Imperfect competition in the fresh tomato industry

Mohammed Hadj Djelloul[(1)], Vincent Réquillart[(2)] and Michel Simioni[(2)]

(1) Université de Poitiers

(2) Toulouse School of Economics (GREMAQ-INRA, IDEI)

Contact: Vincent.Requillart@toulouse.inra.fr

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Abstract:

In this paper, we analyse the market power of the retail industry in the French tomato market. Following the methods developed in the New Empirical Industrial Organization, we develop a structural model of this industry.

The analysis is based on detailed data on final consumption and prices at both shipper and consumer levels for two types of tomatoes in France. The structural model is composed of a system of demand equation and supply equation. Supply equation includes a term that represents the market power of the retail sector. We use different models of demand in order to test the robustness of our results. We show that i) elasticity of demand varies during the year ii) the retail sector exercise only a 'moderate' market power iii) the estimated mark-up of the retail sector varies from 0 to about 0.13 €/kg depending on the period iv) the mark-up is thus small (3% in average) as compared to the consumer price which is mainly explained by cost of production. We conclude to a moderate exercise of market power of the retail sector in this sector.

JEL Classification: L13, Q13, L66, L81

KEY WORDS : Market power, Imperfect competition, Fresh products,

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1. Introduction

The questions of price formation and price transmission in food chains are important as a lot of analysis of the impact of agricultural policy changes generally assume that the prices changes are transmitted to the final consumers. It is therefore important to develop in depth analysis of how food chains are working and how changes in the supply of agricultural productions are transmitted to final consumers. The current debate about the impact on inflation of the significant increase in agricultural prices in 2007 is a good example.

Existing works about how prices are transmitted from producers to consumers in fresh fruit and vegetable sector in Europe do not provide strong support to the thesis of the exercise of a strong market power at the retail level. For example, statistical analysis of price transmission developed by Hassan and Simioni (2004) shows that, on the French tomato market, margins of the retail sector follows a constant pattern. They also showed that in half of the cases, price transmission is symmetric. Moreover, when it is asymmetric, they showed that positive changes in shipping prices are transmitted at a faster rate (to the consumers) than negative changes. To sum up, they did not find evidence of the exercise of 'strong' market power. Recent analysis of productivity gains in the French fruits and vegetables industry and how these gains are distributed along the chain (Butault, 2007) conclude that in the period 1990-2004, 80% of upstream productivity gains were kept by producers and only 20% were transmitted through price decrease. In a perfectly competitive industry, one anticipates that upstream productivity gains are fully transmitted to the consumers. The fact that upstream producers were able to keep a significant part of the productivity gains suggests that for any reasons, some market power was exercised at the upstream level.

The above results contradict the conventional wisdom that the retail sector, which is much more concentrated than the producer sector, exerts significant market power in the fruits and vegetables industry.

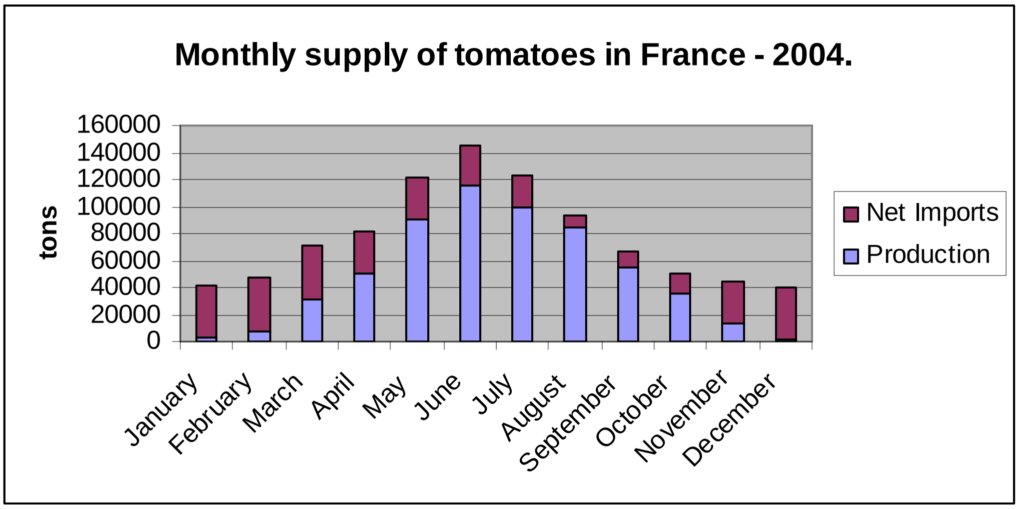
In this paper, we analyse the market power of the retail industry in the French tomato market. More precisely, following the methods developed in the New Empirical Industrial Organization, we develop a structural model of this industry. We follow the methodology used by Bettendorf and Verboven (2000) who analysed price transmission in the European coffee market.

The analysis is based on detailed data on final consumption and prices at both shipper and consumer levels for two types of tomatoes in France. The structural model is composed of a system of demand equation and supply equation. Supply equation includes a term that represents the market power of the retail sector. We use different models of demand in order to test the robustness of our results. We show that i) elasticity of demand varies during the year ii) the retail sector exercise only a 'moderate' market power iii) the estimated mark-up of the retail sector varies from 0 to about 0.13 €/kg depending on the period iv) the mark-up is thus small as compared to the consumer price which is mainly explained by cost of production. We conclude to a moderate exercise of market power of the retail sector in this sector.

2. The French Tomato industry

Tomato is the main vegetable consumed in France. In 2004, households purchased 841 000 t of fresh tomatoes for at home consumption (14 kg/per). In 2004, the French production of fresh tomatoes amounted to 624 000 t while imports were about 435 000 t (and exports amounted to 95 000t). From

November to February, the supply mainly comes from imports while from March to October it mainly comes from the national production (Graph1).

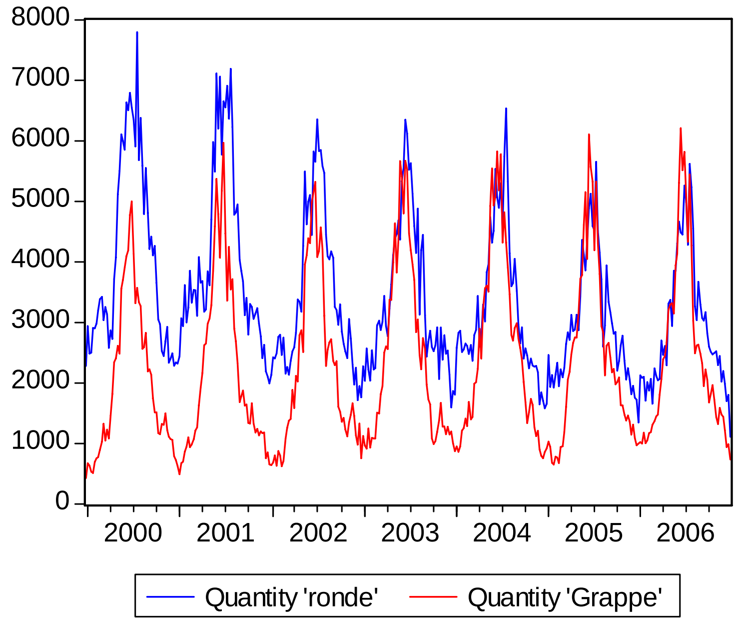


Graph 1: Monthly supply of tomatoes in France, 2004.

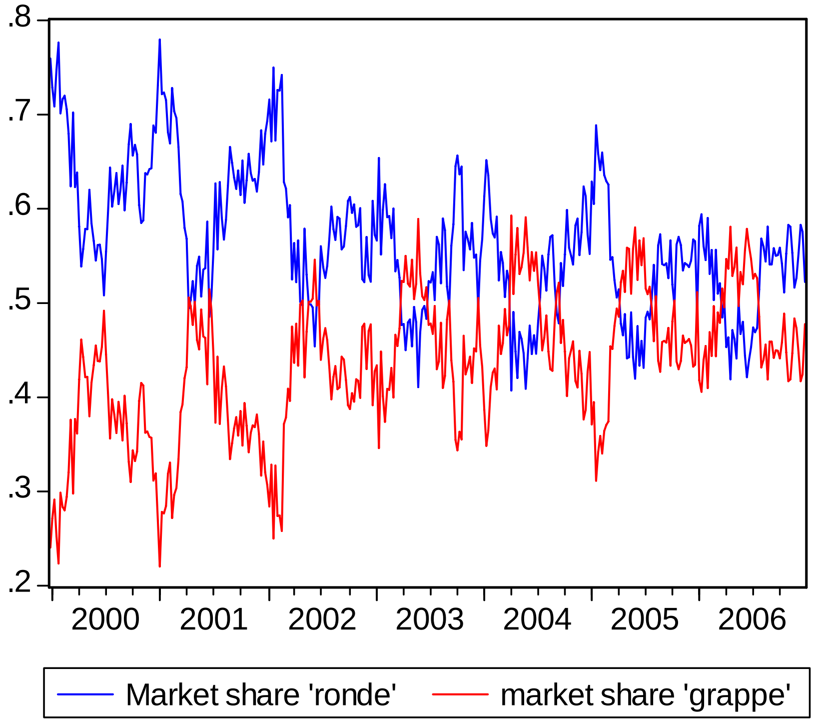
Even if the tomato production is one of the most organized among the fruit and vegetable industry, the production is not concentrated as the 4 main organizations of producers sell 36% of the whole production (Giraud, 2006). The four main producers are Savéol, Prince de Bretagne, Rougeline and Océane which produced about 70, 70, 60 and 25 kt in 2005, respectively. The Hirschmann Herfindahl Index of concentration at the production level is about 400, which is typical of a non concentrated production.
On the contrary the retail sector is much more concentrated. In 2004, 79% of the quantities were sold by 'large' retailers while 14% were sold in open markets, 5% in specialized shops and the remaining 2% corresponds to direct sales and others. As retail sector is highly concentrated in France, CR4 is around 65 to 70% while the HHI is certainly about 2000.

There are different varieties of tomatoes. The main varieties are 'tomate ronde' and 'tomate grappe' which represent more than 80% of the market in 2005 (Linéaires, 2006). The remaining are 'tomate allongée' (about 4% of the market), 'tomate cerise' (about 5% of the market) and other varieties (about 7% of the market).

In this paper, we concentrate our analysis on the two main varieties that is 'tomate ronde' and 'tomate grappe'. As shown on graph 2, the consumption of tomato strongly varies during the year with low consumption in winter and high consumption in summer. Over the period 2000-2006 the 'tomate grappe' has increased its market share, even if during winter (that is when imports are large) its market share is smaller (graph3).

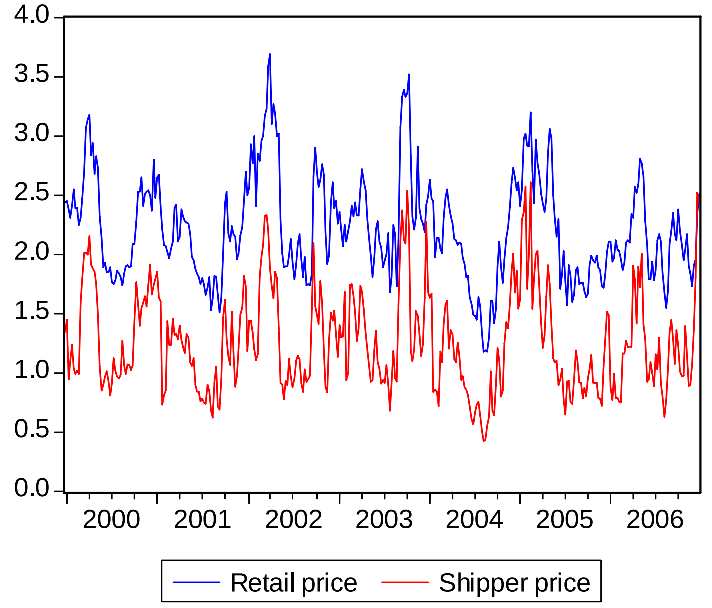


Graph 2: Consumption of ‘tomate ronde’ and ‘tomate grappe’ from 2000 to 2006 (t/week)

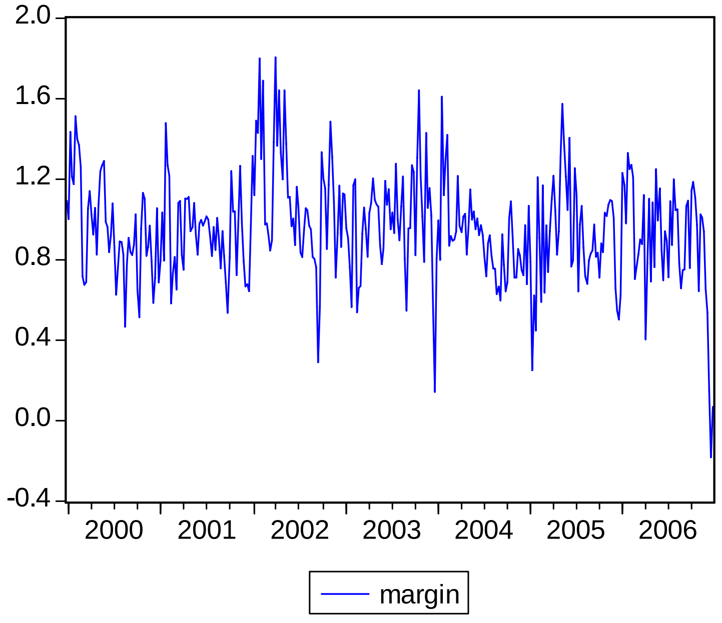


Graph 3: Relative share of ‘tomate ronde’ and ‘tomate grappe’ from 2000 to 2006

As illustrated by the example of ‘tomate grappe’ on graph 4, there is a strong correlation between the consumer price and the shipper price. The ‘margin’ calculated as the difference between the two prices (graph 5) does not exhibit a tendency (see in Annex 1, the graphs for ‘tomate ronde’). There are large and frequent variations around an average. While prices follow a general pattern along the year with lower prices in summer, margins do not exhibit such a tendency. On the contrary, we find 'high' margins and 'low' margins during all the year. The time series of margins are 'mean reverting'.[1]



Graph 4: Tomate grappe: Retail price and shipper price from 2000 to 2006 (€/kg)



Graph 5: Tomate grappe: Retail Margin from 2000 to 2006 (€/kg)

[1] We tested the stationarity of the margin series using the usual KPSS test.

3. Model

3.1. General Model

We develop a simple model for the tomato market composed of a demand and a supply functions. Consumer demand is written as follows:

$$Q_t = Q(p_t, p_t^s, y_t, z_t) \qquad (1)$$

where Q_t represents tomato demand in period t, p_t the consumer price of tomato, p_t^s the consumer price of a substitute, y_t the consumers' income and z_t other variables which influence the demand (mainly meteorological variables).

We model supply of tomatoes by the retail industry. This industry is composed of I firms in competition. The supply depends on strategic behaviour of firms acting on the market. The profit of a firm i acting on the market is written by:

$$\pi_{it} = p(Q_t)Q_{it} - C_i(Q_{it}, w_t) \qquad (2)$$

where $Q_t = \sum_i Q_{it}$ is the total output of the industry, Q_{it} is the output of firm i, $p_t = p(Q_t)$ is the inverse demand function and $C_i(Q_{it}, w_t)$ is the cost function of firm i which depends on the production of the firm and w_t a vector of inputs prices. The first order condition of a profit maximising firm is then given by

$$p_t + p'(Q_t)Q_{it}\theta_{it} = \frac{\partial C_i}{\partial Q_{it}} \qquad (3)$$

where $p'(Q_t)$ is the derivative of the inverse demand function, $\theta_{it} = \frac{\partial Q_t}{\partial Q_{it}}$ the conjectural variation of firm i. It represents the anticipation that firm i forms with respect to the reaction of other firms to a variation of its own level of production. Equation (3) indicates that each firm chooses a level of production which is such that the marginal cost is equal to the marginal revenue. In a perfectly competitive framework, the marginal revenue is the price. In presence of imperfect competition, the second term of the LHS of equation (3) denotes the departure from competitive pricing.
To aggregate over firms requires some assumptions on the cost function (see Appelbaum, 1982) which imply that marginal costs are constant and equal across firms. This assumption seems to be acceptable in our case which deals with the large retail industry. By aggregating over all firms the first order condition, we get:

$$p_t + p'(Q_t)Q_t\theta_t = MC(w_t) \qquad (4)$$

where $\theta_t = \sum_i \theta_{it}$ is a parameter which represents the level of competition within the retail industry and MC stands for the marginal cost. Perfect competition behaviour in the industry leads to θ=0, collusion leads to θ=1 and a positive value in this range is interpreted as an oligopolistic behaviour.

3.2. Demand Specification

Following Bettendorf and Verboven (2000), we specify the demand function as follows:

$$Q_t = \alpha_0 + \sum_{k=1}^{12} \alpha_{1,k} \frac{\left(p_t \big/ p_0^t \right)^{\lambda} - 1}{\lambda} M_t^k + \alpha_2 \frac{p_t^s}{p_{0,t}} + \alpha_3 \frac{y_t}{p_{0,t}} + \alpha_4 R_t + \alpha_5 T_t \qquad (5)$$

where M_t^k is a dummy variable for the kth month (k=1, 12), R_t is the rain during period t, T_t is the average temperature and $p_{0,t}$ is a price index. By choosing different values of λ, we estimate different specifications of the demand function in order to check the stability of results. The demand specification is such that the own-price elasticity of demand is allowed to vary through the year.

3.3. Cost Specification

We analyse the cost of the retail activity. The technology is rather simple as the product is not processed. It is essentially transported, displayed in the shop and sold. The elements of cost are thus mainly the wholesale price of the product, transportation cost and labour cost.
It seems reasonable to assume that these inputs are used in fixed proportion. This leads to write the following marginal cost specification:

$$MC(w_t) = \beta_0 w_t^g + \beta_1 w_t^l + \beta_2 w_t^c \qquad (6)$$

where w_t^g stands for the wholesale price of tomato, w_t^l is the wage rate and w_t^c the transportation cost. Coefficient β_0 is interpreted as the inverse of the rate of transformation of tomato in the retailing activity.
Using (5) and (6), we rewrite the supply equation (4) as:

$$\frac{p_t}{p_{0,t}} = \beta_0 \frac{w_t^g}{p_{0,t}} + \beta_1 \frac{w_t^l}{p_{0,t}} + \beta_2 \frac{w_t^c}{p_{0,t}} - \sum_{k=1}^{12} \frac{\theta}{\alpha_{1,k}} \left(\frac{p_t}{p_0^t} \right)^{1-\lambda} Q_t M_t^k \qquad (7)$$

3.4. Estimation procedure

We add the error terms to equations (5) and (7), and estimate the system simultaneously using the Generalized Method of Moments (Hansen, 1982). This estimator is consistent and asymptotically efficient. We take into account the endogeneity of price, quantity as well as expenditures using exogenous demand and cost shifters (lagged prices and quantities, monthly dummies, meteorological variables, …). When needed, we add auto-correlation between the error terms in the demand equation.

4. Data

In this paper, we estimate the model on two varieties of tomato: ‘tomate ronde’ and ‘tomate grappe’. We use different data sources. All data refers to the period 2000-2006. From the Service des Nouvelles des Marchés du Ministère de l’Agriculture et de la Pêche (SNM-MAP), we got weekly data on prices, both shipper and retail prices for the two varieties of tomatoes. From a consumer panel (TNS-SECODIP), we got weekly data on the quantities purchased by consumers (for each of these two varieties) as well as the weekly expenditures for fresh fruits and vegetables.

Meteorological data are from Météo-France and consist in daily information about the weather in Ile de France.2 It is easy to transform these daily data in weekly data: the amount of rain during a week is obviously the sum of the daily amount of rain over the week while the temperature is the average. Finally, we got monthly data from the French Statistical Institute INSEE. This monthly data correspond to the fruit and vegetable price index (used as a deflator), and to the transport cost index. The labour cost index is quarterly. We transform these monthly (or quarterly) data into weekly data assuming linear change within the period. We finally have 366 observations (7*52 + 2).

We provide in the Table 1 some descriptive statistics of the series. It should be noted that the shipper price is about 50 to 60% of the retail price. The retail 'margins' (calculated as the difference between the retail price and the shipper price) are quite similar for the two products and amount to 0.9 to 0.95 €/kg in average. In average the expenditures for tomatoes is about 8% of the total expenditures for fruits and vegetables.

Table 1 : Summary statistics (Weekly data, prices are expressed in €/kg, quantities in t, expenditures in k€)

	Tomato 'grappe'			Tomato 'Ronde'		
	Wholesale price	Retail price	Quantity	Wholesale price	Retail price	Quantity
Average	1.26	2.21	2 316	0.84	1.74	3433
Std Deviation	0.43	0.44	1 424	0.31	0.32	1340
Min	0.42	1.18	431	0.27	1.13	1112
Max	2.61	3.69	6 212	2.03	2.96	7797

	F&V Expenditures	Transport	Wages	Rain	Temperature
Average	134 512	103.63	111.65	1.60	11.41
Std deviation	15 277	4.25	6.82	1.70	6.14
Min	107 656	95.75	99.88	0.00	-3.14
Max	167 726	113.31	123.42	14.06	29.22

5. Empirical results

We present in Tables 2 and 3 our preferred model estimation results. Two specifications of the demand are investigated: a linear one (λ =1) and a semi-logarithmic (λ = 0). Colinearity between transportation cost and labour cost prevent their simultaneous use in estimation. Different sets of instrumental variables were used.3 To facilitate discussion and comparison, results are displayed in term of elasticity instead of original parameters in the demand equations.4

In the case of 'tomate ronde', we find similar results for the two specifications. All estimated elasticities are of the right signs and are significantly different from 0. The own-price elasticity follows a U-shaped pattern through the year. The demand is price elastic in winter (in the range of 1.5 to 2 in absolute value) and becomes inelastic during spring and summer (in the range of 0.4 to 0.8 in absolute value). Finally, in autumn it becomes elastic. Cross-price elasticity is positive and significantly different from 0 indicating the substitutability between the two varieties of tomatoes. Expenditure elasticity is positive and significantly different from 0. It is larger than 1. Thus, consumers allocate to tomatoes a larger share of their fruits and vegetables expenditures when the latter increase. The

[2] These meteorological data are used as demand shifter. We use the information from Ile de France, as this region concentrates a significant part of the French population.

[3] We select the model based on the Hansen – Sargan J statistics.

[4] Each elasticity is evaluated at the average values of price and quantity. Standard errors are computed using the delta method (Hayashi, 2000).

cyclical characteristic of tomato demand is more pronounced than the cyclical characteristic of fruits and vegetables budget. Temperature is a significant shifter of the demand.5

The supply equation parameter estimates are also quite similar in the two model specifications. The shipping price parameter is lower than 1 which was not expected as this parameter could be interpreted as the inverse of the transformation rate. We anticipated to have a coefficient equal to 1 (no loss) or greater than 1 (if there are some loss in the retail activity).

The parameter of market power is not significantly different from 0 in the linear demand specification while it is significantly different from 0 (at the 10% level) in the semi-logarithmic case.

In the case of 'tomate grappe', we find rather similar results that is right signs for (almost) all the estimated value, a U-shaped pattern for own-price elasticity, substitution between the two varieties. However, the semi-logarithmic specification leads to lower values (in absolute value) of demand elasticities than the linear one. This was not the case when dealing with 'tomate ronde'. Interestingly, the coefficient of market power is now significantly different from 0 for the two specifications.

Table 2. Tomato "ronde" - Empirical results, for two demand specifications.

	Demand: Linear specification		*Demand: Semi-Logarithmic specification*	
	Value	Standard error	Value	Standard error
Own-price elasticities				
January	-1.632	0.360	-1.960	0.439
February	-1.425	0.267	-1.527	0.346
March	-1.502	0.269	-1.178	0.230
April	-1.369	0.242	-0.929	0.167
May	-0.681	0.155	-0.368	0.128
June	-0.465	0.108	-0.278	0.099
July	-0.476	0.110	-0.389	0.126
August	-0.816	0.140	-0.971	0.149
September	-1.199	0.205	-1.113	0.186
October	-1.595	0.259	-1.501	0.236
November	-1.707	0.274	-2.032	0.338
December	-2.272	0.354	-2.652	0.400
Cross-price elasticity	0.595	0.124	0.602	0.128
Expenditure elasticity	1.506	0.161	1.717	0.142
Temperature	46.614	5.507	47.846	5.797
Constant	-1110.734	577.699	-3739.506	552.459
	Supply equation		*Supply Equation*	
Shipping price	0.773	0.030	0.762	0.027
Transp. cost	0.010	0.000	0.010	0.001
Conj. parameter	0.012	0.012	0.020	0.011

Rain was not significant and we thus re-estimate the model without this demand shifter. Due to colinearity, it was not possible to include in the supply equation both the transportation cost and wages.

[5] Weekly amount of rain does not have a significant impact on the demand.

Table 3. Tomato “grappe” - Empirical results, for two demand specifications.

	Demand: Linear specification		*Demand: Semi-Logarithmic specification*	
	Parameter value	Standard error	Parameter value	Standard error
Direct price elasticity				
January	-5.088	0.365	-4.066	0.259
Februrary	-3.888	0.360	-3.326	0.226
March	-2.415	0.221	-1.699	0.144
April	-1.249	0.151	-0.691	0.038
May	-0.528	0.091	-0.120	0.056
June	-0.259	0.655	0.257	0.062
July	-0.599	0.078	-0.263	0.080
August	-1.219	0.113	-1.382	0.129
September	-1.848	0.170	-1.665	0.138
October	-2.821	0.235	-2.307	0.154
November	-2.952	0.238	-2.551	0.178
December	-4.426	0.340	-3.585	0.246
Cross-price elasticity	0.669	0.097	0.461	0.097
Income elasticity	1.356	0.109	0.680	0.147
Temperature	33.455	4.939	45.461	6.544
Constant	175.073	256.123	729.772	276.428
	Supply equation		Supply Equation	
Shipping price	0.902	0.031	0.889	0.033
Transp. cost	0.010	0.000	0.010	0.001
Conj. parameter	0.008	0.004	0.007	0.002

Rain was not significant and we thus re-estimate the model without this demand shifter. Due to colinearity, it was not possible to include in the supply equation both the transportation cost and wages.

From the above results, it is easy to compute the estimated values of the Lerner index which is defined as

$$L_t = \frac{p_t - MC(w_t)}{p_t} = \frac{\theta_t}{\varepsilon_t} \qquad (8)$$

with ε_t the absolute value of the own-price elacticity of demand at time t. The corresponding values are reported in tables 4 and 5. As expected, for ‘tomate ronde’ the Lerner index estimates are not significantly different from 0 in the linear demand specification. In the semi-logarithmic case, it varies from less than 1% to more than 7%. For ‘tomate grappe’ the Lerner index estimates are significantly different from 0 and range from less than 0.2% to 3% in the ‘linear case’ and from less than 0.2% to more than 5% in the ‘semi-logarithmic case’.

The Lerner index is larger in summer than in winter. This is because the own-price elasticity of demand is lower in summer than in winter.

From the Lerner index, we compute the absolute value of the mark-up which can be easily compared to the retail price. This mark-up is due to the exercise of market power by the retail sector. Depending of the month, for the ‘tomate grappe’ the mark-up varies from nearly 0 to about 0.06 €/kg in the linear demand model while it reaches 0.13 €/kg in the semi-logarithmic demand model. The latter model provides estimates of the mark-up which are about twice those estimated with the linear demand model.

Table 4. 'Tomate ronde' – Estimated Lerner indexes (in %) and estimated price-cost margins (in €cents/kg).

	Linear demand		Semi-Logarithmic demand	
	Lerner index (standard error)	Price-cost margin	Lerner index (standard error)	Price-cost margin
January	0.71 (0.82)	ns	1.03 (0.50)	1.65
February	0.81 (0.94)	ns	1.32 (0.64)	2.13
March	0.77 (0.89)	ns	1.71 (0.83)	3.34
April	0.84 (0.98)	ns	2.16 (1.06)	4.64
May	1.70 (1.97)	ns	5.47 (2.41)	10.48
June	2.48 (2.88)	ns	7.27 (3.04)	12.16
July	2.42 (2.82)	ns	5.16 (2.30)	8.11
August	1.42 (1.61)	ns	2.07 (1.07)	3.12
September	0.96 (1.10)	ns	1.80 (0.91)	3.17
October	0.72 (0.82)	ns	1.34 (0.63)	2.42
November	0.68 (0.78)	ns	0.99 (0.48)	1.61
December	0.51 (0.58)	ns	0.76 (0.38)	1.26

ns: non significant Lerner index.

Table 5. 'Tomate grappe' – Estimated Lerner indexes. (in %) and estimated price-cost margins (in €cents/kg).

	Linear demand		Semi-Logarithmic demand	
Lerner index	Lerner index (standard error)	Price-cost margin	Lerner index (standard error)	Price-cost margin
January	0.16 (0.08)	0.38	0.16 (0.06)	0.40
Februrary	0.20 (0.11)	0.47	0.20 (0.07)	0.46
March	0.33 (0.18)	0.84	0.39 (0.13)	1.01
April	0.64 (0.28)	1.66	0.96 (0.31)	2.51
May	1.50 (0.65)	3.42	5.57 (1.58)	12.70
June	3.06 (1.16)	5.81	2.58 (1.20)	4.90
July	1.33 (0.58)	2.44	2.53 (0.98)	4.66
August	0.65 (0.30)	1.12	0.48 (0.17)	0.83
September	0.43 (0.20)	0.90	0.40 (0.14)	0.83
October	0.28 (0.13)	0.65	0.29 (0.10)	0.67
November	0.27 (0.13)	0.59	0.26 (0.09)	0.60
December	0.18 (0.08)	0.42	0.19 (0.06)	0.44

The negative impact of imperfect competition is relatively small. For example, in the case of 'tomate ronde' (using results from the semi-logarithmic model), in absence of market power consumers would benefit from a 3.2% price reduction in average over the year. This price reduction induces an increase in the consumption of 'tomate ronde' by about 2%. However due to substitution between the two varieties the increase in tomato consumption is lower. In the case of 'tomate grappe', the price effect of the imperfect competition varies from 1.1 to 1.9% depending on the model.

6. Concluding Remarks

In this paper, we have estimated the market power of the retail sector in the fresh tomato sector in France. Using tools from the New Empirical Industrial Organization, we have developed a structural model of the sector. According to our results, the retail sector exert some market power vis à vis the consumers. However the exercise of this market power remains moderate. For example, in absence of market power, we estimate that this would induce a price decrease by about 3% in average which leads to marginal increase in the consumption of tomatoes.
While the retail sector is concentrated, these results suggest that, for this product, the competition among retailers is effective. A possible explanation may be that consumers select their retail shop according to the prices of a few number of products, among them the tomato. Then price competition among retailers is rather 'tough' as low price for this product is a tool to attract consumers.

In this paper, we have investigated the market power of retailers vis à vis the final consumers. However, it could be the case that retailers exert some market power vis à vis the upstream level (buying power). Thus, one of the objectives of the CMO in the fruit and vegetable sector is to reinforced coordination at the upstream level through the development of Producers Organizations (PO). Among the different arguments invoked to reinforce coordination at the upstream level, there is the idea that some concentration at the upstream level is needed in order to allow producers to better negotiate with a concentrated retail sector. This is an important question for an extension of our analysis.

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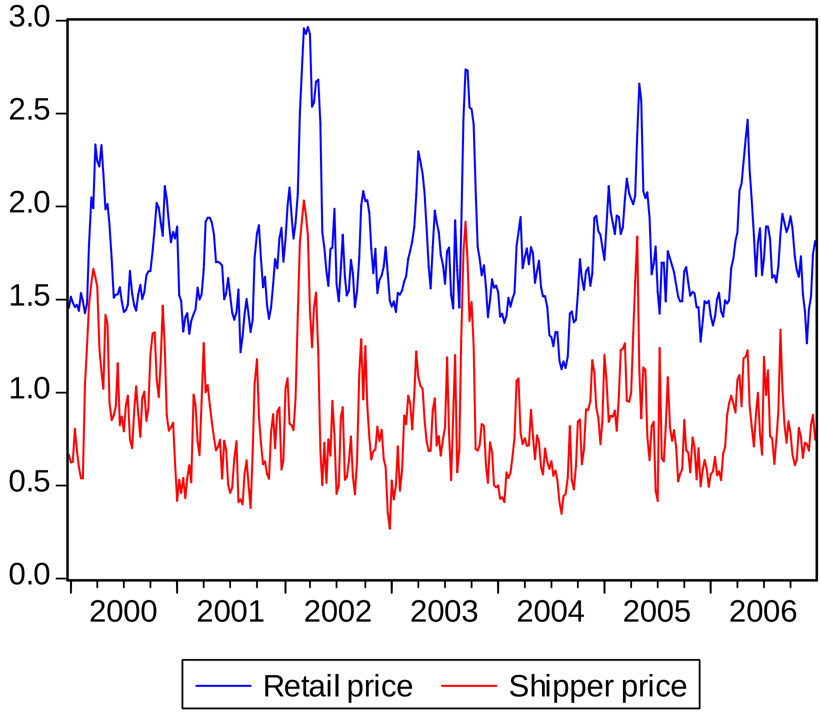
ANNEX

Graph A1: Tomate ronde: Retail price and shipper price from 2000 to 2006 (€/kg)



Graph A2: Tomate ronde: Retail margin from 2000 to 2006 (€/kg)