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Price Transmission During Promotions: A Case Study of Spanish Milk Brands

Yasmine Bedoui[1,2] | Yan Jin[1,2,3] | José María Gil[1,2]

[1]Centre for Agro-food Economics and Development (CREDA-UPC-IRTA), Barcelona, Spain | [2]Department of Agri-Food Engineering and Biotechnology, Technical University of Catalonia, Barcelona, Spain | [3]Agricultural Economics and Rural Policy Group, Wageningen University, Wageningen, The Netherlands

Correspondence: Yan Jin (yan.jin@wur.nl)

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ABSTRACT

Price promotion is the marketing tool typically used by retail brands to boost sales and gain market share. In this paper, we intend to investigate the price transmission mechanism among competitive brands in Spain when price reductions that are associated with price promotions take place. The study is focused on intra-retailer competition in two retailers with different business models. The methodological framework is based on the estimation of a two-regime threshold vector autoregressive model (TVAR) of price levels in which the Private Label price has been considered as the threshold variable. The results suggest that the price responses of manufacturer brands to private label price reductions are much larger than the inverse responses. The price of the private label reacts only weakly to price reductions in manufacturer brands. These responses decrease in strength as the market share of the Private Label increases within the retailer.

1 | Introduction

The food industry is a dynamic sector in which innovation and shifting consumer preferences drive the emergence of new trends daily. In this highly competitive environment, brands strive to capture consumer attention and expand their market share (Paharia, Avery, and Keinan 2014). Within the retail sector, retailers manage brands and adjust their prices to attract customers and boost their market share, employing various marketing strategies, such as advertising, loyalty programs, and price promotions. Among these, price promotion, which is defined as temporary product price reductions (Bennett et al. 2020), is the most widely used tool, accounting for nearly one-quarter of consumer product companies' marketing budgets (Raghubir, Inman, and Grande 2004). In Spain, according to the Spanish Marketing Association (AMKT 2022), expenditures on price promotions reached €2.9 billion by 2022, constituting a significant portion of the overall investment in marketing activities. While retailers aim to increase their sales, these price promotions can lead to brand cannibalization by driving higher sales for the promoted brands while diminishing sales of competing brands during the promotional period (Cohen and Perakis 2020).

The literature on the impact of promotions on brand competition dates to Kumar et al. (1988), who found that price promotions are the most effective marketing tool for driving brand and store substitution. This early work highlighted the significant influence of price promotions in shaping consumer choices between competing brands. Blattberg and Wisniewski (1989) later explored how price changes affect brand competition using a price tier model. Their research focused on how price changes impact the unit sales of competing brands, revealing that price promotions have a greater effect on high-tier brands than low-tier ones. Expanding on this, Pauwels (2007) and Steenkamp et al. (2002) conducted research exploring how the characteristics of both categories and brands influence competitors' responses to price promotions. Their research indicates that the defending brand is heavily affected when the attacker has high brand equity, the defender has low brand equity, the attacker is a private label, and the defender is a private label. Additionally, reactions are stronger when the attacker holds a higher market share, the attack is carried out by a national brand, and the number of competing bands increases.

Adopting a more theoretical perspective in which private and manufacturer brands are viewed as a duopoly market, Rao (1991) used a Nash no-cooperate equilibrium framework in which decisions are adopted sequentially to show the competitive interaction between a national brand and a private label. That study examined how asymmetries in market power impact the strategic decisions of firms related to price promotion, considering factors such as market pricing and consumer choices. Within a similar duopoly framework, Putsis, Jr. (1997) conducted an empirical study using a model that included two first-differenced price equations to explore competitive pricing between national brands and private labels, focusing on promotion and brand proliferation. His results indicate that price followership is relatively weak, as well as a bit stronger for private labels than manufacturer brands' products; that is, branded price cuts produce higher private label price cuts that are greater than the branded price cuts produced by private label price cuts. Moreover, any temporary price reduction also generated price reductions in competing brands, although of lower magnitude. Interestingly, the effects were lower as the market share of private labels increased.

The analysis of price transmission among related markets has been the subject of many studies (Von Cramon-Taubadel and Goodwin 2021). Empirical analyses focusing on how market shocks propagate along the stages of the supply chain, which is known as vertical price transmission, have found evidence of nonlinear price transmission in the food sector (Acosta and Valdés 2014; Ben Kaabia and Gil 2008; Tifaoui and Von Cramon-Taubadel 2017) and between related markets, which is known as horizontal price transmission (Kharin 2019; Yu and Gould 2019). While price transmission in the agri-food sector has been widely studied, a gap remains in the research regarding differences in price transmission between retailers of multiple brands that each sell the same products.

This paper is intended to further explore this issue by analyzing the dynamics of price transmission between private and manufacturer brands. Using a unique scan dataset, our paper contributes to the existing literature in several ways. First, unlike previous research, we are interested in dynamic behavior. In spite of the fact that promotions are associated with temporary price reductions, price reactions may extend for a longer period depending on how markets react. Second, while most of the literature aggregates food market categories, we focus our analysis on a specific product, semi-skimmed milk, which has been subject to continual price promotions over the years. Moreover, to analyze the potential effect of the private label market share on price transmission, we focus our attention on two retailers that follow different business strategies. In other words, we pay attention to whether the price reactions are retailer dependent, providing additional empirical evidence as compared to the more aggregated studies conducted previously. Finally, we also want to determine whether the magnitude of a price reduction matters. To the best of our knowledge, this is the first empirical study to demonstrate how rival brands offering an identical product in two retail environments respond to a price reduction.

The methodological framework used to account for price dynamics is based on the estimation of a threshold time series model, which has been widely used in price transmission studies within the food sector (e.g., Atozou et al. 2019; Awokuse and Wang 2009; Jin and Gil 2023; Jin, Li, and Gil 2024). Threshold models allow us to capture nonlinear price dynamics among brands, enabling us to account for sudden shifts or regime changes in competitive interactions. Moreover, they allow testing for asymmetries, that is, testing whether the magnitude of the initial price reduction matters when analyzing the reactions of rival brands. Because, in time series econometrics, estimated parameters are not economically meaningful, a generalized impulse response function (GIRF) will be calculated to assess the short-run price dynamics among rival brands in the two retail settings. In this study, we have associated price reduction with price promotions. Although this is not true 100% of the time, in the scan database we have used, almost all price reductions were associated with promotion periods. Finally, as we are interested in the dynamic effects of price promotions, we will explore the responses to negative shocks in prices on the part of the various brands considered in this paper.

As mentioned above, we focus our study on semi-skimmed milk in two Spanish retail chains. According to the Ministry of Agriculture, Fisheries and Food in Spain (MAPA), milk is one of the most common products in the Spanish consumer basket, and it is purchased by 97% of households in Spain (Ministerio de Agricultura, Pesca y Alimentación MAPA. 2022a). The most-consumed type of milk in Spain is semi-skimmed milk, which accounts for €1156 million of the €2508 million in total packaged milk consumption in 2022 (Ministerio de Agricultura, Pesca y Alimentación MAPA. 2022b). More than 61% of dairy products are sold in supermarkets or hypermarkets (Statista 2024), and milk is often a loss leader in the competition between stores (Kilic, Akbay, and Tiryaki 2009).

2 | Data

The data for this paper are derived from the Kantar panel dataset, which contains daily records of food purchases for around 10,000 Spanish households from December 2013 to January 2021. For each retailer, weekly household purchases (quantities and expenditures) of semi-skimmed milk have been aggregated. Unit values, as a proxy for prices, are obtained by dividing expenditures by quantities[1].

Retailers typically adopt various business models. To determine whether the reaction to price promotions depends on a retailer's business models, we have selected two retailers that use different business models. Retailer A represents a soft discount business model, with a strong private label and a reduced number of manufacturer brands. Its private label represents almost 90% of semi-skimmed milk sales in the market. Retailer

B has a conventional business model, with more brands on its shelves. In this case, its private label still represents the largest market share (almost 60%), while the largest manufacturer brand accounts for around 15% of the market share. Moreover, these two retailers are the top two retailers in the Spanish market, and leading retailers typically conduct promotional activities more frequently than small retailers.

Figures 1 and 2 show the evolution of semi-skimmed milk prices during the sample period for the various brands at Retailers A and B, respectively. For each retailer, we have selected the two most relevant manufacturer brands (MB1 and MB2), while the third brand (MB3) represents the average of the remaining brands for each retailer. Interestingly, in this paper, MB1 and MB2 are the same across retailers. As can be observed, there is no seasonal component or stochastic trend, but some structural breaks can be identified (highlighted in both Figures). Table 1 summarizes the prices for each brand, clearly showing that prices at Retailer A are consistently higher than those at B, even for identical brands. At both retailers, the third brands ($MB3_A$ and $MB3_B$) have the highest average prices, while the two private label brands (PL_A and PL_B) have the lowest prices.

3 | Methodology

As we are concerned with time series econometric models, the methodological framework used in this paper relies on a sequential test to determine the most adequate model. We test for stochastic data properties and Nonlinearity. Based on the results of these tests, we will specify and estimate the appropriate model with which to analyze the long-term relationships between and the short-term dynamics of brand prices. In the following sections, we present the results of these sequential tests and identify the most appropriate model with which to achieve the research objectives.

3.1 | Stationarity

In the first step, stationarity tests were performed. As mentioned in the previous section, a visual inspection of the series shown in Figures 1 and 2 indicates the presence of structural breaks in most of the series. Traditional unit root tests are vulnerable to incorrectly identifying structural breaks in a series; in the presence of structural breaks, such tests may fail to reject the unit root hypothesis (Herranz 2017). In this study, we used the Zivot and Andrews (2002) unit root test with a structural break, which allows for the endogenous determination of structural breaks according to sample size. The breakpoint is associated with the minimization of the augmented Dickey–Fuller test statistic.[2] The results indicate that in all the series, the null hypothesis of non-stationarity, as opposed to stationarity with a single structural change, was rejected. Thus, we use the price level series for the remainder of this paper.

3.2 | Nonlinearity

Nonlinearity was assessed using the multivariate extension of Hansen (1999) linearity test. Following the approach suggested

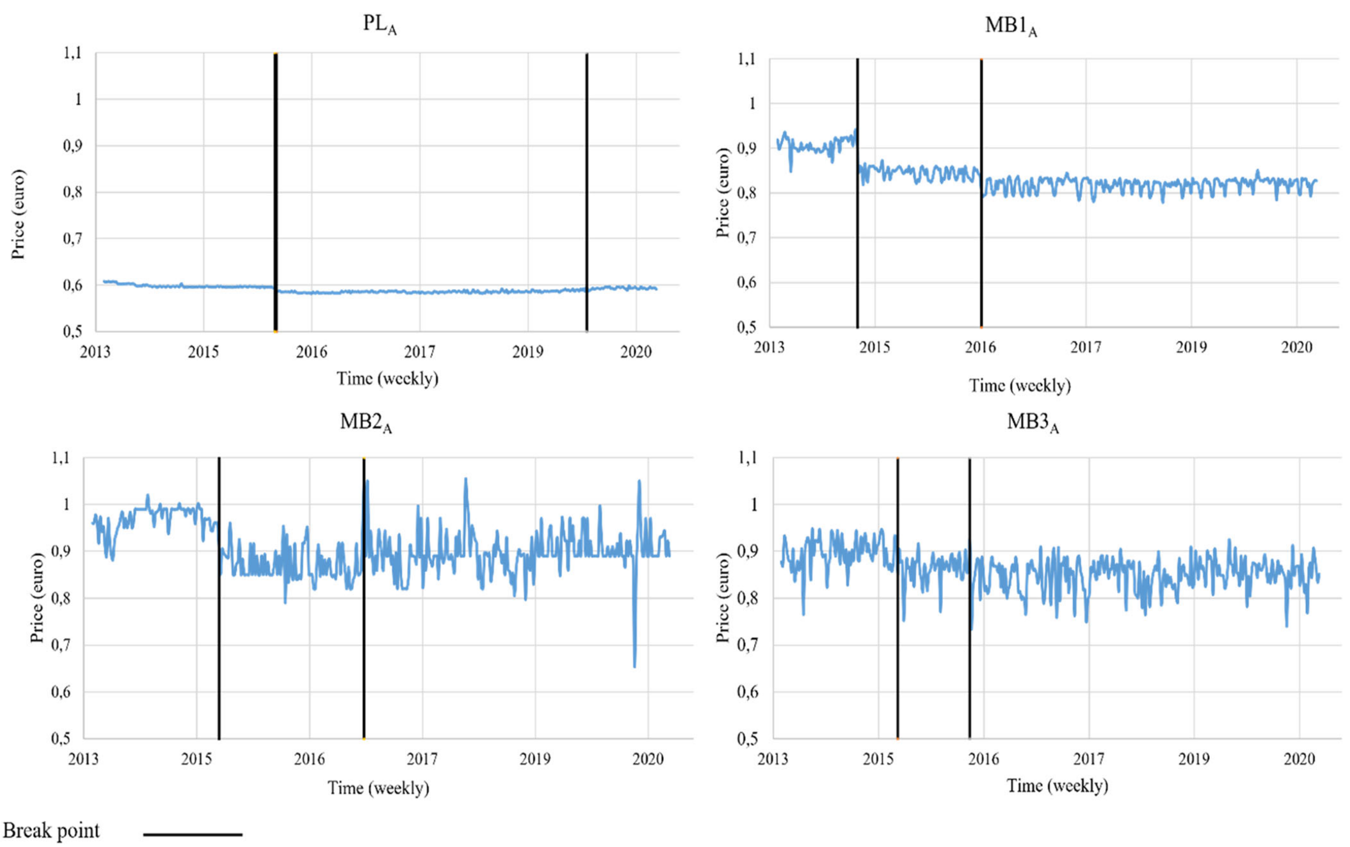

FIGURE 1 | Price variations for semi-skimmed milk at Retailer A.

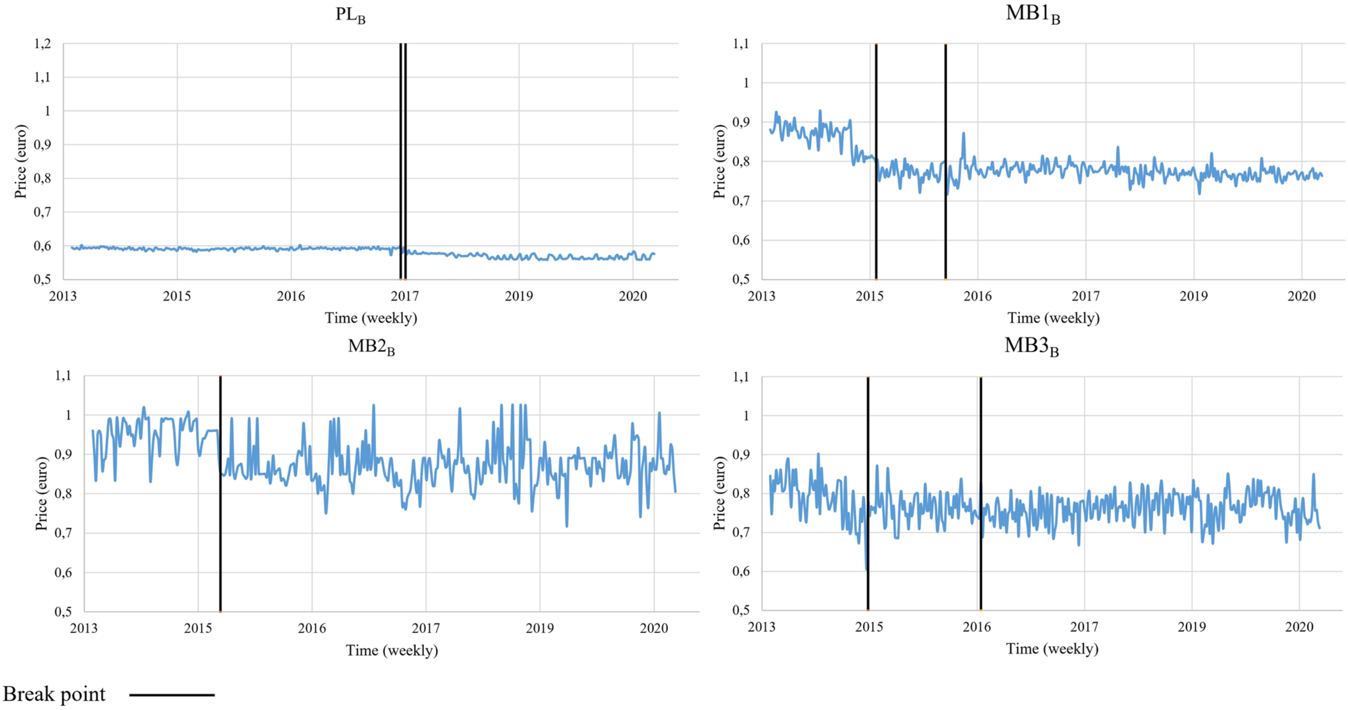

FIGURE 2 | Price variations for semi-skimmed milk at Retailer B.

TABLE 1 | Market shares and price characteristics for each brand at both retailers.

Retailer	Brand	Market share (2013–2021) (%)	Mean	Minimum	Maximum
A	Private label (PL_A)	89.05	0.59	0.58	0.61
	Manufacturer brand 1 ($MB1_A$)	4.50	0.84	0.78	0.94
	Manufacturer brand 2 ($MB2_A$)	0.97	0.91	0.65	1.05
	Remaining manufacturer brands ($MB3_A$)	5.49	0.86	0.73	0.95
B	Private label (PL_B)	59.72	0.58	0.56	0.60
	Manufacturer brand 1 ($MB1_B$)	14.56	0.79	0.72	0.93
	Manufacturer brand 2 ($MB2_B$)	3.30	0.89	0.72	1.02
	Remaining manufacturer brands ($MB3_B$)	22.33	0.77	0.61	0.90

by Lo and Zivot (2001), the first threshold parameter was estimated using the constrained least squares method, while the second threshold was determined using a conditional search with a single iteration. Subsequently, a likelihood ratio (LR) test was conducted to compare the covariance matrices of the models. The optimal number of lags was selected using the Bayesian information criterion (Schwarz 1978), and the result of the Breusch–Godfrey test was used for serial autocorrelation (Breusch 1978; Godfrey 1978). We used the lagged private label price in levels at the two retailers as the threshold variable, as the private label accounts for the largest market share for semi-skimmed milk sales for both retailers[3]. Specifically, we tested the null hypothesis of linearity (one regime) against the alternative hypothesis of nonlinearity (two or three regimes). We employed an LR test, comparing the covariance matrix of two models: Model 0, which was a basic VAR model (assuming linearity), and Model 1, which was a TVAR model with either one or two thresholds. The LR test statistic is expressed as follows.

$$LR_{01} = T\left(\ln\left(\det\Sigma_0\right) - \ln\left(\det\Sigma_1\right)\right) \quad (1)$$

where T is the number of observations, Σ_0 is the estimated covariance matrix of the model under the null hypothesis and Σ_1 is the estimated covariance matrix under the alternative hypothesis. The p-value was calculated via a simulation. The bootstrap distribution was based on resampling the residuals from the null model, estimating the threshold, and performing the test. One thousand bootstrap replications were conducted for all calculations (Aleem and Lahiani 2014). The results were obtained by selecting the middle 70% of the sorted observations, which was in line with the recommendation of Hansen. (1996) that the optimal trimming should be 15%.

The linearity tests for both retailers[4] indicate that the hypothesis of linearity is rejected[5]. Furthermore, when testing a model with two regimes against a model with three regimes, the model with two regimes is statistically preferred in all cases. There, a two-regime TVAR model of price levels was therefore chosen for the two retailers.

3.2.1 | Model Parameters Estimates

Following Tong (1978) and Tsay (1989), the TVAR is expressed as follows:

$$P_t = \alpha_1 + \sum_{j=1}^{h} A_{1j} P_{t-j} + \varepsilon_{t,1}, \text{ if } q \geq W_{t-1}$$

$$P_t = \alpha_2 + \sum_{j=1}^{h} A_{2j} P_{t-j} + \varepsilon_{t,2}, \text{ if } q < w_{t-1} \tag{2}$$

where $\varepsilon_{t,i}$ is a K × 1 vector of noise terms, w_{t-1} is the first lag of the threshold variable; q is the threshold value; P_t is a K × 1 vector of endogenous variables $P_t = (P_{1t} \ldots P_{Kt})$; α is a K × 1 vector of constants; A_{1j} and A_{2j} are a K × K matrix of coefficients for Regimes 1 and 2, respectively; and lag j and h is the autoregressive order, with $j = 1 \ldots h$. In this study, a TVAR with 3(4) lags was selected for Retailer A(B) based on the Bayesian information criterion, taking the lagged private label prices as the threshold variable.

Supporting Information S1: Tables 3 and 4 show the outcomes of the TVAR model estimations for Retailers A and B, respectively. Breusch–Godfrey (Breusch 1978; Godfrey 1978) autocorrelation tests were performed for both models. The results indicate that the null hypothesis of no autocorrelation could not be rejected, confirming the validity of both models. As mentioned above, in the two models, the lagged private label price was selected as the threshold variable. For Retailer A, the threshold value for the private label was €0.588, with 50.4% of the sample being included in Regime 1 and the remaining 49.6% being included in Regime 2. For Retailer B, the private label threshold was €0.573, with a price distribution of 29.1% of the sample in Regime 1 and 71.9% in Regime 2.

3.2.2 | Impulse Response Functions

Short-term dynamics are the dynamics of a variable over a short period, generally following a shock or change generated by a policy intervention, market shock, or unusual event. In time series models, estimated parameters are irrelevant because they do not represent structural equations. The GIRF (Koop, Pesaran, and Potter 1996) is used to analyze the responses of the various prices in a system to a shock in any of them because it is sufficiently flexible to tackle nonlinearities. Responses to a shock depend on the size and sign of the shock and the price history at the point at which the shock hits the system. The GIRF can be expressed as follows:

$$\text{GIRF}\,(h, \sigma, \omega_{t-1}) = \text{E}\,[P_{t+h} \mid e_t = \sigma, \omega_{t-1}] - \text{E}\,[P_{t+h} \mid \omega_{t-1}] \tag{3}$$

where $h = 0, 1\ldots, H$ is the forecast horizon, P is the response variable at horizon h, and $e_t = \sigma$ is a (4×1) vector denoting a specific shock to the system. In our case, as we are interested in the reactions to price promotions, we have restricted our study to the analysis of the responses of brand prices to negative shocks. We have considered three alternative shock sizes, which are equivalent to 1, 2, and 5 standard deviations, to consider potential asymmetric behavior based on the magnitude of the shock. Finally, ω_{t-1} contains the histories of the series.

For each retailer, we have performed two simulations. First, we calculated the short-term dynamic responses of the three manufacturer brands to a shock to the private label price. Second, we shocked the three manufacturer brand prices and investigated how the private label price responded.

4 | Results

4.1 | Retailer A

Figure 3 illustrates the responses of the manufacturer brand prices of semi-skimmed milk ($MB1_A$, $MB2_A$, and $MB3_A$) to a shock to the private label price (PL_A) in both regimes. In both regimes, the three national brands react quickly to negative shocks in the private label price (PL_A). In all cases, responses are negative and increase more than proportionally with the magnitude of the initial shock. If the price reduction is low, manufacturer prices scarcely react. Moreover, the magnitude of the responses is higher in the second regime, which is associated with private label prices over 0.59€/l. Below this threshold price, responses are significantly lower. In other words, the private label price level matters. If we compare the reactions of the three manufacturer brands, there are also differences between regimes. In Regime 1 (low private label prices), the reaction of Manufacturer 2 is higher than that of Manufacturer 1. Remember that in this retailer, the market share of the private label is 89%, while Manufacturers 1 and 2 represent 4.4% and 1%, respectively. In the context of lower prices, the reaction of the manufacturer brand with the highest market share ($MB1_A$) is limited, while the response of the other ($MB2_A$), with a lower market share, is higher to improve its competitiveness, not against the private Label but, rather, Manufacturer 1. However, in Regime 2, which is associated with higher private label prices, the responses of Manufacturers 1 and 2 to private label price reductions are similar if the magnitude of the initial shock is low or moderate. When the magnitude of the initial shock increases, the responses of Manufacturer 2 are stronger, similar to what occurred in Regime 1. In both regimes, the responses of Manufacturer 3, which represents the average of the remaining manufacturer brands competing in Retailer A, are very similar to those of Manufacturer 2, although they are less intense.

Let us now examine the responses of the private label price (PL_A) to price reductions in manufacturer brands (Supporting Information S1: Figure 1). As mentioned, PL_A had a market share of nearly 90% for semi-skimmed milk sales in Retailer A based on its price differential with the manufacturer brands. As can be observed, the reactions to price reductions are negligible. In this case, there are no differences between regimes. Only in

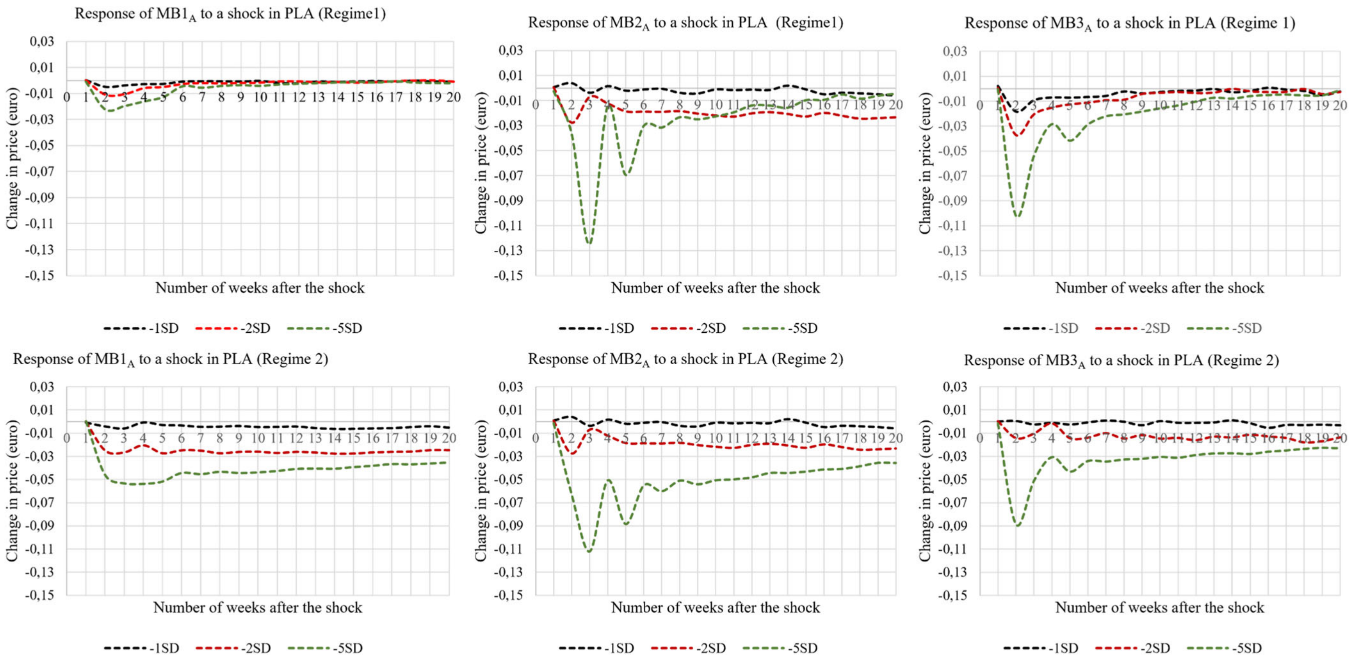

FIGURE 3 | Responses of the manufacturer brands' prices ($MB1_A$, $MB2_A$, and $MB3_A$) to a shock in the private label brand's price (PL_A).

the case of the responses to a high price reduction in Manufacturer 2 are reactions slightly stronger.

4.2 | Retailer B

Figure 4 illustrates how manufacturer brands responded to private label (PL_B) price reductions in Retailer B. In Regime 1, which is associated with private label prices below 0.57€/l, Manufacturer 1 ($MB1_B$), which represents about 15% of semi-skimmed milk sales in this retailer, scarcely reacts immediately after the shock. After 2 weeks, its price dips slightly in an attempt to create short-term gains, but the magnitude of this dip is smaller than the initial private label shock. By week 3, prices began to recover, returning to equilibrium by week 4. Moreover, under this regime, the magnitude of the initial price reduction is irrelevant, as responses seem to behave proportionally. In Regime 2, which is associated with higher private label prices as compared to Regime 1, responses are more significant and occur during more periods. Moreover, responses are not proportional, as their size increases more than proportionally with the magnitude of the initial price reduction. It seems that in the context of higher market prices, there is more room for Manufacturer 1 to achieve competitiveness.

Interestingly, responses on the part of Manufacturer 2 ($MB2_B$), which accounts for 3% of the market share for semi-skimmed milk sales within Retailer B, are larger than those of Manufacturer 1. Prices do not react immediately to private label price reduction, but after 3 weeks, just after the negative response of Manufacturer 1 in week 2, price reductions are large, indicating an intention to achieve competitiveness not only against the private label but also in relation to Manufacturer 1. The rebound takes longer, with prices stabilizing after 9 weeks. More interestingly, in contrast to Manufacturer 1, the price responses of Manufacturer 2 in Regime 2 (higher private label prices) are lower than in Regime 1. This seems to indicate that Manufacturer 2 is more interested in the reaction of Manufacturer 1 than in gaining market share for the private label. When the responses of Manufacturer 1 are higher (Regime 2), the responses of Manufacturer 2, although similar to those in Regime 1, are of lower magnitude. This behavior was shown, more moderately, in Retailer 1, and this is worth mentioning because Manufacturers 1 and 2 are the same in both retailers. This indicates, their similar behaviors, though these have different magnitudes, are associated with the retailer context.

The responses of Manufacturer 3 ($MB3_B$), which represents the collective behavior of smaller brands sold in Retailer B, seem to indicate a different strategy. However, it is difficult to assess the potential reasons for this, as in Retailer B, this composite price is the average of another 10 brands, which may follow different strategies. In any case, comparing the two regimes, responses are of low magnitude in the second regime when the responses of the leading manufacturer brand are large.

Finally, let us consider the private label price response to price reductions in manufacturer brand prices (Supporting Information S1: Figure 2). As in the case of Retailer A, responses are negligible, especially in Regime 2, and associated with periods with high private label prices. Reactions are slightly larger in Regime 1, though only to its main competitor, Manufacturer 1 ($MB1_B$). In this case, it takes 3 weeks for the private label to slightly adjust and thus maintain the price differential with Manufacturer 1. Reactions to shocks from $MB2_B$ and $MB3_B$ are minimal.

5 | Conclusions

This paper was intended to investigate the price transmission mechanism among competitive brands when price reductions associated with price promotions take place. The focus is thus on intra-retailer competition. The semi-skimmed milk market

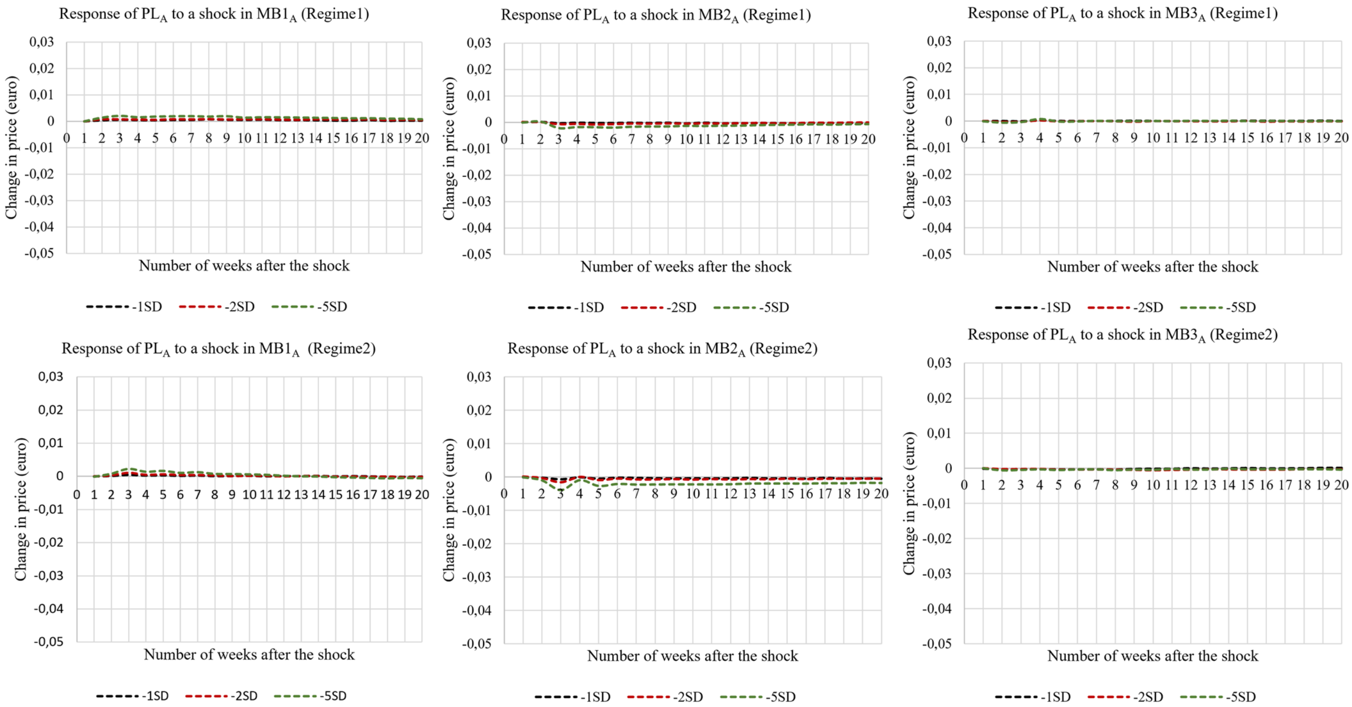

FIGURE 4 | Responses of the manufacturer brands' prices ($MB1_B$, $MB2_B$, and $MB3_B$) to a shock in the private label brand's price (PL_B).

has been chosen as a case study, as this product is typically the focus of price promotions in the retailing industry. The analyses have been carried out on two retailers representing alternative business models. Considering the stochastic properties of the data, the methodological framework used in this study is based on the estimation of a two-regime TVAR model of price levels in which the private label price has been considered the threshold variable. In both retailers, price dynamics differ depending on whether the private label price is below or above 0.58€/l (0.57€/l) in retailer A (B). Impulse response functions have been calculated after negatively shocking the prices of the various brands in each retailer. Several magnitudes of the initial shock have been considered to identify potential asymmetric behavior. This is one of the first studies to analyze intra-retailer competition associated with price promotions.

The results suggest several ideas. First, considering the dominant position of the private label in both retailers, the price response of manufacturer brands to private label price reductions is much larger than the inverse. The price of the private label scarcely reacts to price reductions in manufacturer brands. The responses decrease as the market share of the private label increases within the retailer. Second, manufacturer brand responses, although they are retailer-specific, show similar patterns across retailers. In general terms, the responses of the manufacturer brand with a larger market share (Manufacturer 1) to private label reductions are higher when the private label price is higher than the threshold. Third, it seems that the responses of the second manufacturer brands not only depend on the magnitudes of the initial shock in the private label price but also on the responses of the large manufacturer brands (Manufacturer 1). In fact, the reactions of Manufacturer 2 are higher when the reactions of Manufacturer 1 to Private Label price reductions are lower. Finally, the reactions of manufacturer brands are larger in the retailer in which the private label accounts for a larger market share.

Despite the contributions of this study to the existing literature, it has certain limitations. First, the aggregation of data may conceal some price variability that could be used in estimating competitive reactions. Because we used weekly scanning data, temporal aggregation is not a concern, because prices typically do not vary within a week for a given brand, but it is important to acknowledge that price discrimination between regions could introduce variability into the data. Second, we have considered price reductions to be a proxy for price promotions. We are aware that price reductions can be associated with other drivers, such as changes in transportation costs or decreasing raw material prices. In any case, as mentioned above, a deep analysis of our scan database shows that most of the price reductions are associated with periods in which price promotions exit the skimmed milk market. Third, our study focused on analyzing intra-retailer competition, in which, to some extent, prices and price promotions are the results of not only market conditions but also the agreements signed by the retailer and each manufacturer. We aimed to provide empirical evidence that brand competition is retailer dependent. Note that Manufacturers 1 and 2, which are the same in both retailers, react differently in both retailers and both regimes. This study could be complemented in the future by exploring inter-retailer competition, mainly among private label prices. Fourth, it is important to acknowledge that there are variables not considered in this model, which could influence the responses of brands to promotions by other brands. Factors such as the number of units in stock, the number of products being promoted by other brands, and brands' respective market shares within a retailer may also play a role in shaping brand responses.

The current study is an initial step in examining price dynamics among brands in the agri-food sector. The findings provide insights for brand managers regarding the responses of competitors to price promotions and can serve as a guide for future contract negotiations with retailers. The results of this study may also be relevant for policymakers, even though price promotions are among the private strategies of retailers. In any case, in the current debate regarding the impact of price promotion on unhealthy consumption, the results of this study suggest that such regulation should consider the fact that effects are retailer specific. In this context, future research could extend our analyses to other unhealthy products to determine whether the intra-competition effect is also product dependent.

Author Contributions

Yasmine Bedoui: methodology, software, data curation, investigation, formal analysis, visualization, writing–original draft. **Yan Jin:** conceptualization, methodology, data curation, investigation, supervision, writing–review and editing. **José María Gil:** conceptualization, investigation, validation, supervision, funding acquisition, writing–review and editing.

Ethics Statement

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data is available on request from the authors.

Endnotes

[1] Although unit values may obscure heterogeneity in qualities, we have attempted to overcome this problem by narrowing the chosen products. First, only conventional semi-skimmed milk products have been considered. Products including claims about additional nutrients or carrying labels such as "bio" or "organic" have been excluded. Second, only milk in cartons and plastic packages has been considered. Finally, milk in packages of less than one litre was excluded from this study (its market share was less than 5% during the analyzed period).

[2] The results are shown in Supporting Information S1: Table 1.

[3] We have also considered using the lagged prices of MB1, MB2, and MB3 as potential threshold variables for each retailer. We selected the private label price based on minimizing the Bayesian Information Criterion (BIC).

[4] Results are shown in Supporting Information S1: Table 2.

[5] To ensure that nonlinearity is not a cause of the observed structural breaks, we conducted a series of rigorous tests. The results of these tests, available upon request, confirm that the structural breaks are exogenous events and are not attributable to nonlinearity in the models.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.