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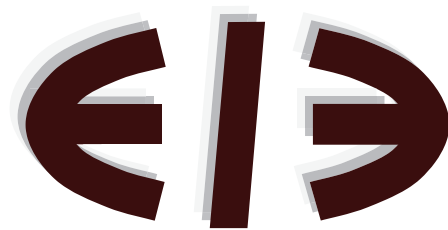## Cournot Oligopoly, Homogeneous Products and Grappa Market: An Econometric Study

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Cournot oligopoly, Homogeneous Products and Grappa Market:
an Econometric Study

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Abstract

In this study, using scanner data, collected from super-market transactions in 2009, we estimate an eight equations simultaneous model with a 3SLS routine, with the objective to empirically analyse the Grappa market structure. Results show that the supply side of the Grappa market is characterized by an oligopolistic structure, where the dominant firms compete as oligopolists à la Cournot with homogeneous products. Firms' competition is mostly played on the quantity grounds and mostly disregards product differentiation strategies. The dominant firms produce and supply a "cheap", homogenous product. Interpretation of the results focus on cultural consumption of this very "ancient" liquor and corroborate previous studies, where hedonic analysis of the demand side has shows consumers' very low/null implicit prices for the product differentiated characteristics.

Jel Code: L13, Q11, C3,

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1. Introduction

Grappa is an Italian brandy distilled from the pomace of grapes used in winemaking whose consumption in Italy dates back from Ancient Romans, (who produced and drank *aqua vitae*, the "water generated by the vineyard"). Grappa is a broadly consumed brandy in Italy. The production and consumption of this liquor in Italy is so ancient that every city historically has developed a different dialect denomination for the (same) drink.

Even though the production and consumption of Grappa is very ancient and diffused in Italy, the economic literature has neglected to study such traditional and important market and there are very few papers on the subject. Galletto and Rossetto (2005), for instance, provide a thorough description of the Grappa demand and supply sides of the market. Onofri and Koch (2006) perform a quasi-hedonic analysis for measuring consumers'implicit prices for the Grappa different characteristics. They find a low willingness-to-pay for product characteristics with respect to a standard product and a strong preference for the traditional", "white" product.

Given the economic literature "vacuum", the paper attempts to fill a gap, by empirically studying the structure of the Italian Grappa market. The paper motivation is twofold. On the one hand, we have addressed the Grappa producers' requests to better understand market dynamics in order to design proper and effective market strategies. On the other hand, though starting from practical requirements, the study is motivated by the desire to add a piece of research to the literature on empirical industrial organization (IO). Industrial organization, in fact, is concerned with the structure of industries in the economy and the behavior of firms and individuals in these industries. The field has historically focused on how markets depart from idealized conditions of perfect competition, whether because of scale economies, transaction costs, strategic behavior, or other factors. From an empirical perspective, this leads to questions about how competition plays out in different markets, how it relates to industry structure and how to model firms' behavior and deviations from theory to reality and backwards. The

challenge for empirical work, in fact, is both a (often) lack of good data and lack of convincing, standardized empirical strategies for evaluating hypotheses about market structure[2]. In this theoretical perspective, we attempt to enrich the IO literature by focusing on the design on an empirical model that captures concrete firms' behavior, choices, reaction to competitors and strategies.

For such purposes, using scanner data, collected from super-market transactions in 2009, we estimate an eight equations simultaneous model with a 3SLS routine, with the objective to empirically analyse the Grappa market structure.

The paper is organized as follows: section 2 sketches the Grappa production technology, supply and demand basic characteristics. Section 2 describes the data and selected variables. Section 3 explains the reasoning that has inspired the empirical modelling. Section 4 presents the econometric results. Section 5 concludes.

2. The Grappa Market

The history of Grappa has its roots in the metaphysical alchemic search for the quintessential classical element along with earth, fire, water, and air. The Greeks called such element aether, or pure, fresh air, and it was believed to be the material of the region of the universe where the gods lived. It was the product of distillation, mostly from wine. When Italian distillers turned their attention to the less valuable pomace, or the skins, seeds, and other residues left after the grapes are crushed for wine, Grappa was born (Antoninetti 2011). The socioeconomic evolution of Grappa came full circle in 1779, when the first family-run professional distillery specializing in Grappa opened its doors on the eastern edge of the Palladian Ponte Vecchio bridge in Bassano del Grappa: the famous, and still operating, Grapperia Nardini (www.nardini.it).

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[2] See Einav and Levin (2010) for a superb critical survey on the status of applied industrial organization

Grappa is produced with the "leftovers" of winemaking since it is distilled from the pomace of grapes used in winemaking The process of production of Grappa starts in the winery where winemaking takes place: after harvesting and grape crushing, the must is separated from grape pomace mainly composed by grape skins and seeds, with or without rasp. In the case of red winemaking, separation of pomace takes place after maceration when fermentation has already started, so that they contain alcohol and a low quantity of sugar. On the contrary, pomace obtained from white winemaking contain sugars not yet fermented. For this reason in this second case the raw vegetable material conferred to the distillery is stored for a variable period to allow alcohol production to occur. For the production of Grappa, the pomace is introduced in large containers (alembics) that are warmed in different ways (bain-marie, steam, direct fire). The warming up allows to produce the spirit (at 78 degrees Celsius) from the pomace. The spirit (in a gas status) moves in the alembic and ends in a pot of water where it becomes Grappa. The production for the very basic product stops at this stage. The potion is sometimes enriched with different flavours and/or barrelled techniques in particular wooden containers. After a couple of years (or more for aged Grappa), Grappa is bottled and ready to be commercialized and consumed. Some producers add flavours or adopt particular ageing or bottling techniques. Moreover, in the last two decades, some producers have worked hard to change the product image, diversifying their production facilities, enriching the standard product (white Grappa, 38 degrees Celsius, no aromatization, no "noble" brand, one litre bottle) with different oenological, taste, aesthetic characteristics[3] and distribution channels. Even though the production of Grappa can occur at different scales (even very small at handcraft, even household level), industrial producers use large quantities of the input-pomace in order to exploit economies of scale and get large quantities of output.

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[3] Standard "white" Grappa is enriched with new flavours, like fruit of medicinal herbs: the gradation is made lighter and the bottles more beautiful.

Grappa's demand is mostly domestic. In the last decade, exports have been increasing but only represent 10-15% of the total production and approximately 10% of the total share of spirits and liqueurs. The main export market is Germany, with 28% of the total export volume, followed by Switzerland (8%). Outside Europe small volumes are sold in the United States and Canada. Grappa is an affordable product, since the average price is moderate around 20 Euros. Price trends are stable across time (Galletto and Rossetto, 2005)

On the supply side, there are more than 200 hundreds Grappa producers in Italy and most of them commercialize their products via super and hyper markets. Eight firms (*Acquavite, Italia Distribuzione Bassano, Nardini, Stock, Dilmoor, Nonino, Franciacorta, Branca*) supply about 60% of the total production, the rest operate in the remaining segments as a fringe. Table 1 shows the 2009 market share of the eight dominant firms in the Italian Grappa market (column 2) and the "residual market share" for each selected firm.

Insert here Table 1

2. Data and Selected Variables

The dataset includes information on sales (such as sale price, brand, product size, alcoholic level, product characteristics, purchased quantity) gathered in 2009 at selected IRI[4] points in the Italian territory at large-scale distribution level that is the main channel covering more than 90% overall production. It is a cross-sectional, scanner dataset[5] with a sample of 3344 observations. For every sold item, the dataset contains information on the sale price[6] (per unit and per litre), the total amount of sold

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[4] IRI (Information Resources Inc.) is an American company that gathers data on the consumer packaged goods industry. The firm operates in 58 countries through stand-alone operations, wholly owned subsidiaries, partnerships and alliances.
[5] At the point of purchase, an electronic device reads a coded ticket on the product through the use of an electronic reader over which the product passes.
[6] The (dataset) price is the final price that the consumers pays at the supermarket. This price is negotiated by Grappa producer and the supermarket and includes a liquor tax that has to be paid to the Italian government. Therefore $P_{total} =$

quantity (per unit and in total litres); the type of Grappa, the liquor gradation and characteristics (for instance, whether the Grappa is produced with a single variety of grapes or not; whether the Grappa is enriched with fruit and/or herbal flavours or not, whether the Grappa is aged and bottled in precious wood containers or not); the format and capacity of the bottle, the brand and the name of the producer and other characteristics of the product. Table 2 contains a description of the selected variables.

Insert here Table 2

Table 3 presents the selected descriptive statistics.

Insert here Table 3

A very important variable is the constructed variable (Q-q_{i_th}). This variable is calculated as the difference between the dominant firms' total traded quantity in the Italian market in 2009 and the i_th firm's traded quantity. It is interpreted as the i_th firm market share/residual demand function for the first eight dominant firms.

3. Empirical Strategy

The empirical strategy aims at defining a model system that simultaneously captures the firms' production decision and features the market structure in the Grappa sector, given the available data and information. In order to define the model architecture, we have reasoned along the following lines. First, we have started from the economic theory indications, according to which the production technology characterizes the market structure. The characteristics of the cost functions (economies of

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$P_{producer}$ + $X_{supermarketmarkup}$ + TAX. For the sake of simplicity we assume that tax and X are equal for all sold items, since we are not able to disentangle that values.

scale in the case at issue) affect the scale of production (large scale). The large scale of production usually determines an oligopolistic structure since a few firms (with large dimensions) are able to supply the all market. (see Varian, 2006). Second, we have broadly benefitted from the expertise (elicited though direct discussions and interviews) of selected major Grappa producers in Italy. From our understanding, (at least "big") producers choose how much Grappa to produce from the pomace every year, with an eye on the competitor's choices. The latter strategy is implemented, for instance, by the "informal" requests to grapes/pomaces sellers on how much input is bought by the other competitors. Given the technological features of the Grappa production, characterised by economies of scale, and the presence of eight dominant firms, the derived oligopolistic market structure is straightforward. However, a deeper analysis of the firms' strategies and a set of meetings with the most important Grappa producers and experts has shed light on the type of oligopoly. The eight dominant firms' crucial decision variable is how much (in terms of total litres or total number of bottles) to produce and sell. This reasoning configures the studied oligopoly as à Cournot oligopoly[7], where the firms compete on the basis of quantity rather than price and each firm makes an "*output decision assuming that the other firm's behavior is fixed.*" (Kreps, 1990).

We were not sure, however, if the Cournot oligopoly were characterized by the production of homogenous or differentiated product. On the one hand, in fact, many producers attempt to differentiate Grappa in many ways. On the other hand, results from previous studies have shown that Grappa consumers prefer homogenous, "old fashion" Grappa (see Onofri and Koch, 2006).

We have finally defined an eight equations model (since there exist eight dominant oligopolists), within which each equation represents the (residual) demand curve faced by the i_th selected firm. The (logged) quantity (q_i) supplied by the i_th firm depends, among other variables, on the (logged)

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[7] An oligopoly à la Cournot is characterized, among the others, by the presence of few firms of large dimensions, strategic interaction among competitors and the choice on how much to produce (total quantity), keeping into consideration the competitors production choices, as a key variable (see Varian 2006). Pricing is decided independently, once quantity has been established, according to each competitor's residual demand curve.

quantity supplied by the other competitors $(Q_{tot} - q_i)$. Such modelling strategy allows us to capture the Cournot oligopoly structure and interpret each equation also as an individual firm's reaction function, since the quantity produced by each individual firm also depends on the (aggregated) quantity produced by the competitors.

The (logged) quantity (q_i) supplied by the i_th firm also depends on the (logged) price of the product (determined by each firm facing the its residual demand curve) and by the hedonic characteristics of the supplied product. The variables that represent the product differentiated characteristics are important to further feature the Cournot oligopoly (e.g. whether the Cournot oligopoly is differentiated or homogenous in the Grappa market).

The model is constructed in such a way that each residual demand curve can also be interpreted as both the firms' reaction functions and as a revenue function[8]. For each line, the empirical model, in Equations 1-8 below, contains a constant and an error term. To our knowledge, there is not in the literature an attempt to model and estimate such market structure

The model has been estimated with a three stage least squared (3SLS) routine. We select the 3SLS estimation method because of the need to estimate simultaneously a system of eight residual demand/reaction functions that represent firms' independent, though interrelated, production choices in

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[8] In microeconomics, demand curve can be interpreted as average revenues. In fact, the market demand curve represents the inverse relationship between demanded quantity of a good and the good price. At the same time, the demand curve can be interpreted as the average revenue curve, that represents the relation between average revenue received by a firm for selling its output and the quantity of output sold. Because average revenue is essentially the price of a good, the average revenue curve is a lso the demand curve for a firm's output.

Market Demand Curve $\rightarrow D = f(P,Q) \rightarrow Q = f(P)$; *Market Inverse Demand Curve* $= P^{-D} = f(Q)$;
Total Rev enue $= TR = f(P,Q) \rightarrow TR = (P)(Q) \rightarrow TR = f(Q)(Q) \rightarrow TR = D(Q)Q$; *Average Revenue* $\rightarrow AR = TR/Q$
$\rightarrow D(Q)Q/Q \rightarrow \underline{D(Q)}$

An average revenue curve is the relation between the average revenue a firm receives from production and the quantity of output pr oduced. The average revenue curve reflects the degree of market control held by a firm. For a perfectly competitive firm with no market control, the average revenue curve is a horizontal line. For firms with market control, especially, like monopolies and oligopolies, the average revenue curve is negatively-sloped. The average revenue curve for a firm with no market control is horizontal. The average revenue curve for a firm with market control is negatively sloped (see Varian, 2006).

a Cournot market structure. In (Zellner and Theil, 1962, pag. 54) own words, the 3SLS routine ".. *goes one step further than 2SLS, since it estimates all coefficients of the entire system simultaneously*".

Equations 1-8 represent the empirical model.

1. $logq_{1,i} = \alpha_0 + log\beta_1(Q_{tot} - q_1)_i + log\beta_3 Price_{1,i} + \sum_{j=1}^{J} \beta_j\, Product\ Characteristics_i + \varepsilon$

2. $logq_{2,i} = \alpha_0 + log\beta_2(Q_{tot} - q_2)_i + log\beta_3 Price_{2,i} + \sum_{j=1}^{J} \beta_j\, Product\ Characteristics_i + \varepsilon$

3. $logq_{3,i} = \alpha_0 + log\beta_3(Q_{tot} - q_1)_i + log\beta_3 Price_{3,i} + \sum_{j=1}^{J} \beta_j\, Product\ Characteristics_i + \varepsilon$

4. $logq_{4,i} = \alpha_0 + log\beta_1(Q_{tot} - q_4)_i + log\beta_3 Price_{4,i} + \sum_{j=1}^{J} \beta_j\, Product\ Characteristics_i + \varepsilon$

5. $logq_{5,i} = \alpha_0 + log\beta_1(Q_{tot} - q_5)_i + log\beta_3 Price_{5,i} + \sum_{j=1}^{J} \beta_j\, Product\ Characteristics_i + \varepsilon$

6. $logq_{6,i} = \alpha_0 + log\beta_1(Q_{tot} - q_6)_i + log\beta_3 Price_{6,i} + \sum_{j=1}^{J} \beta_j\, Product\ Characteristics_i + \varepsilon$

7. $logq_{7,i} = \alpha_0 + log\beta_1(Q_{tot} - q_7)_i + log\beta_3 Price_{7,i} + \sum_{j=1}^{J} \beta_j\, Product\ Characteristics_i + \varepsilon$

8. $logq_{8,i} = \alpha_0 + log\beta_1(Q_{tot} - q_8)_i + log\beta_3 Price_{8,i} + \sum_{j=1}^{J} \beta_j\, Product\ Characteristics_i + \varepsilon$

4. Empirical Results

Table 4 reports 3SLS estimated results.

Insert here Table 4

We can highlight two types of results. The first type of empirical results confirms the hypothesis of the existence of a Cournot oligopoly in the Italian Grappa market, and better qualifies such structure, as a

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Cournot oligopoly with homogenous products. In fact, we can derive such interpretation from three main indicators (and related estimated coefficients). The estimation of the model highlights the inverse (almost linear) relationship between the quantity offered by the i-th firm and the quantity offered by the other oligopolists and confirms the observed firms' Cournot behaviour and strategies. The estimated coefficients for the $(Q-q_{i\_th})$ variable are always negative and statistically significant. This means that each single firm's decision on how much to produce is not independent from the other competitors' decision on the quantity to produce and supply (and is probably modulated at the margin). In fact, the more a firm assumes the competitors will produce, the less the firm will produce. In other terms, each firms' residual demand shrinks the more the competitors' (aggregated) residual demand becomes larger. The estimated relationship can also be interpreted as reaction functions. In addition, the estimated coefficients for the product characteristics are rarely statistically significant (with the exception of the one litre format for the bottle) and their inclusion in the basic model negatively impacts the overall model architecture and results. We interpret such empirical results as the evidence of a further featuring of the Cournot oligopoly in the Grappa market, where homogeneous goods are supplied and competition only occurs on supplied quantity. This can be interpreted as a probable scarce valuation and consideration of product differentiated characteristics in the firms' simultaneous production choice. Finally. the estimated coefficients for the Grappa price are always negative, even though not statistically significant. In this case, we empirically capture the microeconomic standard "price-quantity" inverse relationship. The more quantity is supplied, the lower becomes the price. Since the key decision variable in Cournot oligopoly is the produced quantity, price estimated coefficients that are not statistically significant, might again highlight a scarce attention of the firms on such decision variable and again the existence of a Cournot oligopoly in the Grappa market in Italy.

A second group of selected empirical results allows us to capture single firms' peculiarities. For instance, in the case of *Dilmoor* (the dominant firm, about 15% of the Grappa market), the estimated

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coefficients for the aggregated (Q-q_{i_th}) variable, the *Dilmoor*'s competitor's (aggregated) reaction functions is negative and statistically significant. In addition, differently from the others, the estimated coefficient presents the lower value (-0.61) with respect to the other firms. This can be interpreted as a lower "reactivity" (elasticity) of the *Dilmoor* reaction function to changes in the other dominant firms' reaction functions and confirms the role of dominant Cournot oligopolist. Only for *Acquavite* (about 4% of the total Grappa market), *Nonino* (about 6% of the total Grappa market) and *Franciacorta* (about 10% of the total Grappa market), estimated coefficients for selected product characteristics (38% alcohol and 1 litre format bottle) are statistically significant. In addition, only for *Nonino* (about 6% of the total Grappa market), the estimated coefficient for the "brand" variable is positive and statistically significant for the all equation system and the available dataset. Such results might be interpreted as firms' (*Acquavite, Franciacorta and Nonino*) strategic attempt to differentiate their product through a more "recognizable" brand or format of the bottle or particular alcoholic content.

5. Conclusions

The empirical results show that the Italian retail market for Grappa is characterized, on the supply side, by an oligopolistic structure, where the dominant firms compete as oligopolists à la Cournot with homogeneous products. Firms' competition is mostly played on the quantity grounds and mostly disregards product differentiation strategies, despite some attempts and exceptions (i.e. *Nonino* Grappa). Symmetrically, on the demand side, Onofri and Koch (2006) have shown that demand is characterized by a large portion of consumers with low willingness to pay and low (estimated value of the) implicit prices for the products' characteristics and a relatively scarce propensity for product differentiation (see Onofri and Koch 2006).

An explanation for consumers' preference for a standard, non differentiated product (and for the symmetric success on the supply side of Cournot oligopolists that produce non differentiated products)

can be looked in the tradition. Consumers preferences were formed during thousand of years of consumption. The consumption of such ancient liquor, in fact, has a millenary duration and is culturally endogenized in preference structures. The consumption of Grappa, in fact, dates back from ancient Romans and is (still today) adopted to take care of daily domestic problems: from the empirical care of the flue, to the enrichment of cooking recipes; from a family digestive drink, to domestic disinfectant. Despite the attempts to commercialize and advertise (especially abroad) the product as a fancy "*made in Italy*" product, within the national borders Grappa is a household basic "must-have". The product consumption, therefore, is not (only) linked to the hedonic, consumption pleasure itself (given the existence of many perfect substitutes in the Italian liquor markets), but is also influenced by a strong set of cultural values. Grappa is a product the household needs to "have at home" (the drink is traditionally used for medicaments against flue in the traditional household's set of empirical remedies), even if it is not strongly liked nor consumed, because there is an atavist, generational consumption habit. Those firms that better interpret the atavist, millenary habit to consume Grappa as a basic standard product, are the ones who lead the oligopolistic market.

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Table 1: Market Shares of the Eight largest Firms in 2009

Variable	Firm i's Market Share/Residual Demand	Residual Market Share (Empirical Variable)
q_1 = quantity produced by Acquavite	4%	$Q_{tot} - q_1$
q_2 = quantity produced by Italia-Distribuzione- Bassano	5%	$Q_{tot} - q_2$
q_3 = quantity produced by Nardini	5%	$Q_{tot} - q_3$
q_4 = quantity produced by Stock	7%	$Q_{tot} - q_4$
q_5 = quantity produced by Dilmoor	15%	$Q_{tot} - q_5$
q_6 = quantity produced by Nonino	6%	$Q_{tot} - q_6$
q_7 = quantity produced by Franciacorta	10%	$Q_{tot} - q_7$
q_8 = quantity produced by Branca	11%	$Q_{tot} - q_8$

Table 2: Description of Selected Variables

Price[9]	Grappa price per litre (in 2009 Euros).
Q_tot	Total amount in of Grappa (litres) traded in the selected IRI supermarkets points in 2009
q_i	Firm i's total amount of traded Grappa in the IRI supermarket points in 2009
Gradation	Product j's alcoholic level, measured by volume
Gradation_38%	Alcohol by volume.
Gradation_41%	Alcohol by volume.
Gradation_43%	Alcohol by volume.
Gradation_50%	Alcohol by volume.
Format	Product j's bottle content in litres.
Format_ 0.5	Bottle content equals 0.5 litres.
Format_ 0.7	Bottle content equals 0.7 litres.

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[9] The price is the final price that the consumers pays at the supermarket. This price is negotiated by Grappa producer and the supermarket and includes a liquor tax that has to be paid to the Italian government. Therefore $P_{total} = P_{producer} + X_{supermarketmarkup} + TAX$. For the sake of simplicity we assume that tax and X are equal for all sold items, since we are not able to disentangle that values.

Format_1	Bottle content equals 1 litre.
Format 1.5	Bottle content equals 1.5 litres.
Single Variety	Grappa type, characteristics that indicates whether the Grappa is produced with a single variety of grapes
No_aroma	Non aromatized Grappa, e.g. not enriched with fruit and/or herbal flavours
Brand	Branded Grappa/Bottle.

Table 3: Descriptive Statistics

	Mean	*Standard Deviation*	*Min.*	*Max*
Price	20.53	16.96	2.22	243.4
Q_tot	4959.20	25374.98	0	574711
Gradation	39.36633	8.17	0	60
Format	0.6549641	0.30	0.1	5
Gradation_38%	Dummy Variable. D = 1; 362 Observations			
Gradation_41%	Dummy Variable. D = 1; 94 Observations			
Gradation_43%	Dummy Variable.. D = 1; 200 Observations			
Gradation_50%	Dummy Variable. D = 1; 64 Observations			
Format_ 0.5	Dummy Variable. D = 1; 1230 Observations			
Format_ 0.7	Dummy Variable. D = 1; 1342 Observations			
Format_1	Dummy Variable. D = 1; 324 Observations			
Format 1.5	Dummy Variable. D = 1; 44 Observations			
Single Variety	Dummy Variable. D = 1; 1550 Observations			
No_aroma	Dummy Variable. D = 1; 3056 Observations			
Brand	Dummy Variable. D = 1; 1067 Observations			

Table 4: 3SL Empirical Results

Firm	Variables	Estimated Coefficients
q_1 = Acquavite	$Q_{tot} - q_1$	-0.95***
	Gradation_38%	0.88***
	Format_1	0.93***
	Price	-0.97*
	Constant	143.90
	R^2	0.93
q_2 = Italia-Distribuzione-Bassano	$Q_{tot} - q_2$	-0.92***
	Price	-2.93*
	Constant	-106.50
	R^2	0.85
Q_3 =Nardini	$Q_{tot} - q_3$	0.93***
	Format_1	0.61
	Price	-6.03*
	Constant	-230.09
	R^2	0.90
q_4 =Stock	$Q_{tot} - q_4$	-0.85***
	Format_1	0.84
	Price	0.93*
	Constant	-137.48
	R^2	0.89
Q_5 = Dilmoor	$Q_{tot} - q_5$	-0.61***
	Price	-6.45*
	Constant	355.35
	R^2	0.70
Q_6 = Nonino	$Q_{tot} - q_6$	-0.89***
	Gradation_38%	7.94*
	Format_1	8.27**
	Price	-5.62*
	Brand	'0.006***
	Constant	-316.11
	R^2	0.89
q_7 =Franciacorta	$Q_{tot} - q_7$	-0.82***
	Gradation_38%	0.20*
	Format_1	-1.77*
	Price	-1.48*

	Constant	-60.78
	R^2	0.78
Q_8 =Branca	$Q_{tot} - q_7$	-0.85***
	Format_1	-1.49
	Price	-10.13*
	Constant	250.25
	R^2	0.85

 *** = 1% statistically significant; ** = 5% statistically significant; * = 10% statistically significant.