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Retail price rigidity in perishable food products: a case study

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Abstract

Why are retailers less likely to vary sale prices of food products when the price paid to the farmer falls than when it rises? As far as perishable goods are concerned, this behavior is usually related to the retailer's bargaining power. With a view to analyzing the question in greater depth, this study presents a simplified framework considering an ideal scenario in which the retailer wishes to maintain balanced profits due to external pressures or other factors, such as a competitive distribution market. In the face of changing supply, the price-fixing decision of the distributor may also depend on the risk, measured by the relationship between demand elasticity and variable costs, as a result of uncertainty in consumer response to price variations. The simulation of these scenarios is carried out taking as reference the Spanish tomato market. The results of these applications allow to see that despite a relaxation of bargaining power, price asymmetry is not avoided. This work shows the difficulty for suppliers and retailers to reach agreements which could result in competitive advantages.

Additional key words: demand elasticity; farmer supply; risk.

Resumen

Rigidez de precios minoristas en productos perecederos: un caso de estudio

¿Por qué cuando el precio pagado al agricultor baja, los precios de venta detallista, de los productos alimenticios, varían en menor proporción que cuando éste aumenta? En los productos perecederos este comportamiento se relaciona, generalmente, con el poder de negociación del minorista y con su estructura de costes. Con el objetivo de profundizar en esta cuestión, este estudio presenta un marco simplificado considerando un escenario en el que el minorista desea mantener los beneficios equilibrados debido a presiones externas o a la existencia de una fuerte competencia entre las propias cadenas de distribución. En esta situación, el minorista se enfrenta a un aumento del riesgo como consecuencia del desconocimiento de la demanda que justifica un movimiento asimétrico de precios. Adicionalmente, se realiza una simulación tomando como referencia el mercado español de tomate. Los resultados muestran que pese a la «relajación» del escenario que supone un mayor poder de negociación de las cadenas con sus proveedores, no se evita que se produzcan asimetrías de precios. En este trabajo se aprecia la dificultad de materializar acuerdos de precios entre minoristas y proveedores que pudieran redundar en ventajas competitivas.

Palabras clave adicionales: elasticidad de demanda; oferta del agricultor; riesgo.

Introduction

The present work analyzes why retailers (supermarket chains) are less willing to vary their sale prices of perishable food products when the price they pay to their supplier (farming-marketing firm) falls due to overproduction than when there is a shortage of produce.

Several theories have attempted to explain price rigidity and asymmetry: see *e.g.* Meyer and Von Cramon-Taubadel (2004) and Vavra and Goodwin (2005) for recent literature reviews. Market power, that is the existence of non-competitive structures, is one of the most widely analyzed (Ward, 1982; Neumark and Sharpe, 1992; Peltzman, 2000). From another point of view, imperfect information means that a price increase at production level serves as information for natural coordination between companies. However, not knowing competitors' strategies induces retailers to maintain prices while there is an acceptable volume of demand (Borenstein *et al.,* 1997). On the other hand, the internal structure of costs may mean that a company

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enjoying a comfortable financial situation delays dropping prices as it can afford to take the risk of maintaining higher prices than its competitors (Bedrossian and Moschos, 1998). The theory of change of nominal prices, also known as «menu cost» has also attracted considerable attention (Ball and Mankiw, 1994; Blinder *et al.*, 1998). The cost associated with the change in prices (required labor or materials) has proven to be relevant when deciding to maintain prices stable (Levy *et al.,* 1997, 2002; Owen and Trzepacz, 2002). From a theoretical point of view, Gardner's model (1975) is a very useful tool which allows us to know the effects on the retailer-producer price spread of variations in final demand, production at origin and marketing costs. Kinnucan and Forker (1987) use the context of Gardner's model to explain the influence of changes in the producer's supply on retail prices, finding evidence that final sale prices vary more slowly with lower cost at origin than with higher cost.

In the context of perishable goods, Ward (1982) considers that perishability can be an important source of asymmetric transmission, because retailers could avoid raising prices for fear of being left with a spoiled product. Sexton and Zhang (1996) point out that with a relatively fixed (inelastic) supply, retailers can reduce the prices they pay by a relatively large amount before suppliers are no longer willing to bring their goods to market[1]. This implies that the retailer's relative bargaining power seems more plausible in an industry that deals with perishable and unstorable products (Acharya, 2000).

Despite a large number of studies that have investigated the phenomenon of price transmission in food markets, it is not possible to draw strong conclusions upon which policy decisions could be based. Although many studies seeking imperfect price transmission have found support for it, the evidence is often mixed and varies widely across commodities and countries (Vavra and Goodwin, 2005).

The main aim of the present work is to study the retailer pricing behavior in greater depth, taking as reference the retailer price rigidity observed in the Spanish fresh tomato market (Ministry of Agriculture, Fisheries and Food, MAPA, 2003). We develop a comprehensive and simplified framework, based on an initial situation of behavior that could be termed «ideal», in which retailer and supplier agree to maintain their profits. In other words, a situation in which the relative bargaining power of the retailer may be offset by external pressures or other factors such as a competitive distribution market. In this way, we intend to determine what effects this type of behavior would have on price asymmetry: whether it would be eliminated, or on the contrary would still persist. A further aim is to determine whether such agreements are feasible and able to be stable in time. The model developed allows testing different scenarios and is analyzed in an empirical application.

Methodology

In a first scenario, it is assumed that neither the retailer nor the supplier should lose income in situations of varying supply (assumption «a»). We contemplate an alternative scenario in which the retailer will try to maintain a situation of balanced profit for both parties in order to avoid the intervention of the administration or pressure from producer organizations (Maloni and Brown, 2008). These pressure groups identify asymmetries of prices and price gap between origin and destination with non-egalitarian bargaining between retailer and supplier[2]. In this first model we also assume that total production is marketed (assumption «b»).

These assumptions could even be true in a competitive market. Thus, for example, due to a strong competition between retailers, these might have a vested interest in integrating producers into their supply chain in order to create synergies in the optimization of logistics or improvements in the quality of supply (Marcus and Anderson, 2006). In Spain such a case can be seen in the strategy adopted by the Mercadona supermarket chain (Blanco and Gutiérrez, 2008). Acting in such a way could be beneficial for the retailer by differen-

[1] On the other hand, if supply is highly responsive (elastic), then a similar pricing strategy will mean that retailers are left with little to sell to consumers and their total profit falls accordingly.

[2] For instance, bargaining power of retailer in the Spanish tomato market is derived from the predominance in the marketing process of small cooperative firms. In Almería alone, which is the leading area of production in Spain with a production and sales volume of around 12,000 tonnes, there are 47 such firms (FEPEX, 2009). This means that most of the firms, which bargain individually, sell their tomatoes to common clients, which are the large retailers or purchase centres for multinational distribution chains: Tesco, Aldi, Rewe or Carrefour (Pérez-Mesa, 2007). These companies have access to supplies in different parts of the world, and fair bargaining between small producers and purchasers with great availability of resources is clearly unlikely.

tiating them from the competition (Bhatnagar and Teo, 2009). As Fearne and Hughes (1999) point out, maintaining the supplier's profits is a factor of competitiveness. This implies that the retailer will have to attempt to maintain the supplier's profit and to coordinate supplies (assumptions that are contemplated in the empirical application of the paper). Indeed, this situation might arise even maintaining institutional pressure: in this framework, retailers that best integrate their supplier in the supply chain would be more competitive.

In a second scenario assumption b. is «relaxed», allowing for demand to be different to supply, or that demand is unknown. This is a common scenario for the fruit and vegetables market, as consumer demand is very sensitive to substitute products (even within the same family) or is affected by climatic factors (cold or heat, as in the case of melon and water melon). Variability of demand, especially when dealing with data reported for periods under one year as in the framework of the present analysis, has been shown by Galdeano (2005) and De Pablo *et al.* (2008). In these scenarios, the question is: What causes rigidity in retail price? Specifically we focus attention on demand elasticity, as a component of risk, which changes as a consequence of variations in the quantity supplied, using the structure of variable costs of producer and retailer as a method of transmission.

Backgrounds of differences in pricing behavior

The relationship between farm and retail prices has been the subject of numerous research studies that aim to understand why sales margin for food products change over time. The causes of differences in the way that the retail price adjusts to an increase or decrease in farm price and *vice versa*, *i.e.* asymmetry and rigidity in prices, have been analyzed from different perspectives. These analyses can be categorized as: models of imperfect vertical or horizontal competition, models based on the firm's internal structure (costs, inventories, performance) and other miscellaneous models (*e.g.* those based on the nature of the product or on state intervention). Regarding analytical approach, we find deductive theoretical models (Gardner type) and empirical ones (econometric or inductive). The former analyzes the relationship between farm and retail prices, but they seldom reflect reality, while the latter can detect real asymmetry, but they do not provide a formal explanation of it.

The main cause identified by the literature for rigidity and asymmetry in farm-retail price is the presence of non-competitive behavior, *i.e.* market power (imperfect competition). The argument for this rests on the fact that supply chains for food products are often much less concentrated at the farm level than higher up. This is, therefore, imperfect competition of a vertical type in which larger firms (retailers) take advantage of their bargaining power in the relationship with suppliers. This could cause oligopolistic processors and retailers to react collusively and transmit more rapidly shocks that squeeze their margin than shocks that stretch it (Meyer and Von Cramon-Taubadel, 2004). Market power will thus lead to positive asymmetry[3] in an oligopolistic retail environment: costs and retail margins increase as retail margins are squeezed, whereas cost decreases will not be instantaneously transmitted to price decreases because firms maintain prices above the competitive level (Borestein *et al.*, 1997).

Nevertheless, it may also be possible to justify price asymmetry due to horizontal competition among retailers. Authors such as Bailey and Brorsen (1989) argue that market concentration will lead to positive or negative asymmetry: if a firm believes that competitors will match an increase in output prices, but not an equivalent reduction, positive asymmetry transmission will result. On the other hand, if a firm believes that no competitor will match a price increase but all will match a price cut, negative asymmetry will result. In a similar context, Balke *et al.* (1998), and Brown and Yücel (2000) consider oligopolistic firms that engage in unspoken collusion to maintain higher profits; risk of provoking a price war may make firms reluctant to lower prices, and price adjustment might take place only after some lags. In this case, when input prices rise, each firm will quickly adjust prices upwards to signal that collusion will be maintained, whereas they will wait to lower output prices to avoid undermining a tacit agreement.

Alternative explanations for differences in pricing behavior are due to the adjustment costs and the firm's

[3] Following Peltzman (2000), asymmetry can be classified as either positive or negative. Considering a simplified farm-retailer scenario, if retail price reacts more fully or rapidly to an increase in farm price than to a decrease, the asymmetry is termed positive. Correspondingly, negative asymmetry denotes a situation in which retail price reacts more fully or rapidly to a decrease in farm price than to an increase.

internal structure. The costs of labeling, advertising or promoting goodwill makes the re-marking of prices expensive. Thus, the reaction to a given rise in price might take place with some delay. Authors such as Ball and Mankiw (1994), and Zachariasse and Bunte (2003) have stressed the importance of the menu costs of re-marking prices, such as the cost of reprinting catalogues. Blinder (1982) and Balke *et al.* (1998) based their models on inventory management as the cause of firm adjustment to exogenous shocks. Baley and Brorsen (1989) show that certain firms face significant fixed costs (*e.g.* packers), and in the short run, profit margins may be reduced in an attempt to keep a plant operating at or near full capacity; therefore, as a result of competition between different packers, farm prices may be bid up more quickly than down. On the other hand, Peltzman (2000) argues that it is easier for a firm to reduce inputs in the case of an output reduction than it is to recruit new inputs to increase output. Other explanations are related to different levels of profitability, which can lead to asymmetry according to Bedrossian and Moschos (1998): if a firm is relatively profitable, then it can take greater risks in delaying a price adjustment to a fall in input prices. The model of Ball and Mankiw (1994) uses inflation as an explanation for asymmetric price transmission: in this case, firms would increase prices to correct for accumulated and anticipated inflation; however, transmission of negative shocks would be less necessary as inflation would already have adjusted the prices.

There are some additional theories which explain the existence of differences in price adjustment[4]. Kinnucan and Forker (1987) explain how government intervention can lead to asymmetric price adjustments. Processors and retailers may believe that a reduction in price may be temporary because it will trigger government intervention through support prices. In this context, processors and retailers will not react to a reduction in farm prices but they will believe it is more likely to be permanent. Psychological pricing points, as suggested by Blinder *et al.* (1998), could have an analogous influence on price transmission.

Finally, Acharya (2000), and Sexton and Zhang (1996) have reported perishability of goods as an important factor in the buyer-retailer's ability to influence market prices. Sexton and Zhang (1996) argue that the scarcity rent is allocated between farmers and buyers based on their relative bargaining power, which seems more plausible in an industry that deals with perishable and unstorable products. Ward (1982) suggests that retailers might hesitate to raise prices for fear of reduced sales leading to spoilage. While Heien (1980) argues that changing prices is less of a problem for perishable products than it is for those with a long shelf life, because for the latter changing prices incurs higher time costs and losses of goodwill.

From a theoretical point of view, Kinnucan and Forker (1987) and Von Cramon-Taubadel (1998) consider asymmetries in the framework of the marketing margin model developed by Gardner (1975). In this model, the farm-retail price spread depends on shifts in both retail-level demand and farm-level supply. Under conditions of perfect competition and constant returns to scale, Gardner deduces a stronger impact of retail-level demand shifts than of farm-level supply shifts on the farm-retail price spread.

From a purely practical point of view, numerous research has concentrated on the identification methods and the magnitude of the changes in the farm price reflected in the retail price and *vice versa*. (see *e.g.* Vavra and Goodwin, 2005, for a comprehensive review).

In general, despite wide coverage of this topic in the literature, the one indisputable conclusion is that more research is needed in order to understand the increasingly complicated relationships among prices along the supply chain and the underlying behavior of agents (Meyer and von Cramon-Taubadel, 2004).

This paper provides additional explanations to those exposed above, in particular for perishable products in short time intervals. The scheme proposed changes the role of costs as they generate asymmetry in prices (Fig. 1). By using a simplified model, we attempt to minimize the influence of the afore mentioned main causes of differences in pricing behavior, even assuming that both the farming-marketing firm and the retailer wish to maintain a balanced marketing profit margin. In addition, we try to find empirical justification for the theoretical analytical framework.

Theoretical framework

As expounded in the introduction, several assumptions are considered in our framework. First, a simplified marketing chain, with direct sales from the supplier (farming-marketing firm-industry) to the retailer (su-

[4] Meyer and Von Cramon-Taubadel (2004) name these additional explanations as «miscellaneous».

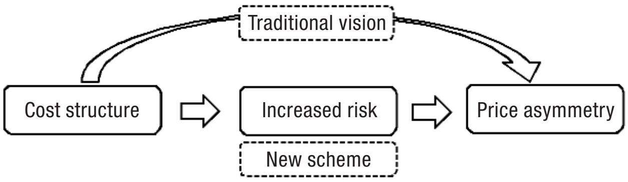

Figure 1. Scheme of work.

permarket chain)[5] is considered, meaning that there are no intermediaries to distort the relationship between retailer and supplier. Second, the potential for retailer's bargaining power is compensated, leading to a scenario in which neither the retailer (supermarket) nor the supplier should lose income in situations of varying supply and when the total production is marketed. As mentioned above, this scenario can result from the pressure of government intervention and producer organizations or to competitive retailer strategies to integrate suppliers[6]. We therefore start from a situation of balanced marketing profit margins in which no pressure is applied to force prices up or down. Thirdly, in relation to the previous two, we assume that the adjustment cost for the retailer is only important in logistic terms (as the main variable cost)[7].

Profit for supplier and retailer

The supplier is a food marketing firm with a lineal function of cost production, $C_t^s(q_t) = c_s q_t + w_s$, where q_t is the quantity marketed at time *t*, c_s is the unit variable cost, and w_s is the fixed cost. If we denote by $I_t^s(q_t)$ the obtained income at time *t,* then the expected profit π_t^s at time *t* is:

$$\pi_t^s(q_t) = I_t^s(q_t) - C_t^s(q_t) = p_t^s q_t - (c_s q_t + w_s) =$$
$$= (p_t^s - c_s)q_t - w_s$$

where p_t^s is the sale price at time *t*. The objective of this firm is to maintain a stable balance of profit over time, then

$$\dot{\pi}_t^s(q_t) = \frac{d\pi_t^s}{dt}(q_t) = 0 \qquad [1]$$

Annex 1 shows the theoretical implications of condition [1] for p_t^s.

Now we consider a retailer firm with a lineal function of cost production, $C_t^r(q_t) = (c_r + p_t^s)q_t + w_r$, where c_r is the unit variable cost and w_r is the fixed cost. The expected profit of the retailer π_t^r at time *t* is:

$$\pi_t^r(q_t) = I_t^r(q_t) - C_t^r(q_t) = p_t^r q_t - (c_r + p_t^s)q_t + w_r$$

where p_t^r is the sales price to consumers. In order to maintain the retailer's own profit and that of the supplier over time, we estimate the sale price p_t^r knowing that

$$\dot{\pi}_t^r(q_t) = \frac{d\pi_t^r}{dt}(q_t) = 0 \qquad [2]$$

where p_o^r and q_o are retail sale price and marketed amount at the start of the period studied. Therefore, the price-demand elasticity which the retailer must withstand to fulfil all the requirements is:

$$\varepsilon_t^r = \frac{p_o^r}{\dot{p}_t^r} \cdot \frac{\dot{q}_t}{q_o} \qquad [3]$$

Annex 2 shows the theoretical implications of condition [2] for p_t^r and ε_t^r.

So far we have assumed that the whole offer is absorbed by demand: $q_t = q_t^m$, where q_t^m is the amount demanded by the market. However, henceforth we shall consider that demand is different to supply:

$$q_t^m = f(p_t^r) \qquad [4]$$

Using data from a period of less than one year as in this analytical framework, it is extremely difficult to establish a relationship like [4] for perishable produce, since there is great seasonal variability: this circumstance has been dealt with at length by Galdeano (2005) and De-Pablo *et al.* (2008). In certain cases we could speak of demand that is difficult to calculate or even unknown. In this situation, ε_t^r would be a measure used to calculate the retailer's risk[8] or a minimum threshold that the retailer should take in order to maintain the retailer's own profit and that of the supplier. The risk taken would be equal to $prob(\varepsilon_t^m < \varepsilon_t^r) = F(\varepsilon_t^r)$, where $F(.)$ is the probability distribution[9] of $\varepsilon_t^m = \frac{p_o^r}{\dot{p}_t^r} \cdot \frac{\dot{q}_t^m}{q_o}$, *i.e.* the

[5] In fact, this situation is close to reality in the case of tomato marketing in Southeast Spain, which is taken as reference in our application (Pérez-Mesa, 2007).
[6] This is in line with new trends of vertical integration in the distribution chain (MAPA, 2003). Unlike Gardner's formulation, which distinguishes between quantities of produce at supplier and retail levels, it is assumed that the total production is marketed, as usually occurs in contracts between farm-marketing firms and supermarkets in Spanish fresh tomato distribution.
[7] There are no additional costs of product storage (considering perishable products), re-marking prices or others.
[8] This definition of risk is in the line of the concept and measure as described by Hardaker (2000) and Just (2003).
[9] Increasing monotone.

real market elasticity as a result of the changes in the price fixed by the retailer in agreement with the supplier. By way of example, if demand were to follow an exponential function $q_t^m = \alpha \cdot p_t^r \exp(b)$, then $b = \varepsilon_t^m$, *i.e.* market elasticity would be constant over time.

As commented above, the situation where $\varepsilon_t^m < \varepsilon_t^r$ would imply that the retailer could not maintain constant profit, which would lead to a break in the pact with the supplier.

It should be noted that if conditions [1] and [2] are fulfilled, there will be an effect on supplier-retail price spread ($m_t = p_t^r - p_t^s$), and this verified below in an empirical way. Annex 3 shows the theoretical consequences.

Results

Application and simulation

Using the described scenarios, we make a simulation based on the price asymmetry observed in the fresh tomato marketing chain in Spain. We consider a farming-marketing firm of tomato (cooperative or a marketing organization, which the farmers own) which supplies directly to a supermarket chain in the northeast of Spain. The sources of both variable and fixed costs are: production and handling at origin (Salinas and Palao, 2002; Pérez-Mesa, 2007), and logistics of supermarket (MAPA, 2003). The initial retail sale price is calculated applying a 20% increase on the variable cost of the supermarket (MAPA, 2003).

Week 1: A balanced scenario

In the initial situation a supermarket chain makes a weekly purchase of 335 tons of tomatoes at €680 ton^{-1}. As described above and for the sake of simplification, the supermarket chain only has to bear the cost derived from logistics (€210 ton^{-1}), the price paid to the producer (€680 ton^{-1}) and a fixed cost of €37,185[10]. The farming-marketing firm has to face a variable cost of €490 ton^{-1} and a weekly fixed cost of €46,900. The retail sale price is €1,070 ton^{-1}. The supermarket knows that at this price it will be able to sell the 335 tons and maintain a balanced profit, *i.e.* a situation in which no pressure exists to force prices up or down. Table 1 shows a summary of the initial scenario. The supermarket chain will obtain a weekly profit of €23,115, while the farming-marketing firm makes €16,750.

Week 2a: Increased supply and retailer negotiation

Now we suppose that in the following week there is an increase in production (for example, as a result of meteorological factors which speed up fruit ripening

Table 1. Results of the simulations

Assumptions	Week 1 (t)	Week 2.a (t+1)	Week 2.b (t+1)
[1] Sale price (€ ton^{-1})	1,070	1,070	946
[2] Demand (ton)	335	335	503
[3] = [1] × [2] Income from sales (€)	358,450	358,450	476,050
[4] Logistics costs (€/t)	210	210	210
[5] = [3] × [2] Total logistics costs (€)	70,350	70,350	105,630
[6] Price paid to farming-marketing firm (€ ton^{-1})	680	500	617
[7] = [6] × [2] Income of farming-marketing firm i(€) = Rest of variable costs of supermarket (€)	227,800	167,500	310,120
[8] = [5] + [7] Total costs of supermarket (€)	298,150	237,850	415,750
[9] = [3] – [8] Supermarket profit margin (€)	60,300	120,600	60,300
[10] Fixed costs of supermarket (€)	37,185	37,185	37,185
[11] = [9] – [10] **Total profit of supermarket**	**23,115**	**83,415**	**23,115**
[12] Variable costs of farming-marketing firm (€ ton^{-1})	490	490	490
[13] = [7] – [12] × [2] Profit margin for farming-marketing firm (€)	63,650	3,350	63,650
[14] Fixed costs of farming-marketing firm	46,900	46,900	46,900
[15] = [13] – [14] **Total profit of farming-marketing firm**	**16,750**	**–43,550**	**16,750**

[10] Estimating 11% of the total weekly costs (MAPA, 2003).

Table 2. Summary of possible strategies to obtain identical profits to week 1 ($C_s = 210$ € ton^{-1})

Variation in production (%)	Tons sold	Retail price	Price paid to farming-marketing firm	Difference between price at origin and retail price	Minimum demand elasticity necessary
50	503	946	617	329	–4.342
40	469	964	626	338	–4.049
30	436	984	636	348	–3.764
20	402	1,008	648	360	–3.470
10	369	1,036	662	374	–3.185
5	352	1,052	671	381	–3.039
1	338	1,067	678	389	–2.918

or because the crop has been badly planned). The farming-marketing firm is now able to sell to the supermarket chain 503 tons (50% more than in the previous week). This increase in production has been general in the whole production area and so reference prices (*e.g.* prices in a local wholesale market) have dropped. The supermarket negotiates a lower purchase price, which is finally established at €500 ton^{-1}. At this price the supermarket may obtain more profit than the previous week if they buy 335 tons at a price of €500 ton^{-1} as opposed to €680 ton^{-1}. The second column in Table 1 includes the extreme situation in which the supermarket continues to buy the same as in week 1.

Week 2b: Increased supply and balance of profits

In order to avoid government intervention, or pressure from producer organizations[11], or even as a business strategy, the supermarket decides to purchase at a higher price than in assumption 2.a (but lower than in assumption 1) in order to maintain the same balance of profits as before absorbing the increase in supply[12]. To do so, the retailer needs to sell at a minimum price of €946 ton^{-1}, and to purchase from the supplier at €617 ton^{-1}. This means that the supermarket chain would have to lower the retail sale price by 12% in order to increase sales by 50%. In other words, the expected quantity-price elasticity is –4.342. What would happen if the demand responded to less elasticity? The supermarket chain would make less profit than in the first week.

Sensitivity analysis

There are intermediate strategies between those exposed for weeks 1, 2a and 2b. Given the excess in production, the farming-marketing firm might think that the supermarket will act fairly, as in the above example. In this case it might send less quantity to the supermarket, thinking that they will respond by lowering retail sale prices in order to obtain the same results as in week 1. Table 2 reflects the different strategies of retail sale prices, prices of liquidation to the supplier and tons sold, without affecting the supermarket's profits with respect to week 1. In parallel, Figure 2 shows the minimum elasticity to which demand should respond if both supermarket and supplier are to maintain the profits made in week 1.

In view of these data, if the supermarket wants to be fair to the supplier given any variation in production,

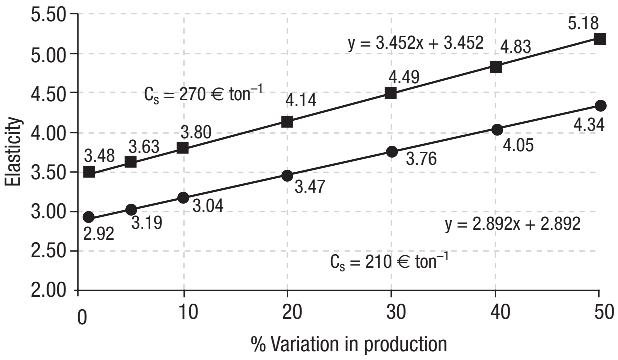

Figure 2. Relationship between the minimum elasticity required (in absolute value) and the % variation in marketed and sold produce.

[11] This often takes the form of protest or bad press regarding the supermarkets' attitude.
[12] This situation is also feasible from a monopolistic point of view in the case of tomato, since in Spain one single town (Almería) accounts for over 40% of national marketed tomato during the winter season.

it should subject itself to market uncertainty, which demands an elasticity of at least 2.9. For example, according to Table 2, if the supermarket decides to market 10% more quantity as the supplier has excess product, its sale price should be 2.6% lower in so consumers purchase the extra 10%.

Any positive variation in the total variable costs would displace the elasticity curve upwards (Fig. 2). Thus, for example, if the logistics cost increased to €270 ton^{-1}, to market 503 tons (50% more than in week 1) a minimum elasticity of 5.183 would be required. A reduction in the cost of logistics to €150 ton^{-1} would reduce the necessary elasticity to sell 503 tons to 3.736.

In short, given a situation of incomplete information or uncertainty, the supermarket may take the risk of lowering prices assuming that there is no guarantee that the increase in demand will compensate the increase in costs.

Decreased supply

Finally, we suppose that there is a decrease in production with respect to week 1. If the supermarket continues buying the total production from the supplier, it would have to pay a higher price than in week 1, which would compensate the farming-marketing firm for the decrease in marketed tons. The supermarket would also sell at a price which would at least equal the profit made in week 1. Figure 3 reflects the effects on quantity-price elasticity which the supermarket must face. Given a reduction in supply of 50% the supermarket would only increase prices by 34%. In such a scenario the consumer would have to respond with an elasticity of 1.446. If the real demand elasticity was less, and the customers bought less, the supermarket's profits would be reduced.

It would seem that the asymmetry of risk, measured by the demand elasticity which the supermarket must face given variation in supply, may be the reason which justifies the retailers' willingness to increase prices in line with rises in cost at origin in times of decreased

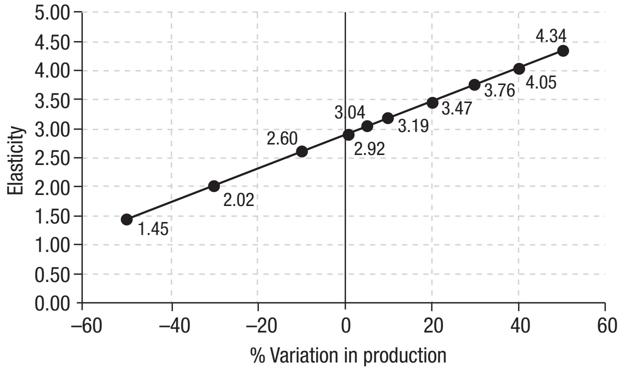

Figure 3. Relationship between the minimum elasticity required (in absolute value) and the % variation in marketed and sold production.

supply, and their reluctance to reduce prices accordingly in times of increased supply.

Supplier-retail price spread and risk calculation

As an example, the supplier-retail price spread ($m_t = p^r_t - p^s_t$) has been calculated using real data of tomato marketing in Almería (Spain)[13]. These prices have been compared with the difference between real sale prices in Andalusian supermarkets and prices obtained by the producer[14]. In short, m_t-real and m_t-calculated are obtained, the latter being the result of considering the theoretical conditions, [1] and [2], to maintain the profits of both supplier and retailer.

Figure 4 shows the evolution of m_t and the harvest (standardized, base 100). Note that m_t-real is larger than m_t-calculated (and *vice versa*) for weeks of peak production. This is evidence, in the short term, of the lack of a strategy on the part of the retailer to benefit their suppliers.

In addition, we have calculated the functional relationship $q^m_t = f(p^r_t)$ in order to then ascertain $prob(\varepsilon^m_t < \varepsilon^r_t)$ using some of the values ε^r_t from Figure 3. The results appear in Tables 3 and 4. The function used is the exponential, and so the coefficient of the price variable will be equal to ε^m_t[15]. It can be seen that there is a very high likelihood that demand will not respond as the retailer

[13] *Source:* Association of Almerian Producers (COEXPHAL). Almería represents 50% of tomatoes sold by Spain and 89% of Andalusia (weeks 45 to 23).

[14] *Source:* Observatory of prices (Andalusian Regional Ministry of Agriculture, 2009).

[15] To calculate $prob(\varepsilon^m_t < \varepsilon^r_t)$ we must know that the variable $T_{\varepsilon^m_t} = \dfrac{\varepsilon^m_t}{\bar{\sigma}_{\varepsilon^m_t}}$ will follow a t-student distribution with *n*-*k*-1 degrees of freedom, where $\bar{\sigma}_{\varepsilon^m_t}$ is the standard deviation of the estimated coefficient, «*n*» the number of data in the sample and «*k*» the number of variables included in the regression.

Figure 4. Comparison between real and calculated supplier-retail price spread ($m_t = p^r_t - p^s_t$). Spanish tomato production and prices, harvest 2008/2009.

would require to maintain profit margin for increases in production above 20%.

Discussion

This paper analyzes differences in pricing behavior in the marketing chain. In particular, it explores the way retail prices adjust to an increase or decrease in farm prices in the context of perishable products.

Numerous research studies have been addressed to understanding why marketing margins for food products have changed over time. They often use bargaining power and cost adjustment to explain price asymmetry and rigidity. Nevertheless, our study has attempted to offer additional explanations, using an analytical framework in which these two main causes are simplified in order to provide a more in-depth analysis of retail price behavior. This analysis is based on the existence of a pact between supplier and retailer to maintain their margins, analyzing i) demand which absorbs the whole supply as a simplified starting point, and ii) differences between supply and demand which create a market risk for the retailer. In both cases there is asymmetric price behavior between retailer and supplier. Although both initial assumptions are rather restrictive, they are compatible with a competitive market if we take into account the trend to incorporate suppliers into the retailers' value chain (Marcus and Anderson, 2006) in order to generate competitive advantages (Bhatnagar and Teo, 2009).

The results show that these actions do not avoid price asymmetry. At the same time, this work shows the difficulty in establishing agreements between supplier and retailer that could give rise to mutual com-

Table 3. Estimation. Dependent variable: $\log(q^m_t)$

Variable	Coefficient
Constant	16.667 (0.000)
Log $(p^r_t) = \varepsilon^m_t$	–2.971 (0.000)
Observations (n)	27
$\bar{\sigma}_{\varepsilon^m_t}$	2.747
R^2	0.505
R^2 Adjusted	0.485
F-Stat	25.508 (0.000)
Durbin-Watson	1.759

The *p*-value appears in brackets.

Table 4. Calculation of probabilities

$\lvert\varepsilon^m_t\rvert < 1.446$	$\frac{q_t}{q_o} = -50\%$	0.004
$\lvert\varepsilon^m_t\rvert < 2.603$	$\frac{q_t}{q_o} = -10\%$	0.277
$\lvert\varepsilon^m_t\rvert < 3.470$	$\frac{q_t}{q_o} = 20\%$	0.799
$\lvert\varepsilon^m_t\rvert < 4.342$	$\frac{q_t}{q_o} = 50\%$	0.999

petitive advantages. However, with this aim in mind, our study shows that in this scenario the supplier and retailer should try to minimize their variable costs and coordinate to program supplies. Acting in this way would considerably reduce the risk that the retailer runs of not being able to sell part of the production, since from this application we observe that a supermarket would have to confront a high increase in price elasticity (risk) to compensate their marketing costs in a situation of increases in supply. On the contrary, the demand elasticity needed to maintain profit margins stable drops as the shortage increases, or the marketing costs are reduced.

In general terms, the present study could help to explain why retailers are more willing to transmit increases in prices at origin when there is a decrease in supply, and less willing to do so when prices are lower in times of more produce.

There are some limitations and extensions to this study which may encourage further work. As it focuses on short-term compensations, it would be of interest to broaden the time scale. Along these lines, an in-depth study is required of possible medium-term strategies (*e.g.* annual ones) for retailers to compensate their suppliers for possible occasional (weekly) losses that they incur.

In short, this study suggests the importance of miscellaneous explanations of this asymmetric price behavior (Meyer and Von Gramon-Taubadel, 2004), and how it may originate due not only to market failures, but also to variations in the supply and demand required to maintain expected profit margins throughout the marketing chain.

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Annexes

Annex 1. Balance of supplier's profit

Maintenance of the supplier's profit over time is equivalent to: $\dot{\pi}_t^s(q_t) = \dfrac{d\pi_t^s}{dt}(q_t) = 0$ *i.e.* $\dot{I}_t^s(q_t) = \dot{C}_t^s(q_t)$.

But $\dot{I}_t^s(q_t) = \dot{p}_t^s\, q_t + p_t^s \dot{q}_t$ and $\dot{C}_t^s(q_t) = c_s\, \dot{q}_t$. Therefore

$$\dot{p}_t^s q_t + p_t^s \dot{q}_t = c_s \dot{q}_t \qquad [a1]$$

This identity represents an optimization situation for the firm, since its marginal income will be the same as its marginal cost as a result of variations in the quantity marketed. Using in [1] the fact that $\dot{I}_t^s(q_t) \equiv I_t^s(q_t) - I_t^s(q_{t-1})$ and $\dot{C}_t^s(q_t) \equiv C_t^s(q_t) - C_t^s(q_{t-1})$, we obtain the following recurrence formula:

$$p_t^s = (p_{t-1}^s - c_s)\cdot\left(\frac{q_t}{q_{t-1}}\right)^{-1} + c_s \qquad [a2]$$

In terms of initial price and initial quantity the equality [a2] become:

$$p_t^s = (p_0^s - c_s)\cdot\left(\frac{q_t}{q_0}\right)^{-1} + c_s \qquad [a3]$$

Annex 2. Balance of retailer´s profit

Maintenance of the retailer's profit over time is equivalent to: $\dfrac{d\pi_t^r}{dt}(q_t) = 0$, *i.e.* $\dot{I}_t^r(q_t) = \dot{C}_t^r(q_t)$. This once again represents an optimization situation for the retailer, since its marginal income will be equal to its marginal cost as a consequence of variations in the amount marketed. Since $\dot{I}_t^r(q_t) = \dot{p}_t^r\, q_t + p_t^r\, \dot{q}_t$ and $\dot{C}_t^r(q_t) = (c_r + p_t^s)\dot{q}_t + \dot{p}_t^s q_t$, we have:

$$\dot{p}_t^r\, q_t + p_t^r \dot{q}_t = (c_r + p_t^s)\, \dot{q}_t + \dot{p}_t^s\, q_t \qquad [a4]$$

Identifying the marginal income and the marginal cost as in annex 1, equation [a4] yields

$$p_t^r = (p_{t-1}^r - c_r - p_{t-1}^s)\left(\frac{q_t}{q_{t-1}}\right)^{-1} + c_r + p_t^s \qquad [a5]$$

In terms of initial price and the initial quantity the above recurrence formula becomes

$$p_t^r = (p_0^r - c_r - p_0^s)\left(\frac{q_t}{q_0}\right)^{-1} + c_r + p_t^s \qquad [a6]$$

Substituting [a2] in [a5] and [a3] in [a6], we obtain:

$$p_t^r = (p_{t-1}^r - c_r - c_s)\left(\frac{q_t}{q_{t-1}}\right)^{-1} + c_r + c_s \qquad [a7]$$

$$p_t^r = (p_0^r - c_r - c_s)\left(\frac{q_t}{q_0}\right)^{-1} + c_r + c_s \qquad [a8]$$

As an intermediate option, the retailer could decide to compensate only the income from the supplier instead of the profit. In this case $c_s = 0$ and equations [a2], [a3], [a5] and [a6] would be:

$$p_t^s = p_{t-1}^s\left(\frac{q_t}{q_{t-1}}\right)^{-1} = p_0^s\left(\frac{q_t}{q_0}\right)^{-1}$$

$$p_t^r = c_r + (p_{t-1}^r - c_r)\left(\frac{q_t}{q_{t-1}}\right)^{-1} = c_r + (p_0^r - c_r)\left(\frac{q_t}{q_0}\right)^{-1}$$

On the other hand, calculating the price-demand elasticity which the retailer must withstand to fulfill all the requirements is:

$$\varepsilon_t^r = \frac{p_0^r}{\dot{p}_t^r}\cdot\frac{\dot{q}_t}{q_0} = -\left[\frac{(c_r + c_s)}{(p_0^r - c_s - c_r)} + 1\right]\cdot\frac{q_t}{q_0} \qquad [a9]$$

From [a9] we can see that: if $\frac{\dot{q}_t}{q_t} = \nu \Rightarrow \frac{q_t}{q_0} = (1+\nu)^t$; v being a constant, *i.e.,* if the percentage growth rate between periods is constant, the elasticity increases ($v > 0$) or decreases ($v < 0$) exponentially over time (faster in the first case). The price p_{r_t} will have the opposite behavior. From [a6] and [a8] we can see that: if $v < 0 \Rightarrow Lim_{t\to\infty}\, \varepsilon_t^r = 0$ and $Lim_{t\to\infty}\, p_t^r = \infty$; if $v > 0 \Rightarrow Lim_{t\to\infty}\, \varepsilon_t^r = \infty$ and $Lim_{t\to\infty}\, p_t^r = p_t^r = c_r + c_s$. The evolution over time of ε_t^s and p_t^r can be seen in Figure A1[16].

Annex 3. Supplier-retail price spread

According to equation [a5] we could represent the supplier-retail price spread ($m_t = p_t^r - p_t^s$) as a function of the variations in marketed production (Fig. A2):

$$\begin{aligned} m_t &= (p_{t-1}^r - p_{t-1}^s - c_r)\left(\frac{q_t}{q_{t-1}}\right)^{-1} + c_r = \\ &= (p_0^r - p_0^s - c_r)\left(\frac{q_t}{q_0}\right)^{-1} + c_r \end{aligned} \qquad [a10]$$

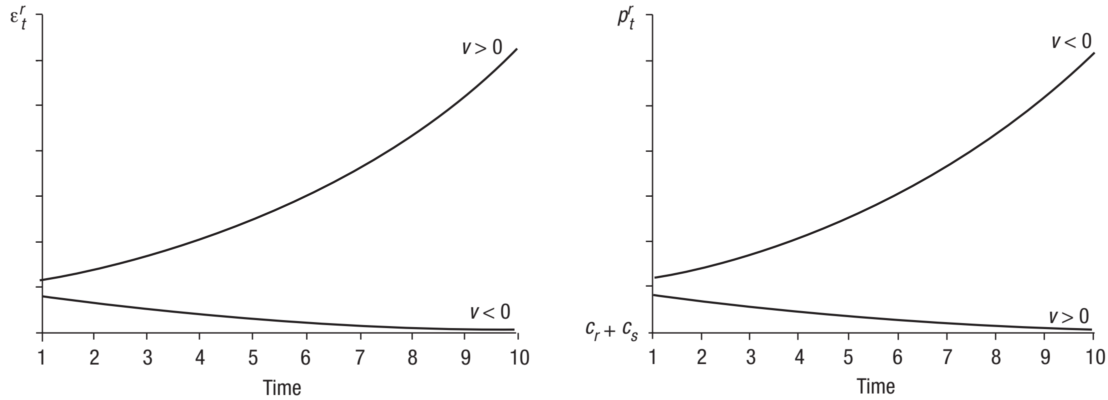

Figure A1. Evolution over time (weeks) of retail price-demand elasticity (ε_t^r) and retail sale prices (p_t^r).

[16] The selling price in the supermarket will depend on changes in production. The trend shows that if there are continued increases in production over time the price of the supermarket is stable and reflects only the costs of marketing. However, if there are continued declines in production, the price of the supermarket grows exponentially. The market risk will move in the opposite fashion. The asymmetry in the behavior of prices is intrinsic to the variation of production, so the prices there will never have a similar (symmetric) conduct with production increases or production decreases.

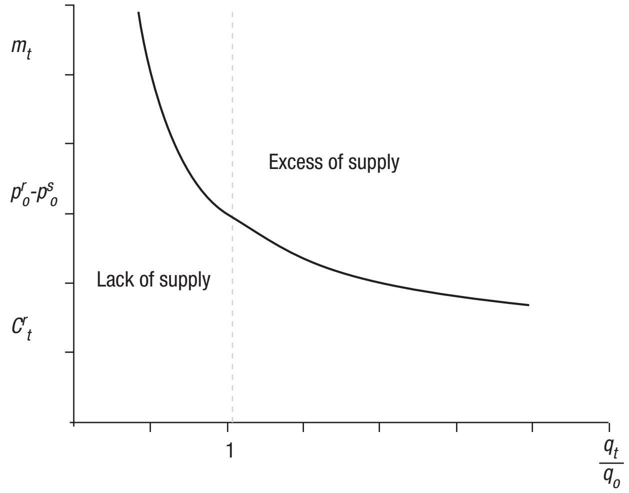

Figure A2. Variation of price between retailer and farmer.

It can be seen that, given the assumptions of this study (see also Annexes 1 and 2), the supplier-retail price spread when production increases ($v > 0$) is smaller than when it decreases ($v < 0$). Note that: if $v > 0 \Rightarrow Lim_{t\to\infty}\, m_t = c_r$; $v < 0 \Rightarrow Lim_{t\to\infty}\, m_t = \infty$. However, in a market situation (with unknown demand) and increases in supply (the most problematic scenario) the retailer will offset the risk by maintaining or even raising m_t[17].

[17] This risk compensation mechanism might explain the behavior of margins (supplier-retail price spread) as expounded by Ben-Kabbia and Gil (2008): «an increase in the origin-destination margin of Spanish tomato when the price at origin falls». These authors detect a trend towards stabilization of price margins when considering their evolution over several periods. This may be due to an implicit propensity of the retailers to maintain the profits of their suppliers. In short, it can be seen that an agreement between supplier and retailer to maintain their profit constant, considering that demand absorbs the whole supply at the price established by the retailer, would produce price asymmetry.
In other words, the proposed solution would give rise to the very same problem it is intended to solve. Moreover, if we take into account demand that is different to supply, the retailer would have to adopt a series of strategies to compensate the risk, and these strategies would also imply price asymmetry.