers, would be more effective in improving market efficiency and minimizing price asymmetry.

The structure of this paper is as follows. Section 2 explains the causes of price asymmetry and outlines the rice markets in Taiwan. Section 3 describes the data sources and the threshold cointegration analysis. Section 4 lists the proof of price asymmetry in the retail market in Taiwan. Section 5 discusses the shocks in paddy rice price and consumer costs, and Section 6 outlines our conclusions.

2. Literature review and rice market in Taiwan

The existence of asymmetric price transmission in rice markets of developing countries has received considerable attention in recent research. For instance, Sanogo and Amadou (2010) discussed the pricing behavior of Nepalese traders in response to price impact from India. They found that compared to positive price deviation, negative deviation converged more quickly towards long-run equilibrium. Fiamohe et al. (2013) analyzed local rice markets in Benin and Mali. They found that in Benin, unlike Mali, price increases in the surplus-zone market were transmitted more quickly to the consumer market, compared to price reductions. Studying the rice market in Sri Lanka, Korale Gedara et al. (2015) found that increases in wholesale prices are transmitted to retail prices more rapidly than decreases. Zakari et al. (2014) demonstrated that spatial price transmission in the domestic wholesale rice market of Niger differed significantly from other nations (the U.S, Thailand, Pakistan, and Vietnam). John (2013) built a price transmission mechanism between the export and domestic rice markets of Thailand. Results showed that in the short-run, the shocks originating in the domestic market had more dramatic effects on export FOB prices. The effects of the shocks originating in the export market took longer to be reflected in domestic wholesale prices. After studying data from 23 developing countries, Baquedano and Liefert (2014) found that although consumer markets are linked to global agricultural markets, variation in world prices and real exchange rates does not significantly impact domestic consumer prices.[3]

Researchers frequently use the local market power wielded by noncompetitive sellers (such as monopolistic or oligopolistic markets) to explain asymmetric price adjustments (Bailey and Brorsen, 1989; Pindyck, 1993, 1994; Griffith and Piggott, 1994; Borenstein et al., 1997; Abdulai, 2000, 2002; Chavas and Mehta, 2004; Capps and Sherwell, 2007; Falkowski, 2010). To reap profits, sellers in a noncompetitive market often adopt collusive pricing strategies. When costs go down, sellers need only maintain their original prices to collude in pricing, which presents downward price rigidity. However, when cost escalations reduce retail profits, prices are immediately increased. As a result, increases in paddy rice prices are transmitted to the retail prices of milled rice more rapidly than are decreases (positive price asymmetry).

Noncompetitive sellers enjoy local market power and are able to keep consumers in the dark about pricing, due to the search cost required to compare pricing information. The less inclined consumers are to compare prices, the less likely sellers are to adjust prices. In other words, if some sellers increase their prices, this compels consumers to compare prices (as the benefit of finding a lower-priced product is relatively greater than the search cost), which encourages further price hikes. If prices are reduced, however, consumers have no incentive to engage in price comparison. Noncompetitive sellers gradually transmit this cost reduction to their retail prices. Therefore, search cost in noncompetitive markets could be a contributor to positive price asymmetry (Johnson, 2002; Radchenko, 2005; Chandra and Tappata, 2011; Lewis, 2011).

Inventory adjustment has been documented as a source of incompletion in farm-retail price transmission. (Maccini, 1978; Blinder, 1982; Borenstein and Shepard, 2002). Changes in product prices often indicate whether retailers are increasing or reducing their stock. A retailer predicting a rise in the price of milled rice would have an incentive to purchase more milled rice and add to their stock. However, the increase in local market stocks pushes retail prices down, keeping the actual price increase lower than expected. In contrast, if a slump in the retail price of milled rice were forecasted, retailers could reduce their milled rice stock. The decrease in local market stocks would mitigate the pressures driving down retail prices. Such inventory adjustments by retailers cause changes in paddy rice prices to not fully influence the retail price of milled rice. Also, if sellers include menu cost in their pricing, then

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[3] *Numerous studies have shown that asymmetric price transmissions in other agricultural commodity markets. For instance, Worth (2000) examined the asymmetric relationship between the retail prices and FOB shipping point prices of fresh vegetables. Girapunthong et al. (2004) found asymmetric adjustments in fresh tomato prices in the producer-wholesale market and the wholesale-retail market. Abdulai (2000) proved the presence of asymmetry in maize prices by establishing the price transmission mechanisms between central and local markets. Zhang et al. (1995) discovered that the wholesale prices of peanut butter asymmetrically reflected the wholesale prices of peanuts. In contrast, Chavas and Mehta (2004) focused on the asymmetry between the wholesale and retail prices of butter. Abdulai (2002), however, discovered asymmetry in pork prices in the wholesale-retail market. Finally, Krivonos (2004) established asymmetric transmission mechanisms between the prices of local and world coffee.*

prices may be slower to react to higher costs (if the gain from price hikes is lower than menu cost), leading to negative price asymmetry.

Although Taiwan has transitioned into a developed nation where Western food is becoming more popular, rice is still a staple food. Each person in Taiwan consumes an average of 45.6kg of rice per year. Rice provides 15.65% of the required daily intake of calories and 28.36% of carbohydrates (Food Supply and Utilization of Taiwan, 2018). Rice fields account for 22.82% of arable land in Taiwan, which produces approximately 1,949,796 tonnes of rice per year (Agricultural Statistics Year Book of Taiwan, 2014). The primary participants in the production-to-sales process for rice in Taiwan include numerous upstream rice farming households and a few downstream rice millers and retailers. The rice millers purchase paddy rice from the farmers, process it into milled rice, and then sell it to the wholesale and retail markets. The production-to-sales process requires investments in the machine equipment for milling, quality screening, and packaging, the costs of which are too high for most farmers. As a result, this process is performed by a small number of rice millers. In other words, imperfect competition is a major characteristic of the milled rice retail market in Taiwan.

The government of Taiwan has implemented several interventions in the rice market. To protect the income of rice farmers, the government implemented policies related to the acquisition of paddy rice at guaranteed prices. The government uses to purchase paddy rice from rice farmers at prices that are guaranteed to be higher than market prices. The annual purchase generally ranges between 20% and 25% of that year's total harvest. Every year, the government announces the prices and quantities to be purchased using each method. For example, from each hectare of the first crop in 2016, the government announced 182,651 tonnes in planned purchases, 95,876 tonnes in purchases under guidance, and 85,452 tonnes in surplus purchases. From each hectare of the second crop, the government announced 31,487 tonnes in planned purchases, 2,019 tonnes in purchases under guidance, and 355 tonnes in surplus purchases (Taiwan Food Statistics Book, 2017). However, the acquisition of paddy rice by the government at guaranteed prices drives up the price of paddy rice in the market, which increases the retail costs of milled rice and forces sellers to raise their prices in response.

In addition to serving as military rations and being set aside for school lunches, the paddy rice that the government purchases also moderates supply and demand on the open market. The retail price of milled rice, as an essential commodity. To maintain steady prices, the government closely monitors the market prices of milled rice and releases public stock accordingly. The Price Stability Taskforce has authority over the Ministry of Justice, Ministry of Economic Affairs, the Fair Trade Commission, and the Consumer Protection Committee in rooting out illegal rice hoarding and price fixing. This price stabilization policy may also force retailers to adopt rigid pricing strategies when costs are rising (negative price asymmetry).

3. Threshold cointegration and data

The variables in this study are defined as follows; rp_t and up_t respectively denote the retail price of milled rice and the price of paddy rice, both presented using natural logarithms. The long-run relationship between rp_t and up_t is

$$rp_t = \theta_0 + \theta_1 up_t + \varepsilon_t \tag{1}$$

which indicates the connection between retail price and the input costs. ε_t signifies random disturbance; θ_1 gauges the influence of paddy rice prices on retail prices, and θ_0 encompasses other retail costs such as labor, the machinery that mills paddy into milled rice, losses, and/or building rent. If rp_t and up_t are both I(1) series, then performing augmented Dickey-Fuller (ADF) tests on the regression residuals of Eq. (1) can reject the null hypothesis of unit roots in practice:

$$\Delta\varepsilon_t = \eta\varepsilon_{t-1} + \sum_{j=1}^{k}\delta_i\Delta\varepsilon_{t-i} + v_t \tag{2}$$

under the hypothesis that $\eta = 0$, unit roots exist in the regression system of Eq. (2) (let Ω be the ADF statistic); $\eta < 0$ means that the regression residuals form stationary series and that a cointegration relationship exists between up_t and rp_t. Eq. (1) is also known as a linear cointegration relationship. The number of lag lengths *k* in the ADF regression of Eq. (2) can be determined using the information criterion. However, if the prices present asymmetric or nonlinear adjustments during their convergence towards equilibrium, then the linear cointegration hypothesis based on the premise of symmetric adjustment will lead to incorrect inferences (Enders and Granger 1998; Enders and Siklos 2001; Abdulai 2002). Pippenger and Goering (1993), Enders and Granger (1998), and Lin and Liang (2010) also indicated that using the linear settings of Eq. (2) directly to perform a cointegration test will result in low testing power due to misspecifications. In other words, the existence of asymmetric adjustments in the system can lead to instability in the equilibrium relationship itself (Balke and Fomby 1997; Hu and Lin 2008). In this respect, Enders and Granger (1998) and Enders and Siklos (2001) proposed threshold cointegration tests to grasp the nonlinear attributes of price adjustments. Below, the disequilibrated adjustments follow the threshold autoregressive process:

$$\Delta\varepsilon_t = I_t\eta_1\varepsilon_{t-1} + (1 - I_t)\eta_2\varepsilon_{t-1} + \sum_{j=1}^{k}\delta_i\Delta\varepsilon_{t-i} + v_t \tag{3}$$

where $I_t = 1$ if $\varepsilon_{t-1} > \tau$, and otherwise I_t =0. τ is the value of the threshold.[4] If $\eta_1 \neq \eta_2$, it indicates that when positive (higher than equilibrium price) or negative (lower than equilibrium price) disequilibrium appear in the system, adjustments would not occur at the same speed. If cointegration exists, then $\eta_1 < 0$ and $\eta_2 < 0$. This study referred to Enders and Siklos (2001) for the critical value of statistic Φ in the threshold cointegration test. In the event that cointegration exists, then η_1 and η_2 will converge to multivariate normal distributions. Furthermore, the conventional *F* test can be used to test for the existence of symmetric adjustments (Chen et al. 2005; Al-Gudhea et al. 2007; Grasso and Manera 2007).

We selected weekly average data for this study, the period of which ranged from 2006M1 to 2015M12 (sample size = 522). The data originated from the grain and grain dealer statistics database of the Agriculture and Food Agency of the Council of Agriculture in the Executive Yuan (http://210.69.25.143/report/search/price/). This study investigated the prices of paddy rice and the retail prices of milled Japonica rice. The unit of all the prices was NTD per hundred kilograms. In addition to overall statistics for Taiwan, we also investigated the major

[4] To obtain the threshold value, we arrange the regression residuals of Eq. (1) in order of value from highest to lowest, and then eliminate the top and bottom 15%. The remainder are considered to be potential threshold values. Next, we use all potential threshold values to estimate the residual sum of squares in Eq. (3). The consistency threshold estimate is the value that minimizes the residual sum of squares (Chan, 1993; Enders and Sikols, 2001; Al-Gudhea et al., 2007; Grasso and Manera, 2007).

agricultural cities individually, including Taoyuan, Hsinchu, Miaoli, Taichung, Changhua, Nantou, Yunlin, Chiayi, Kaohsiung, Pingtung, Yilan, and Taitung.

The estimations of Eqs. (1), (2) and (3) first required the testing of the time series attributes of the various prices. The ADF tests (including both the constant term and the time trend) indicate that all of the variables are I(1) series. Table 1 summarizes the linear cointegration tests (panel A), threshold cointegration tests (panel B) and the cointegration relationships (panel C). The number of lag lengths *k* in Eq. (2) was determined using the Schwarz criterion (SC).

First, the results for statistic Ω indicate that a linear cointegration relationship between rp_t and up_t is supported in all cases. Similarly, the results for statistic Φ strongly suggest the presence of a strong threshold cointegration relationship between rp_t and up_t (12 of the 13 tests rejected $H_0:\eta_1 = \eta_2 = 0$ at the 5% level of significance). Second, a majority of cases (with the exception of Taoyuan, Yunlin, and Taitung), show that negative price deviations from long-run equilibrium are adjusted more quickly compared to positive price deviations. When retail prices are higher than long-run equilibrium value, imperfect competitors, who have greater market power, are not as tempted to drop their prices, and as a result, the estimates of η_1 are lower than the estimates of η_2. According to the *F* test result (Ψ statistic), six cases (Hsinchu, Taichung, Changhua, Chiayi, Kaohsiung, and Yilan) showed significant positive price asymmetry in the long-run.

Panel C of Table 1 displays the estimated cointegration relationships, which indicate a significant long-run equilibrium between the retail prices of milled rice and the price of paddy rice. With Taiwan as an example, when the paddy rice price increases by 1%, a pass-through of 0.681% is shown in the retail price of milled rice in the long run.

4. Asymmetric ECM and the tests for price asymmetry

The existence of a cointegration relationship between rp_t and up_t implies that the short-run dynamic adjustments of milled rice retail prices can constitute an ECM (Engle and Granger 1987):

$$\Delta rp_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i \Delta rp_{t-i} + \sum_{i=0}^{n} \beta_i \Delta up_{t-i} + \rho\varepsilon_{t-1} + \epsilon_t \quad (4)$$

where ϵ_t is the error term. $\varepsilon_{t-1} = rp_{t-1} - \theta_0 - \theta_1 up_{t-1}$ denotes the deviation from the equilibrium, referred to as the error correction term. ρ is the adjustment coefficient of long-run equilibrium. β_i measures the short-run impact of paddy rice price fluctuation, and β_0 indicates the immediate effects of paddy rice price changes. $\beta_i\ \forall i = 1, \cdots, n$ denotes the distributed lag effects of paddy rice price changes. α_i measures the short-run impact of lagged milled rice retail prices.

To capture the effects of price asymmetry, Abdulai (2000) and Grasso and Manera (2007) suggested extending a basic ECM into an asymmetric ECM with threshold cointegration. We thus let variable $x_t^+ = \max\{x_t, 0\}$ and variable $x_t^- = \min\{x_t, 0\}$ be the positive and negative portions of variable x_t, respectively. Therefore, the asymmetric ECM with threshold cointegration can be written as follows:

$$\Delta rp_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i^+ \Delta rp_{t-i}^+ + \sum_{i=1}^{m} \alpha_i^- \Delta rp_{t-i}^- + \sum_{i=0}^{n} \beta_i^+ \Delta up_{t-i}^+ + \sum_{i=0}^{n} \beta_i^- \Delta up_{t-i}^- + \rho^+ I_t \varepsilon_{t-1} + \rho^-(1 - I_t)\varepsilon_{t-1} + \epsilon_t \quad (5)$$

Eq. (5) divides paddy rice price and milled rice retail price into positive and negative variations. β_i^+ (β_i^-) measures the positive (negative) impact to paddy rice prices in the short run; β_0^+ (β_0^-) denotes the positive (negative) immediate effects on paddy rice price changes, and β_i^+ (β_i^-) $\forall i = 1, \cdots, n$ represents the distributed lag effects of paddy rice price changes. α_i^+ (α_i^-) gauges the effects on milled rice retail prices that extend from the past to the current period. ρ^+ and ρ^- indicate the correction rates of the current period toward equilibrium when the retail price of the previous period is greater or lower than the equilibrium price.

Table 2 presents the coefficient estimates resulting from Eq. (5). We employed the SC to determine the optimal numbers of lag length, *m* and *n*, in Eq. (5) (maximum lags = 12). The number below each coefficient indicates the heteroskedastic and autocorrelated consistent (HAC) standard errors devised by Newey and West (1987). The results in Table 2 show that in all cases except Taichung and Yilan, the impact of positive paddy rice prices had greater immediate effects, indicates that the retail prices of milled rice react more swiftly to rising costs than to falling costs in the short run.

As for the estimates of ρ^+ and ρ^-, the majority of the values were negative, which implies that the system is converging to equilibrium. Table 2 reveals that nine cases (Taiwan, Hsinchu, Miaoli, Taichung, Changhua, Nantou, Chiayi, Kaohsiung, and Pingtung) indicate greater adjustments when short-run retail prices of milled rice are less than the equilibrium price.

To present more rigorous evidence, the widely applied Wald coefficient tests can be used in Eq. (5) to test the long-run and short-run asymmetry (Bettendorf et al., 2003; Chen et al., 2005; Frey and Manera, 2007; Grasso and Manera, 2007; Chou and Tseng, 2016). Panel A in Table 3 presents the test results for short-run asymmetry. If the test results reject $H_0{:}\beta_0^+ = \beta_0^-$, then the paddy rice prices have a contemporaneous asymmetric impact on retail prices. In terms of a 10% level of significance, six of the 13 cases presented a contemporaneous asymmetric impact on paddy rice prices. As for the other 22 symmetric autoregression tests ($H_0{:}\alpha_i^+ = \alpha_i^-$ or $H_0{:}\sum_{i=1}^{m}\alpha_i^+ = \sum_{i=1}^{m}\alpha_i^-$), the null hypothesis could only be rejected at a 10% level of significance in three cases. Among the 35 short-run price asymmetry tests in Panel A of Table 3, 9 rejected the null hypothesis at a 10% level of significance.

Panel B in Table 3 presents the test results for a null hypothesis of equilibrium adjustment path symmetry ($H_0{:}\rho^+ = \rho^-$). Viewing the issue with a 10% level of significance, we found the presence of asymmetric equilibrium adjustment path in Taiwan, Hsinchu, Miaoli, Taichung, Changhua, Nantou, Chiayi, Kaohsiung, and Taitung. We also performed simultaneous tests on short-run asymmetry and equilibrium adjustment path asymmetry ($H_0{:}All\ \alpha_i^+ = \alpha_i^-$, $\beta_i^+ = \beta_i^-$, and $\rho^+ = \rho^-$), establishing that the null hypothesis was rejected at a 10% level of significance in nine cases (Taiwan, Hsinchu, Miaoli, Taichung, Changhua, Nantou, Kaohsiung, Pingtung, and Taitung) (Panel C of Table 4).

In conclusion, rejections in any of the above symmetry tests indicate asymmetric adjustments (Chen et al., 2005). Among the 61 tests in Table 3, 27 rejected the null hypothesis (approximately 44.26%). Only in Taoyuan and Yunlin, none of the null hypotheses were rejected. The results in Tables 2 and 3 also reveal that price asymmetry is a widespread phenomenon in the rice market of Taiwan.

Table 1

Cointegration tests

	Taiwan	Taoyuan	Hsinchu	Miaoli	Taichung	Changhua	Nantou	Yunlin	Chiayi	Kaohsiung	Pingtung	Yilan	Taitung
Panel A. Linear cointegration tests													
η	-0.035***	-0.032***	-0.040***	-0.044***	-0.062***	-0.083***	-0.083***	-0.104***	-0.077***	-0.103***	-0.066***	-0.047***	-0.057***
	(0.009)[a]	(0.009)	(0.011)	(0.014)	(0.016)	(0.017)	(0.017)	(0.018)	(0.016)	(0.019)	(0.015)	(0.014)	(0.013)
Ω[b]	-3.790***	-3.446***	-3.483***	-3.231***	-3.953***	-4.776***	-4.861***	-5.900***	-4.870***	-5.354***	-4.496***	-3.238***	-4.397***
Panel B. Threshold cointegration tests													
η_1	-0.030**	-0.040***	-0.026*	-0.031*	-0.012	-0.056***	-0.073***	-0.118***	-0.053***	-0.081***	-0.051***	-0.034**	-0.088***
	(0.013)	(0.012)	(0.014)	(0.018)	(0.019)	(0.022)	(0.022)	(0.031)	(0.020)	(0.020)	(0.019)	(0.016)	(0.020)
η_2	-0.042***	-0.022	-0.068***	-0.060***	-0.138***	-0.129***	-0.099***	-0.097***	-0.120***	-0.337***	-0.087***	-0.089***	-0.034**
	(0.014)	(0.015)	(0.019)	(0.020)	(0.023)	(0.029)	(0.027)	(0.021)	(0.026)	(0.062)	(0.022)	(0.028)	(0.017)
τ	0.00952	-0.04439	-0.02233	0.01827	-0.01902	-0.02223	-0.02399	0.02770	-0.31113	-0.03949	-0.02703	-0.04522	0.03100
Φ[c]	7.383**	6.396**	7.668**	5.811*	17.573***	13.536***	12.103***	17.553***	14.066***	22.741***	10.908***	6.819**	11.914***
Ψ[d]	0.418	0.916	3.152*	1.178	18.973***	4.122**	0.592	0.340	4.262**	15.820***	1.578	3.110*	4.365**
Panel C. Cointegration relationships													
θ_0	3.008***	3.467***	2.875***	3.302***	3.411***	3.592***	3.042***	3.891***	3.605***	3.957***	3.888***	5.396***	0.889***
	(0.086)	(0.139)	(0.112)	(0.101)	(0.134)	(0.089)	(0.085)	(0.093)	(0.097)	(0.073)	(0.076)	(0.216)	(0.181)
θ_1	0.681***	0.617***	0.694***	0.639***	0.628***	0.601***	0.673***	0.564***	0.601***	0.554***	0.565***	0.381***	0.971***
	(0.011)	(0.018)	(0.015)	(0.013)	(0.018)	(0.012)	(0.011)	(0.012)	(0.013)	(0.010)	(0.010)	(0.028)	(0.023)

Notes: [a] The number in (.) under the coefficient is standard derivation. ***, ** and *, which indicate significance at the 1%, 5% and 10% levels.

[b] Ω is the ADF statistics for $H_0: \eta = 0$. ***, **, and * indicate that the null hypothesis was rejected at 1%, 5%, and 10% significance levels.

[c] Φ is the test statistics for $H_0: \eta_1 = \eta_2 = 0$. The critical value for Φ test is tabulated by Enders and Siklos (2001). ***, **, and * indicate that the null hypothesis was rejected at 1%, 5%, and 10% significance levels.

[d] Ψ is F-statistics test for $H_0: \eta_1 = \eta_2$. ***, **, and * indicate that the null hypothesis was rejected at 1%, 5%, and 10% significance levels.

Table 2

Estimation results of asymmetric ECM

	Taiwan	Taoyuan	Hsinchu	Miaoli	Taichung	Changhua	Nantou	Yunlin	Chiayi	Kaohsiung	Pingtung	Yilan	Taitung
α_0	-0.001*** (0.000)[a]	-0.000 (0.000)	-0.001** (0.000)	-0.001* (0.001)	-0.001 (0.000)	-0.002*** (0.000)	-0.001** (0.000)	0.000 (0.001)	-0.001 (0.001)	-0.001** (0.000)	-0.001*** (0.000)	-0.000 (0.000)	0.000 (0.000)
α_1^+	0.409*** (0.084)	0.264*** (0.080)	0.243*** (0.080)	0.349*** (0.071)	0.378*** (0.083)	0.026 (0.114)	0.301*** (0.057)	0.034 (0.092)	0.144** (0.067)	0.189** (0.084)	0.310*** (0.106)	0.334** (0.139)	0.413*** (0.081)
α_1^-	0.410*** (0.061)	0.235*** (0.075)	0.263*** (0.058)	0.229*** (0.058)	0.213*** (0.070)	-0.036 (0.159)	0.086 (0.182)	0.223** (0.090)	0.130 (0.079)	0.116 (0.223)	0.206*** (0.073)	0.028 (0.018)	0.339*** (0.124)
α_2^+				0.038 (0.072)						0.172** (0.081)		-0.010 (0.049)	
α_2^-				-0.025 (0.070)						0.062 (0.092)		-0.002 (0.005)	
α_3^+				-0.203** (0.087)								0.050 (0.045)	
α_3^-				-0.158** (0.063)								0.013*** (0.005)	
α_4^+				0.083 (0.065)									
α_4^-				0.247*** (0.052)									
β_0^+	0.267*** (0.057)	0.284*** (0.057)	0.319*** (0.079)	0.293*** (0.058)	0.075 (0.049)	0.342*** (0.070)	0.165*** (0.039)	0.278*** (0.099)	0.241*** (0.066)	0.258*** (0.064)	0.257*** (0.065)	0.014 (0.012)	0.108*** (0.036)
β_0^-	0.136*** (0.037)	0.199*** (0.068)	0.236*** (0.065)	0.140*** (0.041)	0.076** (0.034)	0.102*** (0.035)	0.115** (0.051)	0.144 (0.097)	0.232*** (0.064)	0.109*** (0.034)	0.102*** (0.033)	0.017 (0.017)	-0.003 (0.012)
ρ^+	-0.005 (0.009)	-0.035*** (0.013)	-0.003 (0.011)	-0.020 (0.017)	0.004 (0.009)	-0.081*** (0.025)	-0.056** (0.024)	-0.125*** (0.033)	-0.045** (0.019)	-0.082*** (0.019)	-0.039** (0.016)	-0.024 (0.023)	-0.020*** (0.008)
ρ^-	-0.042*** (0.009)	-0.029** (0.014)	-0.089*** (0.023)	-0.093*** (0.022)	-0.057** (0.026)	-0.193*** (0.048)	-0.128*** (0.027)	-0.106*** (0.028)	-0.140*** (0.032)	-0.289*** (0.059)	-0.075*** (0.023)	-0.021** (0.010)	-0.003 (0.005)

Notes: [a] The number in (.) under the coefficient is standard derivation, which is calculated using the Newey-West HAC covariance matrix estimation.

***, ** and *, which indicate significance at the 1%, 5% and 10% levels. The optimal lags of asymmetric ECM are determined using SC (maximum lags = 12).

Table 3

Tests for price asymmetry

	Taiwan	Taoyuan	Hsinchu	Miaoli	Taichung	Changhua	Nantou			Yunlin	Chiayi	Kaohsiung	Pingtung	Yilan	Taitung
Panel A. Tests for short-run price asymmetry															
$H_0: \alpha_1^+ = \alpha_1^-$	0.000[a] [0.998]	0.056 [0.813]	0.042 [0.838]	1.489 [0.223]	1.992 [0.159]	0.241 [0.624]	1.399 [0.238]			2.079 [0.150]	0.022 [0.883]	0.390 [0.533]	0.079 [0.779]	4.574 [0.033]	0.224 [0.637]
$H_0: \alpha_2^+ = \alpha_2^-$				0.456 [0.500]									0.644 [0.423]	0.026 [0.873]	
$H_0: \alpha_3^+ = \alpha_3^-$				0.172 [0.678]										0.627 [0.429]	
$H_0: \alpha_4^+ = \alpha_4^-$				3.492 [0.062]											
$H_0: \sum_{i=1}^{m} \alpha_i^+ = \sum_{i=1}^{m} \alpha_i^-$				0.026 [0.871]								1.019 [0.313]		4.012 [0.046]	
$H_0: \beta_0^+ = \beta_0^-$	3.585 [0.059]	0.790 [0.375]	0.612 [0.435]	3.893 [0.049]	0.001 [0.976]	9.892 [0.002]	0.574 [0.449]			0.765 [0.382]	0.010 [0.920]	3.619 [0.058]	5.946 [0.015]	0.022 [0.881]	8.348 [0.004]
Panel B. Tests for equilibrium adjustment path asymmetry															
$H_0: \rho^+ = \rho^-$	6.247 [0.013]	0.075 [0.784]	9.950 [0.002]	4.929 [0.027]	4.350 [0.038]	4.373 [0.037]	3.851 [0.050]			0.197 [0.658]	5.916 [0.015]	10.363 [0.001]	0.158 [0.692]	0.021 [0.884]	3.510 [0.062]
Panel C. Tests for short-run price asymmetry and equilibrium adjustment path asymmetry															
$H_0: All\ \alpha_i^+ = \alpha_i^-$, $\beta_i^+ = \beta_i^-$ and $\rho^+ = \rho^-$	3.457 [0.016]	0.434 [0.729]	3.839 [0.010]	3.703 [0.001]	2.295 [0.077]	7.588 [0.000]	2.786 [0.040]			0.961 [0.411]	2.020 [0.110]	5.832 [0.000]	4.251 [0.006]	1.027 [0.401]	3.498 [0.016]

Notes: [a] The number in this table is *F*-statistics. The number in [.] under *F*-statistics is *p*-value.

To enable a more precise examination of whether milled rice retail prices adjust asymmetrically to the impact of positive or negative paddy rice prices, we employed the impulse response function to calculate the degree of adjustment in retail prices according to each period. Let IR_j^+ be the degree of response in the retail price of milled rice in the jth period when the paddy rice price in the tth period increases by 1%. Thus, the impulse response of the retail price in the tth period is as follows:

$$IR_0^+ = \frac{\partial \Delta rp_t}{\partial \Delta up_t^i} = \beta_0^+ \tag{6}$$

and the impulse response of the retail price in the $t+1$th period is as follows:

$$\begin{aligned} IR_1^+ &= \frac{\partial \Delta rp_{t+1}}{\partial \Delta up_t^i} \\ &= \beta_1^+ + \alpha_1^+ \frac{\partial \max\{\Delta rp_t, 0\}}{\partial \Delta up_t^i} + \alpha_1^- \frac{\partial \min\{\Delta rp_t, 0\}}{\partial \Delta up_t^i} \\ &\quad + \rho^+ \frac{\partial \max\{rp_t - \theta_0 - \theta_1 up_t, \tau\}}{\partial \Delta up_t^i} + \rho^- \frac{\partial \min\{rp_t - \theta_0 - \theta_1 up_t, \tau\}}{\partial \Delta up_t^i} \\ &= \beta_1^+ + \begin{cases} \alpha_1^+ IR_0^+ & \text{if } IR_0^+ > 0 \\ \alpha_1^- IR_0^+ & \text{if } IR_0^+ \le 0 \end{cases} + \begin{cases} \rho^+ (IR_0^+ - \theta_1) & \text{if } IR_0^+ - \theta_1 - \tau > 0 \\ \rho^- (IR_0^+ - \theta_1) & \text{if } IR_0^+ - \theta_1 - \tau \le 0 \end{cases} \end{aligned} \tag{7}$$

where $rp_t = \Delta rp_t + rp_{t-1}$ and $up_t = \Delta up_t + up_{t-1}$. Similarly, the impulse response of the retail price in the $t+2$th period is:

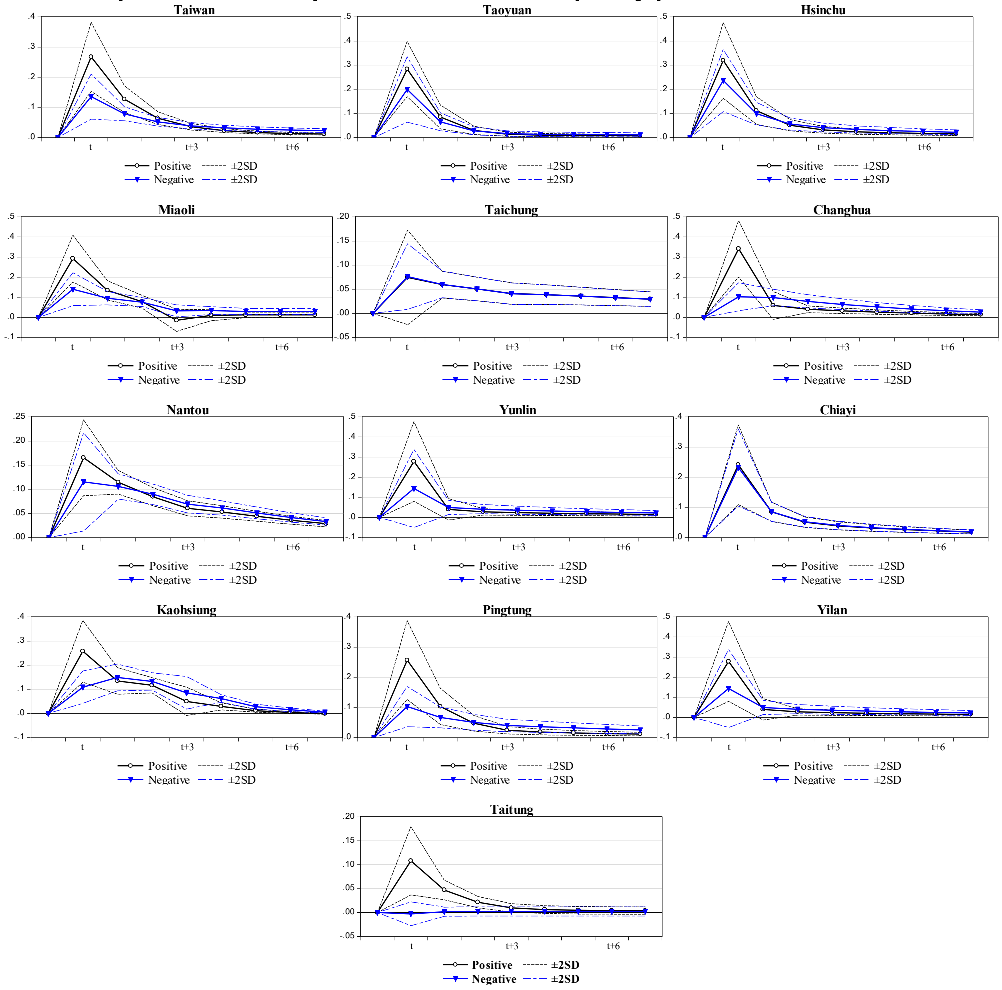
$$\begin{aligned} IR_2^+ &= \frac{\partial \Delta rp_{t+2}}{\partial \Delta up_t^i} \\ &= \beta_2^+ + \begin{cases} \alpha_1^+ IR_1^+ & \text{if } IR_1^+ > 0 \\ \alpha_1^- IR_1^+ & \text{if } IR_1^+ \le 0 \end{cases} + \begin{cases} \alpha_2^+ IR_0^+ & \text{if } IR_0^+ > 0 \\ \alpha_2^- IR_0^+ & \text{if } IR_0^+ \le 0 \end{cases} \\ &\quad + \begin{cases} \rho^+ (IR_0^+ + IR_1^+ - \theta_1) & \text{if } IR_0^+ + IR_1^+ - \theta_1 - \tau > 0 \\ \rho^- (IR_0^+ + IR_1^+ - \theta_1) & \text{if } IR_0^+ + IR_1^+ - \theta_1 - \tau \le 0 \end{cases} \end{aligned} \tag{8}$$

and so on. Similarly, to calculate the degree of adjustment in the retail price of milled rice in the jth period when the paddy rice price decreased by 1% (IR_j^-), β_j^+ was replaced with β_j^-.

Fig. 1 exhibits the impulse response function (IR_j) in the retail prices of milled rice in the case cities resulting from the impact of positive and negative paddy rice prices. The dotted lines indicate ±2SD. In Fig. 1, it is clear that in most of the cities, the retail price adjustments were greater in the event of positive cost impacts (especially in the first week). This demonstrates that market power, search costs, and inventory adjustment are factors of influence in the Taiwanese farm-retail price transmission mechanism. Although retail price adjustments were generally associated with positive price asymmetry in price shocks of paddy rice, the extent of price asymmetry differs from region to region. For example, retail price adjustments in Changhua and Taitung showed strongly positive price asymmetry. According to Tables 1 and 2, retail prices in Taichung and Chiayi demonstrate significantly positive price asymmetry in the long-run, but respond symmetrically to the positive/negative impacts of paddy rice prices in the short run. In Taitung, retail price adjustments showed negative price asymmetry in the long-run, but positive price asymmetry in the short-run. This is because although η_1 and η_2 (or ρ^+ and ρ^-) are said to indicate how quickly positive and negative price deviations adjust towards equilibrium, the actual reaction of short-run prices –from positive/negative cost impacts is calculated using other coefficients from Eq. (5). In other words, if we limited ourselves to only discussing price adjustments greater or less than equilibrium, we may produce biased results. This highlights the importance of distinguishing between short-and-long run price asymmetry. The differences in price asymmetry between regions may also be attributable to the varying effectiveness of price stabilization mechanisms.

Figure 1

Responses of retail price of milled rice to paddy price shocks in Taiwan



5. Asymmetric price transmission and consumer costs

Asymmetric price transmission implies that consumers may suffer loss due to price fluctuations (Borenstein, et al., 1997; Bettendorf et al., 2003; Korale Gedara et al., 2015). Although the analysis in Sections 3 and 4 indicate that price asymmetry is common in the

Taiwanese rice market, different regions show different types of price asymmetry. Decision-makers must clearly understand how paddy rice price changes affect consumer costs, as this relationship has important policy implications.

Based on the assumption of consumption inertia (Xia and Li, 2010) and the fact that rice is a staple food in Taiwan, we hypothesized that consumers consume a fixed amount of milled rice per week. The impulse response function shows how much the retail price of milled rice is adjusted each period for every 1% of variance in paddy rice price. For example, if paddy rice price increases by 1% in the tth period, then the retail price of milled rice increases by IR_0^+% in the tth period, IR_1^+% in the $t+1$th period, and so on. Likewise, consumer cost increases by IR_0^+% in the tth period, $(IR_0^+ + IR_1^+)$% $t+1$th period, and so on. We then let $S_j^+ = \sum_{i=0}^{j} IR_i^+$ represents the degree of cumulative adjustment in the retail price of milled rice in the jth period when the paddy rice price increased by 1% in the tth period:

$$
\begin{aligned}
& S_0^+ = IR_0^+ = \beta_0^+ \\
& S_1^+ = S_0^+ + \beta_1^+ + \begin{cases} \rho^+(S_0^+ - \theta_1) \text{ if } S_0^+ - \theta_1 - \tau > 0 \\ \rho^-(S_0^+ - \theta_1) \text{ if } S_0^+ - \theta_1 - \tau \leq 0 \end{cases} + \begin{cases} \alpha_1^+ S_0^+ \text{ if } S_0^+ > 0 \\ \alpha_1^- S_0^+ \text{ if } S_0^+ < 0 \end{cases} \\
& S_2^+ = S_1^+ + \beta_2^+ + \begin{cases} \rho^+(S_1^+ - \theta_1) \text{ if } S_1^+ - \theta_1 - \tau > 0 \\ \rho^-(S_1^+ - \theta_1) \text{ if } S_1^+ - \theta_1 - \tau \leq 0 \end{cases} \\
& \qquad + \begin{cases} \alpha_1^+ (S_1^+ - S_0^+) \text{ if } (S_1^+ - S_0^+) > 0 \\ \alpha_1^- (S_1^+ - S_0^+) \text{ if } (S_1^+ - S_0^+) < 0 \end{cases} + \begin{cases} \alpha_2^+ S_0^+ \text{ if } S_0^+ > 0 \\ \alpha_2^- S_0^+ \text{ if } S_0^+ < 0 \end{cases} \\
& \quad \vdots \\
& S_j^+ = S_{j-1}^+ + \beta_j^+ + \begin{cases} \rho^+(S_{j-1}^+ - \theta_1) \text{ if } S_{j-1}^+ - \theta_1 - \tau > 0 \\ \rho^-(S_{j-1}^+ - \theta_1) \text{ if } S_{j-1}^+ - \theta_1 - \tau \leq 0 \end{cases} \\
& \qquad + \begin{cases} \sum_{i=1}^{m} \alpha_i^+ (S_{m-i}^+ - S_{m-i-1}^+) \text{ if } S_{m-i}^+ - S_{m-i-1}^+ > 0 \\ \sum_{i=1}^{m} \alpha_i^- (S_{m-i}^+ - S_{m-i-1}^+) \text{ if } S_{m-i}^+ - S_{m-i-1}^+ < 0 \end{cases}
\end{aligned} \tag{9}
$$

Similarly, to calculate the degree of cumulative adjustment in the retail price of milled rice in the jth period when the paddy rice price decreased by 1% (S_j^-), β_j^+ was replaced with β_j^- in Eq. (9).

The cumulative adjustment function shows that when paddy rice price increases or decreases by 1% in the tth period, the change in consumer cost is ($S_j^+ - S_j^-$) %. Therefore, we can use the area between positive/negative cumulative adjustment functions at a specific time to measure changes in consumer cost (Borenstein et al., 1997; Bettendorf et al., 2003):

$$\Delta\, consumer\ cost = \int_{j=0}^{p} (S_j^+ - S_j^-) dj \tag{10}$$

where p indicates the length of the estimation period. Eq. (10) can be calculated using simple linear interpolation. Fig. 2 shows the changes in the consumer cost of milled rice, driven by the positive or negative cost impacts of paddy rice price. The dotted lines indicate ±2SD. The figure shows that in most cities (with the exception of Taichung, Chiayi, and Yilan), price asymmetry increases consumer costs. To provide a clear explanation of data, we assumed that each consumer consumes an average of 1kg of milled rice per week.[1] In Taiwan, consumer costs increased by 0.07% in Week 1 (tth period). This means that price asymmetry in the rice market increased the cost of 1kg of milled rice by 0.07%. By Week 3 ($t+2$th period), the cost difference was close to 0.5%, indicating that the cost of 3kg of milled rice had increased by nearly 0.5%. By Week 8 (two months later), consumer costs had risen by 1.43%. This means that if 1kg of milled rice has a retail price of NT$44.00, within eight weeks consumers will pay NT$5.03 more for the same product due to price asymmetry.[2] In the same period of time (eight weeks), the intermediaries of the rice market (such as rice millers and retailers) will have earned an additional NT$118.61 million.[3]

Generally speaking, price asymmetry in the Taiwanese rice market means that fluctuation in paddy rice prices drives up consumer costs. However, market intermediaries also benefit from supernormal profit.[4] From a consumer protection viewpoint, this has given the government reason to implement price stabilization measures in an attempt to improve the allocation of resources. Fig. 2 illustrates regional differences; for example, consumer costs do not fluctuate significantly in Taichung, Chiayi, and Yilan. In the cases of Taiwan, Miaoli, Changhua, Pingtung, and Taitung, however, consumer costs have risen significantly. These differences may be attributable to varying levels of market power in different regions, and the effectiveness of price stabilization policy. First, although the government monitors the market and releases state-owned rice stocks in order to stabilize retail prices, public policy is concerned with overall, rather than regional, fairness. If distributors in a particular area have stronger market power, then local retail prices are less likely to be affected by public policy. Second, distributors stand to gain supernormal profit from price asymmetry, which enables them to invest in more advanced equipment that will improve product quality. This further limits the effectiveness of price stabilization policy. Third, notwithstanding the existence of laws and public offices established to weed out illegal hoarding and price fixing, these are relatively passive measures that do not completely prevent distributors, incentivized by supernormal profit, from enabling price asymmetry.

Despite considerable emphasis from the government of Taiwan on stabilizing the retail prices of milled rice, we found that positive price asymmetry is still common in the Taiwanese rice market. We believe that this is driven by local market power. Although the government has invested heavily in monitoring prices and interfering in the market, it may be more effective to establish open, transparent mechanisms that provide consumers with comprehensive price information. In a noncompetitive market, consumers do not enjoy full information disclosure and incur search costs in seeking out information. P roviding full pricing data would help consumers compare prices and improve market competitiveness. Subsidizing the purchase of milling equipment and supporting farmers in enhancing their

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[1] *In 2018, each Taiwanese consumed an average of 45.61 kg of milled rice, which equates to 0.88kg per week. For ease of reference, we have rounded this figure up to 1kg of milled rice per week.*

[2] *In 2018, the average price of 1kg of milled rice in Taiwan was NT$44.05.*

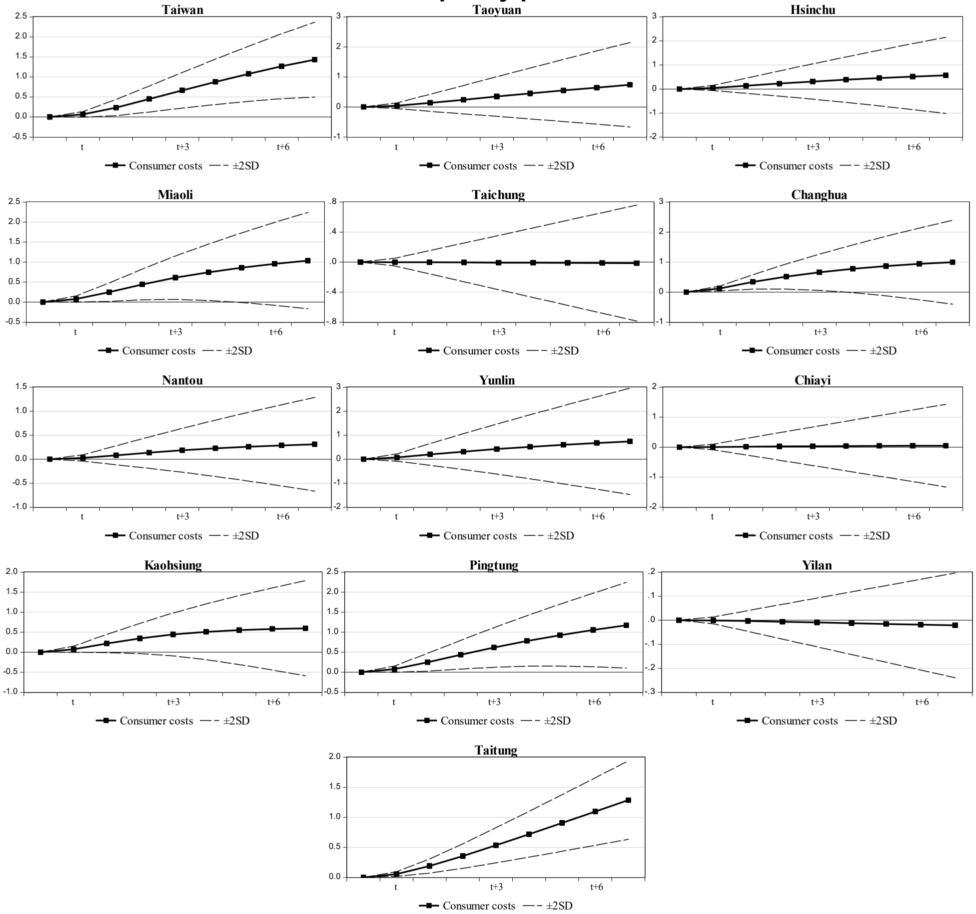
[3] *In 2018, the population of Taiwan numbered 23,580,080. Therefore, within eight weeks, sellers earn an additional NT5.03\times$23403635.*

[4] *These results were obtained by comparing the effect of a one-off rise/reduction in paddy rice price on consumer cost. We did not analyze trends of ongoing fluctuation in paddy rice price. Although this scenario is not completely analogous, the results still provide valuable reference.*

production and marketing capacities could also lead to a more competitive market. These measures may contribute to relieving price asymmetry in the Taiwanese rice market.

Figure 2

Consumer costs and paddy price shocks in Taiwan



6. Conclusion

The importance of rice as the staple in Taiwan emphasizes the significance of price fluctuations on the costs of consumers. Determining whether asymmetric price transmission mechanisms exist between retail prices of milled rice and paddy rice prices is a concern for consumers as well as a focus of government administration. Some studies which only focused on market integration or neglected the characteristics of price asymmetry in the short run. This study emphasized the asymmetry in the farm-retail price transmission, and performed threshold cointegration tests to identify the existence of stable cointegration relationships between the retail prices of milled rice and paddy rice prices in the major agricultural cities of Taiwan. We found that retail price adjustments to negative price deviations from long-run equilibrium are faster than adjustments to the positive ones with a null threshold. The estimation of asymmetric ECMs and impulse response functions indicated that in the short run, retail prices responded more strongly and swiftly to positive paddy rice price impacts. This shows that asymmetric price transmission in the Taiwanese rice market can be caused by factors such as market power, search costs, and inventory adjustment. Furthermore, the results of various price asymmetry tests support the view that price asymmetry is a widespread phenomenon. However, the extent of price asymmetry differs from region to region. Lastly, price asymmetry implies that increases in paddy rice price are transmitted to consumer costs more rapidly than decreases. This enables suppliers in the production-distribution chain to earn supernormal profit.

Although Taiwan has already transitioned into a developed nation, the government is still active in stabilizing the retail prices of milled rice, for example by releasing state-owned stock to regulate supply-demand, or working to stamp out illegal hoarding and price fixing. Despite these measures, positive price asymmetry is still common in the Taiwanese rice market, perhaps due to the limited effectiveness of government policy or the incentive of supernormal profit. Because positive price asymmetry is rooted in a noncompetitive market, we recommend that the government establish open, transparent mechanisms to disclose full pricing information to consumers. Also, subsidizing the purchase of processing equipment and supporting farmers in enhancing their production and marketing capacities could raise competitiveness in the rice market, potentially discouraging price asymmetry. Going forward, research can be emphasized asymmetry in farm-wholesale and wholesale-retail price transmissions, so as to examine the differences between different stages. In addition to having important implications for policy makers, a phenomenon of price asymmetry in production-distribution chain services as a key element in evaluating welfare effects of market failure.

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