Imperfect competition in the fresh tomato industry*

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Abstract

In this paper, we develop a structural model to analyze the market power of the retail industry in the French fresh tomato market. The analysis is based on aggregate data on final consumption and prices at both shipper and consumer levels for the two main varieties of tomatoes in France. The structural model is composed of a system of demand equations, supply equations and pricing equations which include terms that capture the oligopoly and oligopsony power of the retail sector and that account for product differentiation. We show that: i) elasticity of demand varies during the year ii) the retail sector exercises only "moderate" market power iii) the exercise of market power decreases over time iv) if markets were competitive, in the case of the "grappe" tomato, retail price would decrease by about 2% to 12% depending on the year; v) in absence of market power, shipping price might be 10% to 54% higher than observed. In summary, given that distortions are smaller in the case of the "ronde" tomato, we conclude that there is a moderate exercise of market power by the retail sector in the French tomato market.

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1 Introduction

Do retailers exert market power in the fresh fruit and vegetables markets? In EU countries, as the retail industry distributes a significant proportion of fruit and vegetables, non-competitive behavior might have a significant impact on consumption, surplus and welfare. It may also have an impact on the success of public campaigns across European countries promoting fruit and vegetable consumption as for example the "5 a day" campaing. In this paper, we shed some light on the degree of non-competitive distortions in the French fresh tomato market.

There is some evidence of distortions due to non-competitive behavior in retailing in the EU. Thus, in a recent investigation, the UK competition commission concluded that they have 'concerns in two principal areas ... several groceries have strong positions in a number of local markets, ... and that the transfer of excessive risk and unexpected costs by grocery retailers to their suppliers if unchecked will have an adverse effect on investment and innovation in the supply chain and ultimately on consumers' (UK Competition Commission (2008)). Barros et al. (2006) showed a positive correlation between retail concentration at the local level and consumer prices. They also found that the most important clients obtain lower prices, suggesting the exercise of buyer power vis à vis the suppliers. Smith (2004), analyzing the UK market, also showed a positive link between consumer prices and retailer concentration at the local level. Biscourp et al. (2008) also found such a link in the case of France. In addition, they demonstrated that in France the enforcement of a specific regulation (the ban of below-invoice retail prices) has weakened competition among retailers. Moreover, the retail sector is often blamed for taking advantage of increasing prices to enlarge its margins on the consumer side. The recent increase in agricultural prices offers an example of that concern across European countries[1].

Compared to processed food, fresh fruit and vegetables have some particularities that

[1] Major national newspapers often report on consumer concern about rising prices, for example, *El Mundo* (Spain) (June 2, 2008 http://www.elmundo.es/mundodinero/2008/06/02/economia/1212407337.html), or *The Times* (UK) (January 15, 2008 http://business.timesonline.co.uk/tol/business/economics/article3189773.ece).

can make the exertion of market power easier, especially on the supply side. Firstly, the fact that they are not processed means that producers deal directly with retailers. Given that agricultural production in Europe is usually undertaken by small or low-concentrated farmers, the bargaining power of these farmers in any negotiation with the highly concentrated retail sector is likely to be negligible. Secondly, fresh produce prices are highly seasonal and volatile, depending on weather conditions. Retailers are usually accused of using their market power to lower producer prices excessively under bad demand conditions[2]. Conversely, under favorable demand conditions, they are accused of increasing prices excessively[3]. Recent studies do not support this view of asymmetric price transmission. For instance, a report by London Economics (2004) shows that, in the European Union, most studies point to symmetric price transmission in fruit and vegetables. Hassan and Simioni (2004) addressed this question for the case of tomatoes and chicory in France and found that asymmetric price transmission is as frequent as the symmetric case. When transmission is asymmetric, they did not find evidence for the widespread assertion that shipping price increases are completely and rapidly passed on to consumer prices while there is a slower and less complete transmission of shipping price declines. They found the opposite, i.e., that price declines are more rapidly transmitted to consumers than price increases. Moreover, the UK Competition Commission (2008) found that 'the analysis on fruit supply chain does not support the hypothesis that grocery retailers in the UK have engaged in demand withholding in the fruit industry'.

Depending on the degree of perishability of products, different models of price formation have been developed and estimated using firm-level data. For products that are highly perishable, Sexton et al. (2006) focused on price formation at the upstream level. They designed a model where producers and retailers bargain to share the surplus from

[2] A recent example can be found in *Le Figaro* (France), February 29, 2008 http://www.lefigaro.fr/conso/2008/02/29/05007-20080229ARTFIG00321-les-producteurs-de-laitue-etrangles-par-les-mecanismes-de-marche-.php

[3] A recent example can be found in *Le Figaro* (France), August 19, 2008 http://www.lefigaro.fr/conso/2008/08/19/05007-20080819ARTFIG00330-manger-des-fruits-et-legumes-c-est-plus-cher-cet-ete-.php

selling the product. They estimated that producers were able to keep about 20% of the surplus to be shared. For products that are storable, Richards and Patterson (2003, 2005) developed and estimated a model allowing for both buyer power and seller power for various fruit and vegetable in the US. The model allows testing if retail price fixity is used as a mechanism permitting tacit collusion among retailers. They found evidence of seller power and in some cases of buyer power by retailers. They also found some evidence that market power decreases with quantities that are sold.

To the best of our knowledge, there are no studies on the estimation of retailer market power for fruit and vegetables in the European Union. This paper attempts to fill this gap and to provide insights on retailer market power for the fresh tomato industry in France. In the paper, we use aggregate data on the fresh tomato market and we build on the framework developed by Appelbaum (1982) and Schroeter (1988), which is suitable for this kind of data. As in Wann and Sexton (1992), our model deals simultaneously with oligopoly and oligopsony power while a significant part of this literature only deals with oligopoly (e.g., Schroeter (1988), Bettendorf and Verboven (2000)) or imposes equality of oligopoly and oligopsony conjectures (e.g., Schroeter and Azzam (1990), and Gohin and Guyomard (2000))[4]. Our modeling allows for seasonality changes of elasticities of supply and demand, an important feature for fresh products which, at least on the demand size, exhibit significant changes over the year. We also take into account product differentiation as we deal with the two main varieties of tomatoes that are relatively close substitutes. We find evidence of a moderate exercise of market power by the retail sector. Our results suggest that distortions are larger on the producer side than on the consumer side and that they tend to decrease over time.

The paper is organized as follows: In Section 2, we briefly present the French fresh tomato industry. In Section 3, we detail the model used. We then develop the empirical strategy in Section 4, and we provide some information on the data used in Section 5. Results are presented and discussed in Section 6. We conclude in Section 7.

[4]For a survey on market power in the food sector, see Sexton and Lavoie (2001).

2 The French Fresh Tomato Industry

The tomato is the main vegetable consumed in France. In 2004, households purchased 841,000 tons of fresh tomatoes for consumption at home (14 kg/per capita). In 2004, the French production of fresh tomatoes amounted to 624,000 T. while imports were about 435,000 tons (and exports amounted to 95,000 tons). From November to February, the supply comes mainly from imports while from March to October it comes mainly from national production (Figure 1).

[FIGURE 1 AROUND HERE]

Even if 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 only 36% of the whole production (Giraud (2006)).[5] The Hirschmann-Herfindahl Index (HHI) of concentration at the production level is about 400, which is typical of non-concentrated production.[6] On the contrary, the retail sector is much more concentrated. In 2004, the market share of retailing chains was 79%, 14% for open markets, 5% for specialized shops and the remaining 2% for direct sales and others. The HHI of the retail industry is about 2000 with a CR4 ranging from 65 to 70%.

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

We focus on the two main varieties, the 'ronde' tomato and the 'grappe' tomato. Table 1 shows some descriptive statistics for prices and quantities of both varieties. It should be noted that the shipping price is about 50 to 60% of the retail price. The retail 'margins' (calculated as the difference between the retail price and the shipping price) are quite

[5]The four main producers are Savéol, Prince de Bretagne, Rougeline and Océane which produced about 70, 70, 60 and 25 thousand tons in 2005, respectively.

[6]For example, according to the US merger Guidelines, an HHI lower than 1,000 means 'low' concentration, an HHI between 1,000 and 1,800 correponds to 'moderate' concentration and an HHI larger than 1,800 corresponds to a 'high' concentration.

similar for the two products and amount to 0.9 to 0.95€$/kg$ on average. On average, the expenditure for tomatoes is about 8% of the total expenditures for fruits and vegetables.

[TABLE 1 and FIGURE 2 AROUND HERE]

As shown in Figure 2, the consumption of tomatoes strongly varies during the year with low consumption in winter and high consumption in summer. Over the period 2000-2006, the 'grappe' tomato increased its market share, even if during winter (when imports are large) its market share is smaller (Figure 3).

[FIGURE 3 AROUND HERE]

As illustrated by the example of 'grappe' tomatoes in Figure 4, there is a strong correlation between the consumer price and the shipping price. The 'margin' calculated as the difference between the two prices (Figure 5) does not exhibit a trend. These patterns also hold for the 'ronde' variety .[7] There are large and frequent variations around an average. While prices follow a general pattern throughout the year with lower prices in summer, margins do not exhibit such a trend. On the contrary, we find 'high' margins and 'low' margins during the whole year. The time series of margins seems to be 'mean reverting'.[8]

[FIGURES 4 and 5 AROUND HERE]

On the production side, most domestic production is from greenhouses. The production process can be described as follows: tomatoes are planted from December to February (depending on the region and on the planning of the producer). Then, after 8/10 weeks, production starts. A given plant will produce 5/6 tomatoes every week during the productive season, which lasts about 10 months after planting. The rate of production depends

[7] The figures for 'ronde' were omitted but are available from the authors upon request.

[8] Augmented Dickey and Fuller tests clearly reject the null hypothesis of non-stationarity, whatever the variety of tomato considered. Indeed, the values of the statistics, i.e. -10.710 and -7.241 for 'grappe' tomatoes and 'ronde' tomatoes, respectively, are smaller than the critical test values at the 1 percent level, whose values are -3.983 and -3.448 , respectively. These critical values depend on the chosen number of lagged first differences of the dependent variable (here the margin) in the test equation (see Harris and Sollis (2003) for more details).

on solar radiation which is not controlled (it is too costly to light the greenhouses to favor early production and it is difficult to regulate too hot conditions in summer). All others inputs such as water, minerals, fertilizers or pesticides are controlled. Therefore, during the year, there is almost no way to adjust the production to strategically react to changes in the economic environment. For example, delaying the harvest of a given week with the expectation of receiving higher prices the following week (in response to low demand) will have negative consequences on future production of the plants. As a consequence, producers do not follow such strategies. The only possibility to adapt to bad economic conditions in the short run is to store tomatoes for some period (less than a week) after harvest. Thus in the very short run, due to the technology, production is almost insensitive to prices.

3 Model

We develop a model inspired by Appelbaum (1982) and Schroeter (1988) for the French fresh tomato industry . In particular, we consider a vertical chain with a large number of producers offering two varieties of tomatoes which are bought by retailers who then resell to final consumers. Our setting is close to Schroeter and Azzam (1990) or Wann and Sexton (1992).

Consumer demand is written as follows:

$$Q_{jt}^{d} = D\left(p_{jt}, p_{kt}, y_t, Z_{1t}\right) \ , \ j,k = 1,2$$

where j and k index product varieties ('ronde' and 'grappe'), such that the demand for product j at time t depends on its own price (p_{jt}), the price of the other variety (p_{kt}), income (y_t) and other shifters affecting demand (Z_{1t}).

Supply is given by:

$$Q_{jt}^{s} = S\left(r_{jt}, w_t, Z_{2t}\right) \ , \ j = 1,2 \ , \ k \neq j$$

where r_{jt} represents the shipping price of the raw material, w_t represents the price of other inputs, and Z_{2t} other supply shifters. We assume that the price of a given variety in a given period t does not affect the supply of the other variety in that period. This assumption is motivated by the fact that producers cannot switch from one variety to the other in the short run, as explained above.

Based on the description of the retailing technology, we assume a transformation rate of raw material into final product equal to 1. We also assume linear pricing between producers and retailers. Then the problem of the retailer i is to choose q_{jt}^i and q_{kt}^i to maximize:

$$\pi_t^i = P_1\left(Q_{1t}^d, Q_{2t}^d\right) q_{1t}^i - R_1\left(Q_{1t}^s\right) q_{1t}^i + P_2\left(Q_{1t}^d, Q_{2t}^d\right) q_{2t}^i - R_2\left(Q_{2t}^s\right) q_{2t}^i - C_i\left(q_{1t}^i, q_{2t}^i\right)$$

given the demand and supply equations defined above, such that $Q_{jt}^d = Q_{jt}^s = \sum_i q_{jt}^i$, with q_{jt}^i being the output of product j by firm i at time t. $P(\cdot)$ is the inverse demand function of each product, $R(\cdot)$ is the inverse supply function, and $C_i(\cdot)$ is firm i 's non-raw material input cost depending on quantity and other input prices.

The first-order conditions from this optimization problem are:

$$p_1 + \left[\frac{\theta_{11}^{id}}{\varepsilon_{11}} + \frac{\theta_{21}^{id}}{\varepsilon_{21}}\right] p_1 + \left[\frac{\theta_{11}^{id}}{\varepsilon_{12}} + \frac{\theta_{21}^{id}}{\varepsilon_{22}}\right] \frac{p_2 q_2^i}{q_1^i} = r_1 + C_{i1}^{'} + \left[\frac{\theta_{11}^{is}}{\eta_{11}}\right] r_1 + \left[\frac{\theta_{21}^{is}}{\eta_{22}}\right] \frac{r_2 q_2^i}{q_1^i}$$

$$p_2 + \left[\frac{\theta_{12}^{id}}{\varepsilon_{11}} + \frac{\theta_{22}^{id}}{\varepsilon_{21}}\right] \frac{p_1 q_1^i}{q_2^i} + \left[\frac{\theta_{12}^{id}}{\varepsilon_{12}} + \frac{\theta_{22}^{id}}{\varepsilon_{22}}\right] p_2 = r_2 + C_{i2}^{'} + \left[\frac{\theta_{12}^{is}}{\eta_{11}}\right] \frac{r_1 q_1^i}{q_2^i} + \left[\frac{\theta_{22}^{is}}{\eta_{22}}\right] r_2$$

where $C_{ij}^{'} = \frac{\partial C_i(\cdot)}{\partial q_j}$ is the non-raw material input marginal cost, $\varepsilon_{jk} = \frac{\partial Q_j}{\partial P_k}\frac{P_k}{Q_j}$ $(j, k = 1, 2)$ is the elasticity of demand, $\eta_{jk} = \frac{\partial Q_j}{\partial r_k}\frac{r_k}{Q_j}$ is the elasticity of raw material input supply and $\theta_{jk}^{il} = \frac{\partial Q_j^l}{\partial q_k^i}\frac{q_k^i}{Q_j^l}$, $(j, k = 1, 2$ and $l = d, s)$, is the firm i's conjectural variation elasticity. 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. We allow conjectures to be different upstream and downstream. Following Schroeter and Azzam (1990), the $\theta's$ can give a measure of the non-competitive distortions in a market, although one should be careful in making inferences about the extent of market power, as pointed out by Corts (1999). As noted in Schroeter and Azzam (1990), θ_{11}^{il} and θ_{22}^{il} should be between 0 and 1, such that in a perfectly competitive market there is no distortion at all $\left(\theta_{jj}^{il}=0\right)$, because no firm expects to be able to affect total output when choosing its own quantity, while $\theta_{jj}^{il}=1$ would correspond to the case of a monopoly. The values and signs of the cross-conjectural parameters, θ_{12}^{il} and θ_{21}^{il} , are not restricted in general. For example, they could be negative if products were substitutes. In summary, the first-order conditions just tell us that for each product the marginal revenue is equal to the marginal cost of the material input plus the marginal cost of non-material inputs needed to provide the good. Under perfect competition, the price would equal the price of the raw product plus the marginal non-material input cost.

This analysis has been developed at the firm level. However, using aggregate data requires some assumptions to guarantee that there is an industry counterpart to the first-order equations given above. Basically, what is needed (see Schroeter and Azzam (1990)) is constant and equal marginal costs of production across firms plus non-jointness of production. In our context, this means that retailing marginal costs are identical and that retailing of variety 2 does not affect the marginal cost of retailing of variety 1, and vice versa. More explicitly:

$$C\left(q_1^i, q_2^i\right) = C_{i1}q_1^i + C_{i2}q_2^i = C_1 q_1^i + C_2 q_2^i$$

Nevertheless, an aggregate counterpart for the first-order conditions is not guaranteed to exist, so they must be written in terms of industry average values. The interpretation of the $\theta's$ is now that they are quantity-weighted averages of the corresponding individual $\theta's$. Therefore, the industry averaged first-order conditions can be written as:

$$p_1 + \left[\frac{\theta_{11}^d}{\varepsilon_{11}} + \frac{\theta_{21}^d}{\varepsilon_{21}}\right] p_1 + \left[\frac{\theta_{11}^d}{\varepsilon_{12}} + \frac{\theta_{21}^d}{\varepsilon_{22}}\right] \frac{p_2 q_2}{q_1} = r_1 + C_1 + \left[\frac{\theta_{11}^s}{\eta_{11}}\right] r_1 + \left[\frac{\theta_{21}^s}{\eta_{22}}\right] \frac{r_2 q_2}{q_1}$$

$$p_2 + \left[\frac{\theta_{12}^d}{\varepsilon_{11}} + \frac{\theta_{22}^d}{\varepsilon_{21}}\right]\frac{p_1 q_1}{q_2} + \left[\frac{\theta_{12}^d}{\varepsilon_{12}} + \frac{\theta_{22}^d}{\varepsilon_{22}}\right] p_2 = r_2 + C_2 + \left[\frac{\theta_{12}^s}{\eta_{11}}\right]\frac{r_1 q_1}{q_2} + \left[\frac{\theta_{22}^s}{\eta_{22}}\right] r_2$$

From these equations we define, as in Schroeter and Azzam (1990), the following measures of market power:

$$L_1 = -\frac{1}{p_1}\left\{\left[\frac{\theta_{11}^d}{\varepsilon_{11}} + \frac{\theta_{21}^d}{\varepsilon_{21}}\right] p_1 + \left[\frac{\theta_{11}^d}{\varepsilon_{12}} + \frac{\theta_{21}^d}{\varepsilon_{22}}\right]\frac{p_2 q_2}{q_1}\right\}$$

$$L_2 = -\frac{1}{p_2}\left\{\left[\frac{\theta_{12}^d}{\varepsilon_{11}} + \frac{\theta_{22}^d}{\varepsilon_{21}}\right]\frac{p_1 q_1}{q_2} + \left[\frac{\theta_{12}^d}{\varepsilon_{12}} + \frac{\theta_{22}^d}{\varepsilon_{22}}\right] p_2\right\}$$

$$M_1 = \frac{1}{r_1}\left\{\left[\frac{\theta_{11}^s}{\eta_{11}}\right] r_1 + \left[\frac{\theta_{21}^s}{\eta_{22}}\right]\frac{r_2 q_2}{q_1}\right\}$$

$$M_2 = \frac{1}{r_2}\left\{\left[\frac{\theta_{12}^s}{\eta_{11}}\right]\frac{r_1 q_1}{q_2} + \left[\frac{\theta_{22}^s}{\eta_{22}}\right] r_2\right\}$$

$$D_1 = \frac{p_1 L_1 + r_1 M_1}{p_1 - r_1} = \frac{p_1 - r_1 - C_1}{p_1 - r_1}$$

$$D_2 = \frac{p_2 L_2 + r_2 M_2}{p_2 - r_2} = \frac{p_2 - r_2 - C_2}{p_2 - r_2}$$

L measures the degree of distortion on the consumer side, M measures the distortion on the producers' side and D is an aggregate measure of market power. In general, we will have higher distortions the smaller the elasticities and /or the larger the $\theta's$ are.

In order to illustrate the importance of these distortions, other comparisons of interest can be made with respect to the estimated competitive price. Perfect competition in retailing implies $p_j = r_j + C_j = p^*$. Provided we have estimates of supply and demand equations, one can impose competition and then solve for the market clearing price. This procedure provides a comparative static estimate of the competitive price, i.e., the price that clears the market if we do not allow for any distortion and we keep other things equal.[9] With p^* we can also compute the competitive quantity and the distortions between actual and competitive prices and quantities.

[9] More precisely, we compute the counterfactual competitive price for one variety as if nothing had changed for the other variety, i.e., in the counterfactual for 'ronde' tomatoes we do not impose that the market for 'grappe' tomatoes is behaving competitively simultaneously, and the other way round.

4 Empirical Strategy

4.1 Demand specification

We consider a linear demand function[10] of the form:

$$Q_{jt} = \sum_{m=1}^{12} \alpha_{j1m} p_{jt} M_{tm} + \alpha_{j2} p_{kt} + \alpha_{j3} y_t + \alpha_{j4} Tm_t + \alpha_{j5} Q_{jt-1} + \alpha_{j6} Q_{kt-1}$$

p_{jt} represents the real price of variety j and p_{kt} the price of variety k. M_m is a dummy for month m such that the own-price elasticity of demand is allowed to vary throughout the year. y_t is consumer income in real terms. As we do not have that data, we take as a proxy the total expenditure in fruits and vegetables. Tm is the average temperature. The consumption of tomatoes shows a positive autocorrelation and therefore one-period lagged quantities are introduced to control for the autocorrelation of the series. That is also why we do not introduce a constant term. The cross-lagged quantity is introduced because it is reasonable to think that present consumption of tomatoes will be correlated with total past consumption, and not only with consumption of one variety. Therefore, covariates will explain the variation between previous and current consumption and hence elasticities should be understood as short-run price elasticities.

4.2 Supply specification

The supply of tomatoes is modelled as a linear function[11]:

$$Q_{jt} = \sum_{m=1}^{12} \beta_{j1m} r_{jt} M_{tm} + \beta_{j2} Sun\_NO_t + \beta_{j3} Q_{jt-52}$$

r_{jt} is the material input price j interacted with a monthly dummy. Sun_NO_t is a measure of the total solar radiation during week t in a representative producer area in

[10] Linear demand is a common specification used in this literature (see, for example, Wann and Sexton (1992), Bettendorf and Verboven (2000), or Richards and Patterson (2005)).

[11] Again, linearity of supply functions is not unusual. See, e.g., Durham and Sexton (1992).

France. As explained before, sunlight is one of the most important determinants of tomato production. Q_{jt-52} is introduced as a proxy for productive capacity in week t because of this dependence of production on seasonal climatological conditions and also because the planted area does not vary much during the sample period. Therefore, this variable would be playing the role of a weekly constant term.

4.3 Pricing equation 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, and other cost shifters that in this specification are summarized by the price index of transportation costs ($TrCost$) in real terms. Labor costs follow a pattern similar to transportation costs, suggesting collinearity between them. Moreover, when both variables are used to estimate the pricing equation, the wage index is always non-significant. Therefore, we are not using it to model the cost side.

Inputs are assumed to be used in fixed proportions.[12] Therefore, we can write the following empirical counterpart of the first-order conditions, which are estimated in implicit form:

$$p_1 = r_1 + \gamma_1 TrCost + \left[\frac{\theta^s_{11}}{\eta_{11}}\right] r_1 + \left[\frac{\theta^s_{21}}{\eta_{22}}\right] \frac{r_2 q_2}{q_1} - \left[\frac{\theta^d_{11}}{\varepsilon_{11}} + \frac{\theta^d_{21}}{\varepsilon_{21}}\right] p_1 - \left[\frac{\theta^d_{11}}{\varepsilon_{12}} + \frac{\theta^d_{21}}{\varepsilon_{22}}\right] \frac{p_2 q_2}{q_1}$$

$$p_2 = r_2 + \gamma_2 TrCost + \left[\frac{\theta^s_{12}}{\eta_{11}}\right] \frac{r_1 q_1}{q_2} + \left[\frac{\theta^s_{22}}{\eta_{22}}\right] r_2 - \left[\frac{\theta^d_{12}}{\varepsilon_{11}} + \frac{\theta^d_{22}}{\varepsilon_{21}}\right] \frac{p_1 q_1}{q_2} - \left[\frac{\theta^d_{11}}{\varepsilon_{12}} + \frac{\theta^d_{21}}{\varepsilon_{22}}\right] p_2$$

The variability in supply and own and cross demand elasticities allows the identification of all behavioral parameters. These elasticities are simultaneously estimated in the demand and supply equations. Therefore, the only exogenous variable in these pricing equations is the transportation cost index.

[12] By fixed proportions we mean that there is no substitution between inputs and that the technology is linear.

4.4 Estimation

We add idiosyncratic error terms and estimate the system of six simultaneous equations using the Generalized Method of Moments (GMM) proposed in Hansen (1982). TM, $TrCost$, and Sun_NO are treated as exogenous variables and used as instruments for all equations in the system. Q_{jt-52} and Q_{kt-52} are considered to be predetermined and therefore added to the set of instruments as well. Considering that there is only evidence of an $AR(1)$ in quantities, Q_{t-52} should not be correlated with the error term at time t. The set of instruments is completed with rainfall intensity and an energy price index, both interacted with month dummies. These instruments are used to control for the endogeneity of retail and material input prices, quantities, and total fruit and vegetables expenditures.

5 Data

Our sample runs from 2000 to 2006 and we use different data sources. From the Service des Nouvelles des Marchés du Ministère de l'Agriculture et de la Pêche (SNM-MAP), we obtained weekly data on shipping prices for the two varieties of tomatoes. From a consumer panel (TNS-Worldpanel), we obtained weekly data on the quantities purchased and the price paid by consumers (for each of these two varieties) as well as the weekly expenditures for fresh fruits and vegetables, used as a proxy for household income.

Meteorological data are from INRA and Météorologie Nationale and consist of daily information about the weather in Ile de France (for the demand side) and in the northwest and southeast (for the supply side)[13]. It is easy to transform these daily data into 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 obtained monthly data from the French Statistical Institute INSEE. This monthly data correspond to the fruit

[13] We use data from Ile de France as a demand shifter because a significant part of the French population is concentrated in this region. Regarding the supply side, the main areas of production are the northwest and the southeast of France.

and vegetable price index (used as a deflator), and to the transport cost index. The labor cost index is quarterly. We transform these monthly (or quarterly) data into weekly data assuming linear change within the period. In the end, we have 365 observations ($7*52+1$).

6 Results

For both products, we find very significant coefficients with the expected signs (see Table A1 in the appendix, which reports the estimated value of the parameters as well as the associated $t-$statistics). With respect to the demand side of the model, all estimated price elasticities are of the right signs and are significantly different from 0. Figure 6 plots the average, maximum, and minimum demand elasticities for the 'grappe' variety by month.[14] Demand is clearly more elastic in autumn and winter than in summer, following a U-shaped pattern consistent with the seasonal variation in consumers' taste for fresh products. The same pattern holds for the 'ronde' variety, although in this case the elasticities are much lower. Cross-price elasticities are positive and significantly different from 0 , indicating the substitutability between the two varieties of tomatoes. On average, the cross-price elasticity for 'ronde' tomatoes is 0.4 and it is 0.7 for 'grappe' tomatoes. The expenditure elasticity for 'ronde' tomatoes is positive while it is negative for the 'grappe' variety, but both are highly non-significant. This might be due to substitutions among fruit and vegetables when expenditures increase, meaning that consumers diversify their purchases. Finally, temperature acts as a significant demand shifter.

[FIGURE 6 AROUND HERE]

With respect to the supply side, all estimated elasticities also have the right sign and are significantly different from 0. From Figure 7, we can see that the supply elasticity of the 'grappe' variety has some seasonality but it is less pronounced than in the demand side (the pattern for 'ronde' is similar). Supply seems to be slightly more elastic in the months

[14] We only present Figures for 'grappe' tomatoes. Results for the 'ronde' variety are available from the authors upon request.

when there is no national production at all (December and January), suggesting that the elasticity of imports could be larger because import dealers can divert their supplies to other countries if prices are too low. Nevertheless, supply elasticity is in general quite small, which is consistent with the fact that producers cannot store the product and therefore, in the end, they are forced to sell regardless of prices being low or high.

[FIGURE 7 AROUND HERE]

Regarding the exercise of market power, all the estimated conjectural elasticities are positive and significantly different from 0 for 'ronde' tomatoes. It is not the case for 'grappe' tomatoes, as only cross-conjectural coefficients are significantly different from 0 (cf. Table A1 in the appendix). To have an estimate of the distortion created by the exercise of market power, we computed the D, L and M indexes defined above (Table 2). The exercise of market power is higher in the case of 'grappe' tomatoes than in the case of 'ronde' tomatoes. According to the results, the distortions created upstream and downstream are of a similar order of magnitude.

[TABLE 2 AROUND HERE]

As elasticities vary within the year, the distortions also vary. Figure 8 shows the evolution of the D index for the 'grappe' variety over the whole sample period. It seems that the distortions were higher at the beginning of the period than at the end of the period.[15]

[FIGURE 8 AROUND HERE]

Using supply and demand functions, we do a comparative static exercise where we compute a counterfactual situation assuming perfect competition of the retail sector (both vis à vis the upstream sector and the downstream sector). In 2001, the competitive retail

[15] According to our data, in the penultimate week of 2006, the retail price was smaller than the shipping price for 'grappe' tomatoes, thus implying negative margins for this variety. This is the only period in our sample where this happens, the reason for it not being clear. In any case, this explains the sudden jump of index D2 at the end of the sample (Figure 8).

price would be 4.98% lower than the non-competitive one for 'ronde' tomatoes (Table 3). The shipping price would be 21.12% higher than the non-competitive one. In 2006, the differences between competitive price$s$ and non-competitive prices are much smaller.

[TABLE 3 AROUND HERE]

[TABLE 4 AROUND HERE]

We find higher distortions in the case of 'grappe' tomatoes and also that they were higher in 2001 than in 2006.

Consumers' gains under a perfectly competitive framework, at least in 2006, would be small, meaning that distortions on the demand side are negligible. However, producers would be better off as they would perceive around a 10% higher shipping price for 'grappe' tomatoes, although just 1% higher in the case of 'ronde' tomatoes. Nevertheless, the distortions were much more important in 2001, with distortions of up to 54% in the shipping price of the 'grappe' variety. Figures 9 and 10 illustrate the pattern of observed and counterfactual competitive prices and the decline in distortions from 2001 to 2006 for the 'grappe' variety.

Table 4 shows the distortions in quantities from the counterfactual exercise in 2001 and 2006. For the 'ronde' variety, they are negligible, but for the 'grappe' tomato, we find an almost 10% distortion in consumption in 2001 that seems to be corrected at the end of the sample period.

[FIGURES 9 AND 10 AROUND HERE]

7 Conclusion

In this paper, we propose a structural model of retailer behavior in the fresh tomato industry and we use it to estimate the average market power in the retailing activity. According to our results, the retail sector exerts 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 consumer's price decrease for the 'grappe' variety from 2 to 12% depending on the year, and an even smaller reduction for the 'ronde' variety. This would lead to a 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 small number of products, among them the tomato. Then price competition among retailers is rather 'tough' as a low price for this product is a tool to attract consumers.

It is mainly producers of tomatoes who suffer from the market power of the retail industry. In absence of market power, the shipping price might be 1 to 21% higher than the observed one for 'ronde' tomatoes and 10 to 54% higher for 'grappe' tomatoes. Given the inelasticity of supply this has no significant impact on quantities. It is mainly a transfer from producers to retailers. In the long run this might have some consequences as it could lower the profitability of production and therefore it could also discourage the entry of new producers.

Finally, according to our results, the exercise of market power was larger in 2001 than in 2006.

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Tables

Table 1 : Summary statistics.

	Average	Std. Dev.	Min.	Max.
'Ronde' Tomato				
Shipping price	0.84	0.31	0.27	2.03
Retail price	1.74	0.32	1.13	2.96
Quantity	3,433	1,340	1,112	7,797
'Grappe' Tomato				
Shipping price	1.26	0.43	0.42	2.61
Retail price	2.21	0.44	1.18	3.69
Quantity	2,316	1,424	431	6,212

(Weekly data. Prices expressed in €/kg, quantities in Tons)

Table 2: Average Distortion due to the exercise of market power (%).

	'Ronde' Tomato		'Grappe' Tomato	
	2001	2006	2001	2006
Upstream (M)	5.06	-0.78	19.35	6.22
Downstream (L)	6.61	0.71	18.47	1.71
Total[16] (D)	16.45	0.26	67.35	11.98

Table 3: Average difference between observed price and competitive prices (in % of observed price).

	'Ronde' Tomato		'Grappe' Tomato	
	2001	2006	2001	2006
Retail price	-4.98	-0.28	-12.13	-2.14
Shipping price	21.12	1.06	54.54	9.89

[16] Recall that D is a weighted sum of L and M: $D = \frac{p}{p-r}L + \frac{r}{p-r}M \neq L + M$

Table 4: Average difference between observed and competitive quantities (in % of observed quantity).

	2001	2006
‘Ronde’ Tomato	1.25	0.08
‘Grappe’ Tomato	9.36	1.24

Figures

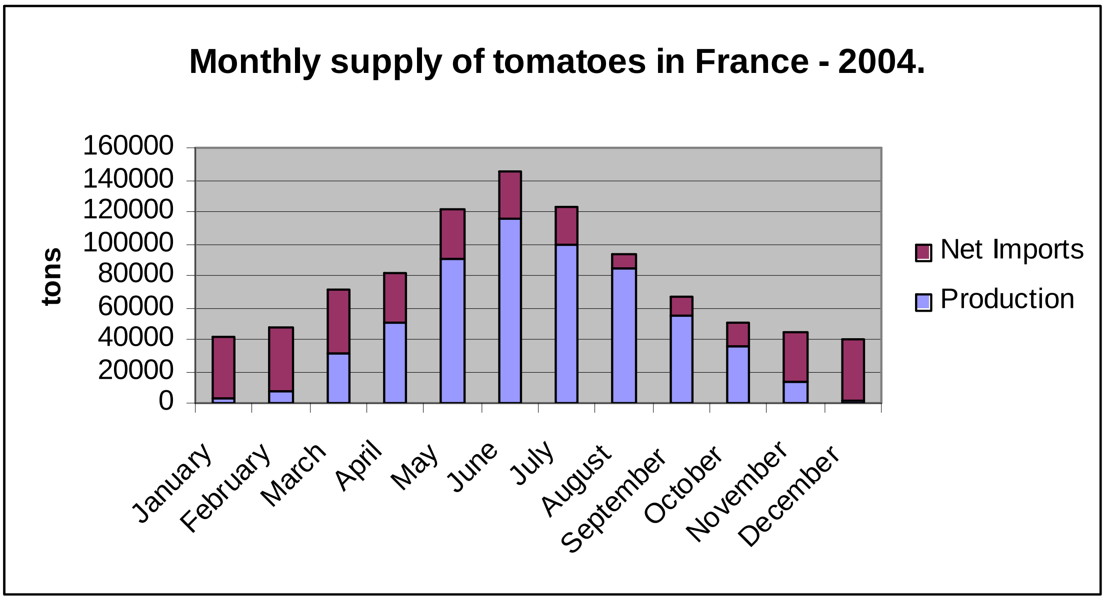

Figure 1: Monthly supply of tomatoes in France, 2004.

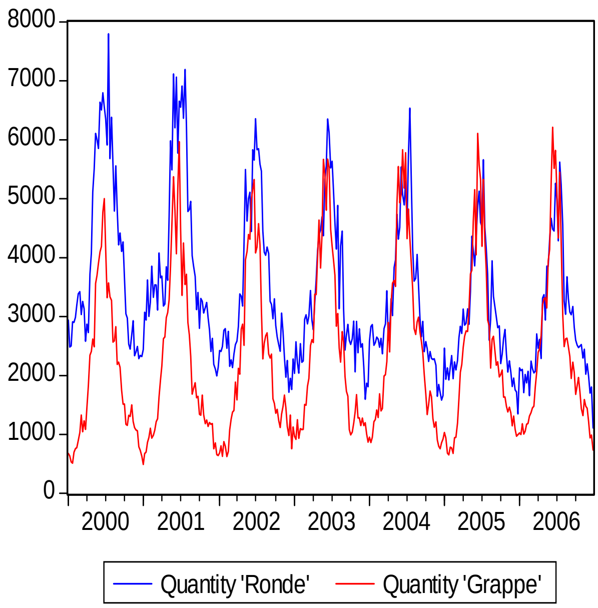

Figure 2: Consumption of 'ronde' tomatoes and 'grappe' tomatoes from 2000 to 2006 (T./week).

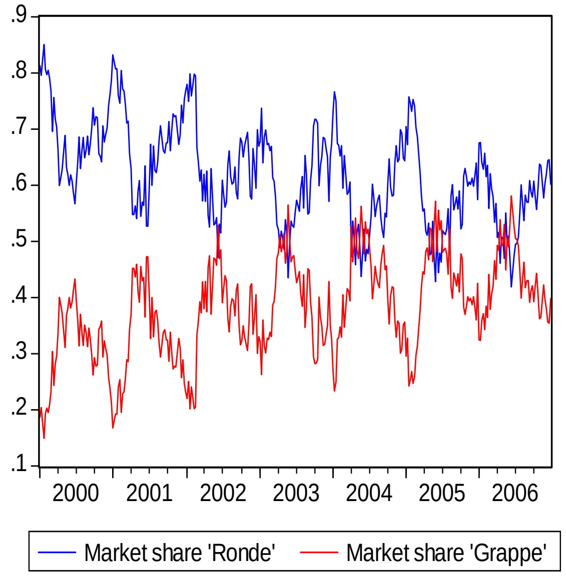

Figure 3: Relative share of 'ronde' tomatoes and 'grappe' tomatoes from 2000 to 2006.

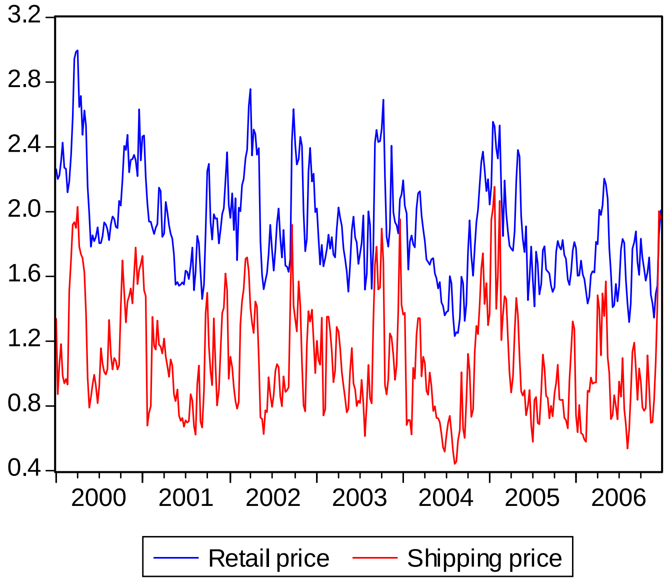

Figure 4: 'Grappe' Tomatoes: Retail price and shipping price from 2000 to 2006 (€/kg).

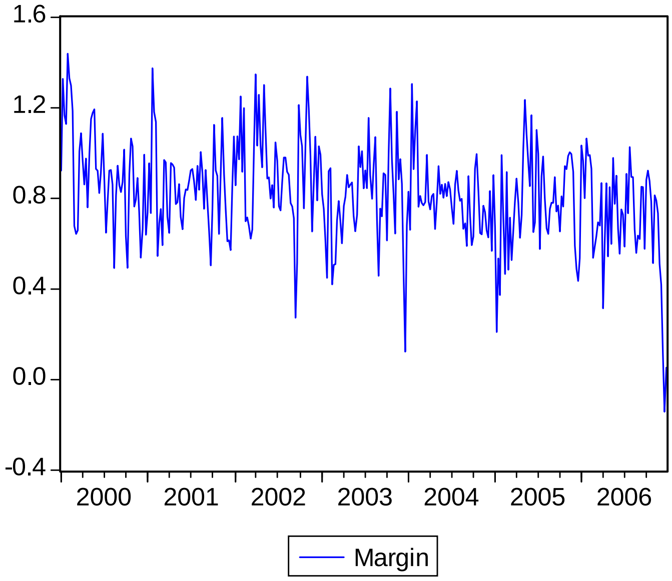

Figure 5: ‘Grappe’ tomatoes: Retail Margin from 2000 to 2006 (€/kg).

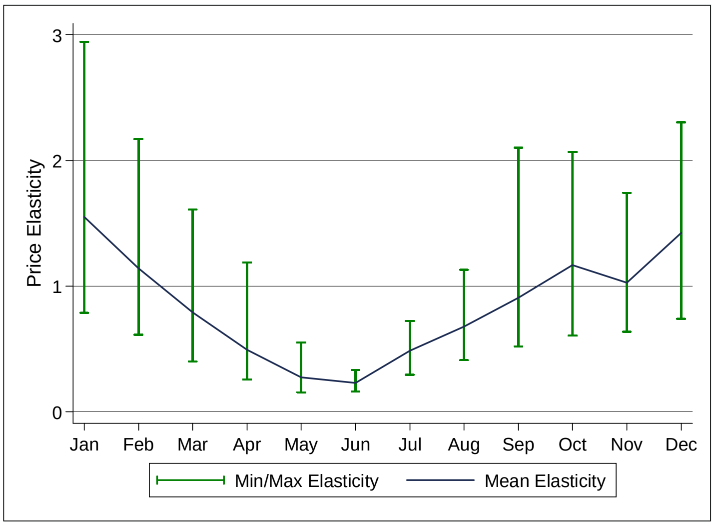

Figure 6: Monthly average of retail price-elasticities, ‘grappe’ tomato (absolute value).

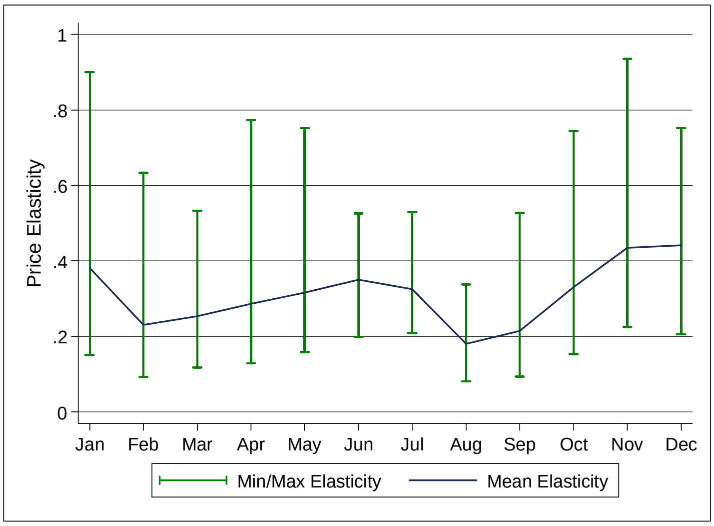

Figure 7: Monthly average of shipping price-elasticities, ‘grappe’ tomato.

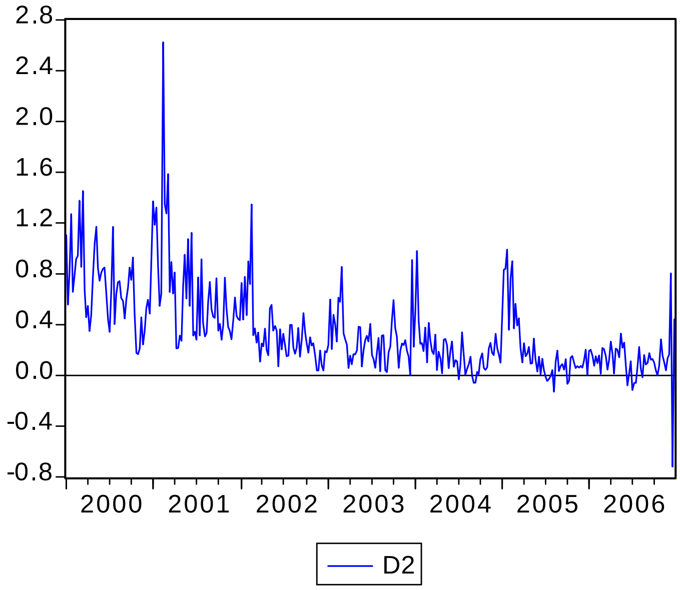

Figure 8: Total distortion due to market power, ‘grappe’ tomato.

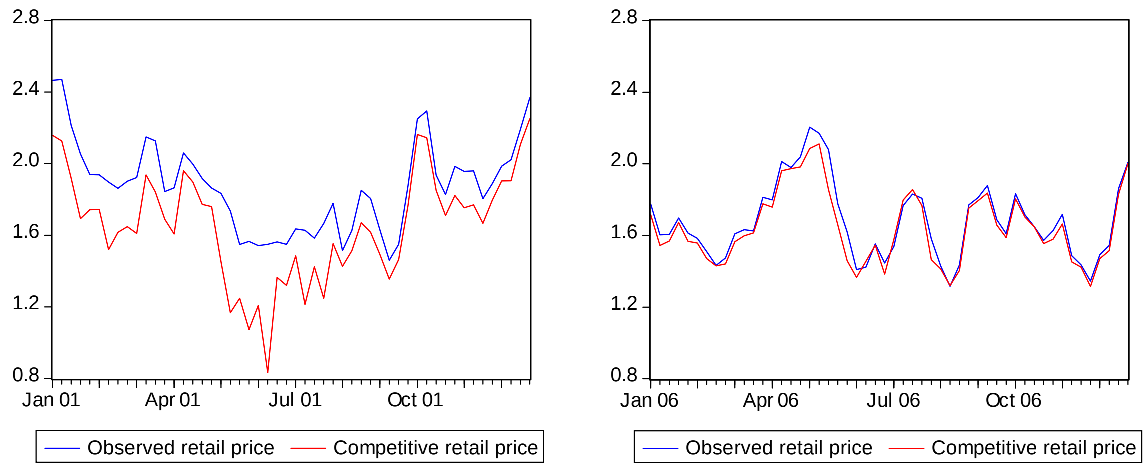

Figure 9: Evolution of retail prices for ‘grappe’ tomatoes from 2001 to 2006.

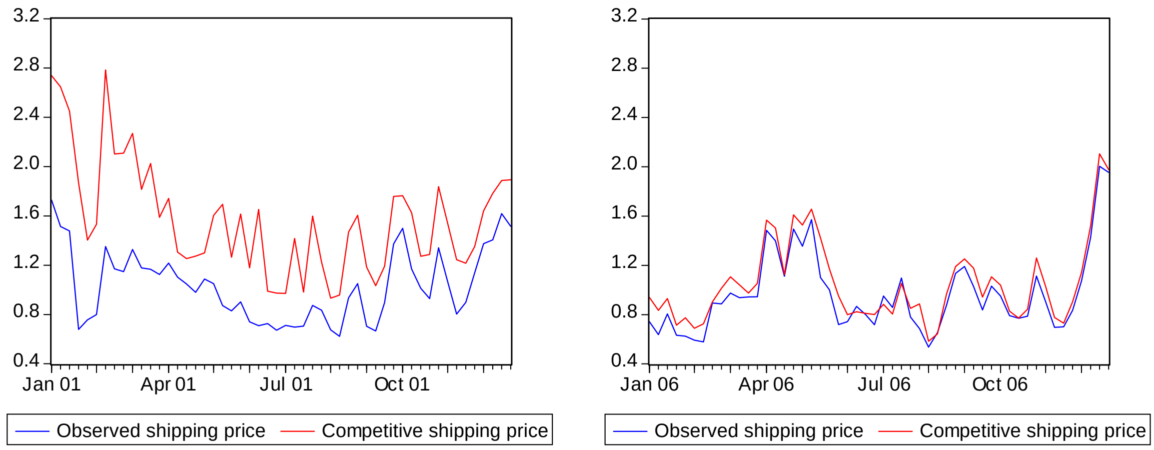

Figure 10: Evolution of shipping prices for ‘grappe’ tomatoes from 2001 to 2006.

Appendix

Table A1: Results from the estimation of the full system.

	'Ronde' Tomato		'Grappe' Tomato	
Demand parameters	Value	t-statistic	Value	t-statistic
January	−801.165	−4.310	−588.339	−6.325
February	−769.888	−4.415	−582.954	−5.785
March	−743.850	−4.648	−584.794	−5.590
April	−701.428	−4.734	−579.016	−5.204
May	−522.117	−3.802	−541.035	−4.699
June	−567.788	−4.343	−703.794	−5.385
July	−767.123	−6.146	−1,113.147	−8.540
August	−928.604	−7.101	−1,054.188	−8.217
September	−912.786	−6.383	−936.558	−7.912
October	−883.446	−5.717	−798.371	−7.517
November	−894.331	−5.302	−682.989	−6.887
December	−905.884	−5.022	−625.461	−6.531
Cross-price effect	649.520	4.923	766.180	5.596
Income	0.0002	0.191	−0.0003	−0.223
Temperature	20.530	6.436	24.710	6.784
Q_{t-1} 'own'	0.894	30.40	0.852	24.203
Q_{t-1} 'cross'	0.010	0.319	0.097	3.351

	'Ronde' Tomato		'Grappe' Tomato	
Supply parameters	Value	t-statistic	Value	t-statistic
January	$1,267.220$	9.500	256.770	13.755
February	851.332	7.590	208.578	6.964
March	616.219	6.020	290.638	8.562
April	447.212	4.508	556.658	8.380
May	918.312	5.030	$1,211.372$	10.064
June	$1,391.096$	5.994	$2,219.923$	15.774
July	$1,643.781$	7.292	$1,517.753$	12.399
August	760.860	5.332	542.047	5.754
September	636.013	5.606	372.909	6.361
October	967.404	10.251	389.848	12.435
November	$1,051.704$	11.587	513.860	13.998
December	971.989	13.061	282.026	11.200
Q_{t-52}	0.592	33.859	0.449	20.924
Sun_NO	0.068	9.722	0.078	14.275

Conjectural elasticities	'Ronde' Tomato		'Grappe' Tomato	
Demand side	Value	t-statistic	Value	t-statistic
θ 'own'	0.052	2.936	0.005	0.483
θ 'cross'	0.022	2.708	0.071	2.902
Supply side				
θ 'own'	0.012	1.973	-0.010	-1.620
θ 'cross'	-0.015	-2.636	0.024	2.671