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Market Power in the Dutch Coffee Market, 1990-1996

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- ABSTRACT -

Title: Market Power in the Dutch Coffee Market, 1990-1996

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The significance of coffee to the world economy cannot be understated. In the past years, prices of coffee beans have experienced large fluctuations, whereas consumer prices for roasted coffee hardly responded, that is, were perceived to remain high, or decline too slowly. This issue has drawn concerns about market power in coffee markets. The present study investigates the market power in the Dutch coffee market. I analyze the degree of market power using an oligopoly model and a time-series aggregate data with monthly information about the Dutch coffee market over the period 1990 to 1996. The econometric approach uses a direct measure of marginal cost and estimated demand elasticity to obtain information about oligopoly behavior in the Dutch coffee market. I find that there are about ten firms in the market. The results indicate a fairly low elasticity in price for roasted coffee demand and the importance of controlling for seasonality.

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I. INTRODUCTION

The worldwide influence of coffee growing and drinking began in the Horn of Africa, and has spanned a long and rich history. Many nations in Africa such as Kenya, Rwanda, and Burundi even depended on coffee export revenues for financial support in varying degrees during the Second World War. As time went by with social and economic upheavals, coffee has become increasingly popular with global consumers in their daily lives. Coffee culture has also spread to countries with great coffee traditions of their own, such as Italy, Germany, and Scandinavia. Today, coffee as a new type of beverage has become omnipresent in all continents, which is dramatically improving its general quality. It is now possible to consume good coffee in all major cities of the world, from New York City to Stockholm to Peking; we are drinking more, and more importantly, better coffee.¹ The significance of coffee to the world economy cannot be understated. It is one of the most valuable products in world trade, and its cultivation, processing, trading, transportation, and marketing result in different kinds of economic effects. Therefore, the hype over coffee arises in much economic research. In the past years, prices of coffee beans have experienced great fluctuations, whereas consumer prices for roasted coffee hardly responded, that is, were perceived to remain high, or decline slowly. It implies a weak correlation between coffee beans and consumer prices (Bettendorf and Verboven, 1998). This issue has drawn a great deal of concern regarding market power in coffee markets.

The core objective of this paper is to estimate the degree of competition in the Dutch coffee market. For this purpose, I use a time-series aggregate data and an empirical oligopoly model to explore the degree of market power within the Dutch market. The dataset contains monthly information on the Dutch coffee market between the years 1990 to 1996. This data has been used by Bettendorf and Verboven (1998) to study competition in the Dutch coffee market. Our model is based on Bresnahan (1989) and Porter (1983), Bettendorf and Verboven (1998,

¹ Link address, http://www.ico.org/coffee_story.asp?section=About_Coffee

2000), as well as Koerner (2002) who employed a similar model to the coffee market in the Netherlands and Germany respectively. Steen and Salvanes (1999) and Durevall (2006) extend the model to contain short-run and long-run dynamics. Here however, my econometric approach is more in the spirit of Genovese and Mullen who, in their study of the U.S. sugar refining industry, used direct measures of marginal cost and conduct parameters to explore the static oligopoly behavior of the demand function.

Roasted coffee is considered to be a homogenous product since aggregate coffee market data is utilized. This study makes use of the competitive behavior in the Dutch Roasted Coffee industry. The production technology is quite simple and the industry suffers many changes in the degree of competition, allowing us to measure the methodology under varying structural conditions.

This paper uses a direct measure of marginal cost and estimates demand elasticity to obtain information about oligopoly behavior in the Dutch roasted coffee market. First, I estimate the elasticity of demand, and then measure with the Lerner index. Using estimated elasticity, I compute the conduct parameter that gives information about competition in the Dutch coffee market. The key findings are that there are about ten firms in the market, which implies small market power. The results also demonstrate a fairly low elasticity in price for roasted coffee demand and the importance of controlling for seasonality.

The structure of the paper is as follows. Reviews the research literature in section 2, then present a theoretical background for the empirical model in section 3 and illustrate the data with figures in section 4. Section 5 estimates the demand elasticity under log-linear regression and also examines the conduct parameter. This allows us to construct the Lerner index and the adjusted Lerner index, with which I find measures directly within symmetric cost function. Section 6 reports the empirical results and discusses the possible explanations. Section 7 summarizes the findings and draws conclusions.

A Look into the Background of the Dutch Coffee Market

Coffee growing and drinking began in the Horn of Africa, but the Dutch were the first to introduce the coffee plant to Central and South America, which has prevailed as the dominant producer of the cash crop in the present age.²

In the Dutch Coffee market, coffee bean prices experienced a decline at the end of 1992. However, consumer prices hardly responded, that is, were perceived to remain high, or decline slowly. As in the middle of 1994, coffee bean prices rose more than twice their original amounts, while consumer prices increased by only 50 percent. It implied a weak relationship between coffee bean and consumer prices. Owing to the fact that most of, or even all, the consumer markets, are dominated by a few MNCs, the issue of market power of the roasted coffee firms has been brought into the scene. To be noticed during the sample period, the Dutch coffee market is characterized by one dominating company, Douwe Egberts. Earnings of this company is approximately account for 60% to 70% of total sales in the Dutch market, whereas the other companies compete in the remaining segment of the Dutch market. Imports towards growth trend in Dutch coffee market, but is quite small (Bettendorf and Verboven, 1998).

According to N.R.C. (29 March 1997), it claimed that the Dutch coffee industry observers have provided some alternative explanations for the observed weak relationship between coffee beans and consumer prices. Firstly, coffee beans are not the only determinant influence the marginal costs of production for roasted coffee. Such as, Labor and packaging costs, are also as potential parts of the production costs. Secondly, firms are reluctant to raise prices as this will lower consumer demand. Instead, firms would absorb price increases by lowering their markups. (Bettendorf and Verboven, 1998)

² Link address, http://www.ico.org/coffee_story.asp?section=About_Coffee

II. LITERATURE REVIEWS

Some early literature has collected market data and employed a static and perfect competitive equilibrium to obtain cost and demand information. More recent research has emphasized estimations of demand and cost under imperfect competition in varying product markets.

In response to the important challenge of measuring cost, 'New Empirical Industrial Organization' (NEIO), is motivated and has offered numerous approaches with which to tackle this problem. Some literature such as Bresnahan (1982), Suslow (1986), and Baker and Bresnahan (1989), attempt to observe the firm's markups by estimating demand function. Others estimate the parameters of the firm's supply relation instead. A lot focusing on evaluation with market power and conjectural variation include Rosse (1970), Bresnahan (1982), Bresnahan (1989), Lau (1982), Ellison (1994), Wolfram (1999), Genesove and Mullin (1998) and Corts (1999).

Corts (1999) uses the conduct parameter method estimated in empirical studies of market power in industry organization and argues that the methodology creates a bias in measure of the market power. Corts discusses the conjectural variations model and analyzes the application of the CPM to data. Simulation of the dynamic oligopoly model shows that it is misleading the degree of market power. Since the estimated of $\hat{\theta}$, the asymptotic parameters, observes the marginal response of price, the markup to the demand shocks may result in a bias that seems to be important for small estimates of the conduct parameter and it is corresponding to the demand.

Genesove and Mullin (1998) explore the conduct and cost components in the U.S. sugar refining industry with complete demand information underlying the static oligopoly models. It employs the quarterly and monthly data to examine during the period 1890 to 1914. Genesove and Mullin suggest measures of marginal cost and conduct directly and indicate a small market power. To estimate the demand, it constructs L_{η} to declare the structural

features. The estimation of the conduct and cost parameters under specific forms of assumptions. They find that the deviation across demand specifications, $\hat{\theta}$ underestimates L_{η} , is too slight to be negligible. Meanwhile, the conduct parameter θ as a free parameter provides a better estimation of cost. Genesove and Mullin seek to illustrate the relationship between structure and conduct. It captures a decline in the degree of market power as the structural changes in the sugar industry. The resulting of cost was observed to be sensitive to the assumed model. The predictive power, however, could be improved with direct cost measure in partial cost information. On the whole, the methodology approach is mostly validated, and the results are shown to be robust on the demand functions in Genesove and Mullin's.

Bettendorf and Verboven (1998) address the weak relationship between the prices of coffee beans and consumer prices in the Dutch coffee industry. It mainly examines an aggregate model of oligopolistic interaction with publicly available monthly data on the aggregated Dutch market, and discusses the models both on supply and demand side. Bettendorf and Verboven provide three alternative experiments and find that the relatively large share of costs other than coffee bean costs is the substantial explanation for the observed weak correlation. The research of Bettendorf and Verboven also point out that markup absorption is quantitatively much more significant under a Cournot duopoly and monopoly. That is, it utilizes the estimates to explain the evolution of consumer prices and simulates the model under alternative behavioral assumptions to further research oligopoly behavior and market power. The analysis of result reveals that consumer prices would have been increased and would have weak volatility in response to the volatility in coffee bean prices.

Moreover, some studies focus on the other approach to research the oligopoly behavior, Feuerstein (1996) estimates the German coffee industry with a long run dynamics model, as well as Steen and Salvanes (1999) who extend the model to cover short and long run dynamics. The approach used in Durevall (2006) is more the spirit of the above literature. It

is based on the model of Bettendorf and Verboven (1982), and develops the long-run solution of the econometric model to examine a conduct parameter.

Specifically, Durevall (2006) apply an empirical oligopoly model to test the competition in the Swedish coffee market covering the period 1978 to 2002. Durevall shows the market structure and sets an oligopoly model by using time-series data to measure the degree of market power in the Sweden roasted coffee market over the sample period. To evaluate functions for demand and pricing, Durevall examine for long-run relationships between the variables with cointegration analysis. The main results demonstrated no market power in the long run, while only slight evidence of market power was shown in the short run. That is, in the long run, the price of coffee would not influence the trend in coffee consumption; however, there is only a short-run relation between quantity and price in the Swedish roasted coffee market.

III. THEORETICAL FRAMEWORK

Many theoretical models in Industry Organizations are analyzed by the supply-side approach, that is, the firm-side approach. In general, the behavior of firms is often affected by unobserved determinants. Cost, is one of the major factors that influences the firms' behavior and it is hard to observe directly. Thus, the investigation of market power is not obvious if the cost parameters are unknown (market power is measured by markup, $\frac{P-mc}{P}$). Most of the 'New empirical industrial organization' research is motivated by this issue. That is, learning about the cost side and learning the extent distribution of market power made us to construct the conduct parameter in our study.

As to a homogenous good industry, we need the knowledge of demand and production technology. Here demand is easiest to think about the case of a homogenous product. In case of monopoly, the profit as a function of quantity for firm i is given by

$$\pi(q_i, q_{-i}) = (P(Q) - c) \times q_i \quad (1)$$

where, $Q = \sum_n q_n = q_1 + \dots + q_i + \dots + q_n$ is the total amount of goods sold in the market and q_i is the quantity produced by firm i . Based on static oligopoly theory, the First-Order Condition (FOC) of profit maximization is

$$P + \theta \times Q \times \frac{\partial P(Q)}{\partial Q} = c \quad (2)$$

where P is the equilibrium oligopoly price, Q is the industry output and c is the marginal cost. The parameter θ is called the market power or conduct parameter. Taking the following values, the conduct parameter θ can be estimated like this:

1. $\theta = 0$ for perfect competition;
2. $0 < \theta < 1$ for oligopoly;
3. $\theta = 1$ for perfect collusion or monopoly.

Bresnahan's (1989) survey emphasizes that the conduct parameter θ has been interpreted as "the average collusiveness of conduct". According to the classical Cournot model, it implies

$$\frac{\partial \pi(\cdot)}{\partial q_i} = 0 \implies P + \frac{q_i}{Q} \times Q \times \frac{\partial P(Q)}{\partial Q} = c \quad (3)$$

It get $\theta = \frac{q_i}{Q} = \frac{1}{n}$ in the case of identical firms, thus, $\theta = \frac{1}{n}$ where n is the number of firms.

Here, it is hypothesized that all firms are identical with the same cost structure form, since roasted coffee is the final product transformed with a fixed-coefficient material of cost of coffee beans. Within the observation of roasted coffee and beans price and estimations, we can directly measure marginal cost and conduct and assess the value of independent cost information. With capture to cost information, θ can be measured in the following way:

$$\theta = \eta(P) \frac{P-c}{P} \equiv L_\eta \quad (4)$$

Equation (4) means that θ equals the Lerner index adjusted for elasticity, L_η ; where $\eta(P)$ is the demand elasticity and L_η is the elasticity-adjusted Lerner index.

Specifically, a very common and straightforward measure of market power is the *Lerner Index*, defined as the markup related to the price of the good. The *markup*, is defined as the difference between price and marginal cost, which indicates how the competition works on the specific product market. If competition is low this will infer a deadweight-loss to society, thus this market might need competition policy regulation.

The Lerner index ranges from a low of zero to a high of one, with higher values implying greater market power. A Lerner index that equals zero ($L=0$), means perfect competition, with no market power. A Lerner index equal to one ($L=1$), indicates collusion or monopoly in the market. A Lerner index between zero and one ($0 < L < 1$), there is oligopolistic interaction between firms in the market.

However, one major drawback is that the Lerner index requires data on price and marginal cost: this is normally not reported, or not reported truthfully, by companies on the market since it is strategic information. Accounting data are also poor estimates of the true marginal costs, and hence, in the absence of consistent and reliable information about the cost structure

in an industry or a particular firm, the computed values of the Lerner index are at most a rough estimation. Therefore, the *Adjusted Lerner Index*, $L\eta$, essentially the Lerner index adjusted with the elasticity of demand, is another closely related measure of market power we control for.

Technology of Coffee Production

Roasted coffee is a homogenous product. The price of roasted coffee always tended toward uniformity. Through the specific links, cultivation, processing, trading, transportation and marketing, coffee beans could be purified into roasted coffee finally purchased by consumers.

Often it is difficult to observe a good estimate even though it is possible to measure the marginal cost. In the case of the coffee roasting business however, the production technology of the roasted coffee process is quite simple, involving just the roasting, grinding and packaging of the coffee beans. Generally, coffee beans are transformed at a fixed and known proportion into roasted coffee. In addition to fixed-coefficient materials cost of coffee beans, variable costs also include labor and other costs. Therefore, the marginal cost of roasted coffee in period t , c_t , is constant and could be allowed to formulate a robust model such as:

$$c_t = c_0 + k \times P_t^b \quad (5)$$

where c_0 shows all variable costs other than those related to coffee beans, such as labor and packaging; and k is a parameter that measures the fixed-coefficient technology in production. P_t^b is the price of coffee beans. (Here, it accepted the coefficient k that remains unchanged when estimated in the entire period.)

Demand

There are three core issues arising in demand estimation: *the frequency of data*, *the choice of instruments*, and *functional forms*.

The more frequent the data, the more probably misleading the estimation of demand elasticity. If one uses the high-frequency data such as weekly data, it would lead to the estimation of monopoly price being much higher than the optimal price for a monopolist. Then it would cause a much lower degree of market power at observed prices. So as a compromise, it chooses quarterly and monthly data to estimate in this study.

The Second issue is the choice of instruments. Consider the factors shift demand or supply side to yielding the instruments variables. On the one hand, incomes of consumers affect the demand, as well as the other factors such as the price of the goods, the price of the substitutes and so on. Generally speaking, an increase in income could raise the demand from consumers in the market. An increase in the wage of the consumer would have a positive impact on consumption. As for the price of the goods, cutting the price of the goods will lead to an increase in consumption, and vice versa. At the same time, consumers are likely to purchase the alternatives, such as tea instead of coffee. The preferences of consumers as a factor shifting the demand could be considered. The seasonality is also one of the main factors, which we need to control for.

On the other hand, supply mostly depends on costs and technology of production. Some important factors that affect the supply of coffee are the price of coffee beans and price of labor. Meanwhile, some other factors, not included in the model, such as the cost of packaging, weather, and import or export restrictions also have an effect on the supply of coffee. The prices of coffee are endogenous, which correlated with the error terms. Since supply depends on production cost as input prices for coffee beans and labor price, thus these variables can be as instrumental variables for price in the demand equation, and it is necessary to treat demand and supply simultaneously to estimate demand.

Functional forms are included in the Demand estimation. A linear or a log-liner demand curve is commonly applied in the NEIO research. A general functional form for the demand curve is defined as

$$Q(P) = \beta(\alpha - P)^\gamma \quad (6)$$

where $Q(P)$ denotes quantity demanded; P is the price of roasted coffee; β represents the size of market demand; γ is convex index; and α is the maximum willingness to pay if $\gamma > 0$.

Underlying the constant marginal cost, c , the implied monopoly price is shown:

$$p^M(c) = \frac{\alpha + \gamma c}{1 + \gamma}$$

The specific cases according to the equation (6), for a quadratic demand curve, $\gamma = 2$; for linear demand curve, $\gamma = 1$; for a log-linear demand curve, $\alpha = 0$, $\gamma < 0$; and for a exponential demand curve, $\alpha, \gamma \rightarrow \infty$ and α/γ is constant.

For a simplistic way, our study makes use of a log-linear form to estimate and demonstrate. Admittedly, some others utilize a variety of normally functional forms to compare the costs and conduct estimation. The common four forms to estimate demand are expressed in the Quadratic, the Linear, the Log-Linear, as well as the Exponential, as follows.

Quadratic:	$\ln Q = \ln(\beta) + 2 \ln(\alpha - P) + \varepsilon$
Linear:	$Q = \beta(\alpha - P) + \varepsilon$
Log-Linear:	$\ln Q = \ln(-\beta) + \gamma \ln(P) + \varepsilon$
Exponential:	$\ln Q = \ln(\beta) + \frac{\gamma}{\alpha} P + \varepsilon$

These expressions are shown with the effect of seasons. Here, ε is the error term with the proportional shifts in demand. Variations in β , thus does not affect the monopoly price. (Genesove and Mullin, 1998)

Conduct Parameter

The conduct parameter θ , from which information about the market power of the firms and their competitive, or less competitive, behavior is inferred, can be derived from the profit maximization condition of firms in oligopolistic interaction: $\theta = \eta * \frac{p-c}{p} = \eta * L = L_\eta$.

Obviously, the conduct parameter is in fact that previously defined as the Adjusted Lerner Index. However, what was previously done was a computation of the Adjusted Lerner index using the available set of observations on prices and our computed values for the marginal cost, and averaging over the results.

Hence, without any further assumptions, it is hard to take an estimate of the conduct parameter in the roasted coffee market. In order to obtain an estimation of the true conduct parameter in this market, it could employ regression analysis and under the classical Gauss-Markov assumptions, or their relaxations, there could be obtained an unbiased and/or consistent estimator for the conduct parameter. Thus, to identify θ , it could rely on a non-proportional, seasonal dummy in dynamic oligopoly.

Rearrange the expression (4) of the conduct parameters so as to have price on the left hand side and the other variables on the right hand side. That is, it yields the following pricing function of the conduct parameter, the estimated demand and the cost parameter within the time period t :

$$P_t(c) = \frac{\eta}{\eta - \theta} c_t \quad (7)$$

where η is the estimated demand elasticity.

Rearrange (7) into a regression equation and it gives the equation:

$$P_t = \beta * c_t + \varepsilon_t \quad (8)$$

In (8), price in period t , P_t , is the dependent variable and cost, c_t , is the explanatory variable. ε_t is the parameter. Here, no constant is included. The coefficient, β , implying that the estimated coefficient of cost which is equal to $\frac{\eta}{\eta - \theta}$. That is,

$$\beta = \frac{\eta}{\eta - \theta}$$

Therefore, directly measure the conduct parameter, θ , as being equal to:

$$\hat{\theta} = \frac{\hat{\eta}(\hat{\beta} - 1)}{\hat{\beta}} \quad (9)$$

IV. DATA

Data Description

The analysis makes use of a time-series aggregate data with monthly information on the Dutch coffee industry during the time period 1990 to 1996. Bettendorf and Verboven (1998) also provide details about the data. In this paper, it utilizes monthly and quarterly data because the high-frequency data such as weekly data would lead to estimating a misleadingly low elasticity of demand. The analysis begins with the 1990s and the reason I would like to employ this entire period is mainly due to the data in this period being typical and characteristic of the reaction of the research issues in the Dutch coffee market.

This study utilizes the dataset on coffee consumption and production in the Dutch market to illustrate the estimation. Data on imports and exports of Dutch roasted coffee come from the Central Bureau for Statistics (CBS, Maandstatistiek van de Buitenlandse Handel). The figures are publicly available even though some are missing on stock changes. Coffee consumption is approximated as production minus net exports of roasted coffee. As published in the International Coffee Organization, all variable costs other than the cost of coffee beans itself, represented by c_0 , are estimated to be around 4 guilders over the sample period. The fixed technology in production, k , being the transformation rate of beans into roasted coffee, is estimated at 1.19 kg of beans. This remaining unchanged coefficient could be taken into account over the sample period and beyond.

The data contains 84 observations and 14 variables that I provide and use to estimate the entire period: maand, year, month, qu, cprice, tprice, oprice, income, q1, q2, q3, q4, bprice and wprice, respectively. More specifically, *maand* refers to year and month of observation; year refers to year of observation, month refers to month of observation; *qu* represents per capita consumption of roasted coffee in kg; *cprice* represents the price of roasted coffee per kg in current guilders; *tprice* represents the price of per kg tea in current guilders; *oprice*

represents the price index for other goods; *incom* is income per capita in current guilders; *q1*, *q2*, *q3*, *q4* stand for the dummy variables for four seasons, season 1(January to March), season2 (April to June), season 3 (July to September), and season 4 (October to December), respectively; *bprice* is the price of coffee beans per kg in current guilders; and *wprice* is the price of labor per man hours, which are for full-time workers, defined as workers employed 160 hours per month during the sample period.

Data descriptions are shown in the following table:

TABLE 1 Data description

VARIABLES DESCRIPTION	
DEFINITION	NAME
year of observation	year
month of observation	month
per capita consumption of roasted coffee in kg	qu
price of roasted coffee per kg in current guilders	cprice
price of tea per kg in current guilders	tprice
price index for other goods	oprice
income per capita in current guilders	income
a dummy variable for season 1, 1 if season 1, 0 if the others	q1
a dummy variable for season 2, 1 if season 2, 0 if the others	q2
a dummy variable for season 3, 1 if season 3, 0 if the others	q3
a dummy variable for season 4, 1 if season 4, 0 if the others	q4
price of coffee beans per kg in current guilders	bprice
price of labor per man hours (work 160 hours per month)	wprice

NOTE: Data include variables over 1990-1996.

Data Analysis of the Relationship between Variables

Some potential core variables carry out the analysis of demand for roasted coffee, such as consumption of coffee and the related prices of coffee. This section mainly describes characteristics of the variables to some extent and provides some relative preliminaries to obtain the empirical results with figures. Having presented and discussed the data, it is useful to start with a discussion of the relationships over time, 1990-1996.

Table 2 describes summary statistics. The sample covers the period from 1990 to 1996. It also concludes the seasonal statistics information. Table 3 gives the correlation between the variables.

TABLE 2 Sample statistics and **TABLE 3 Correlation between the variables** here (see Appendix).

Here, it presents the analysis within the graphs in the following:

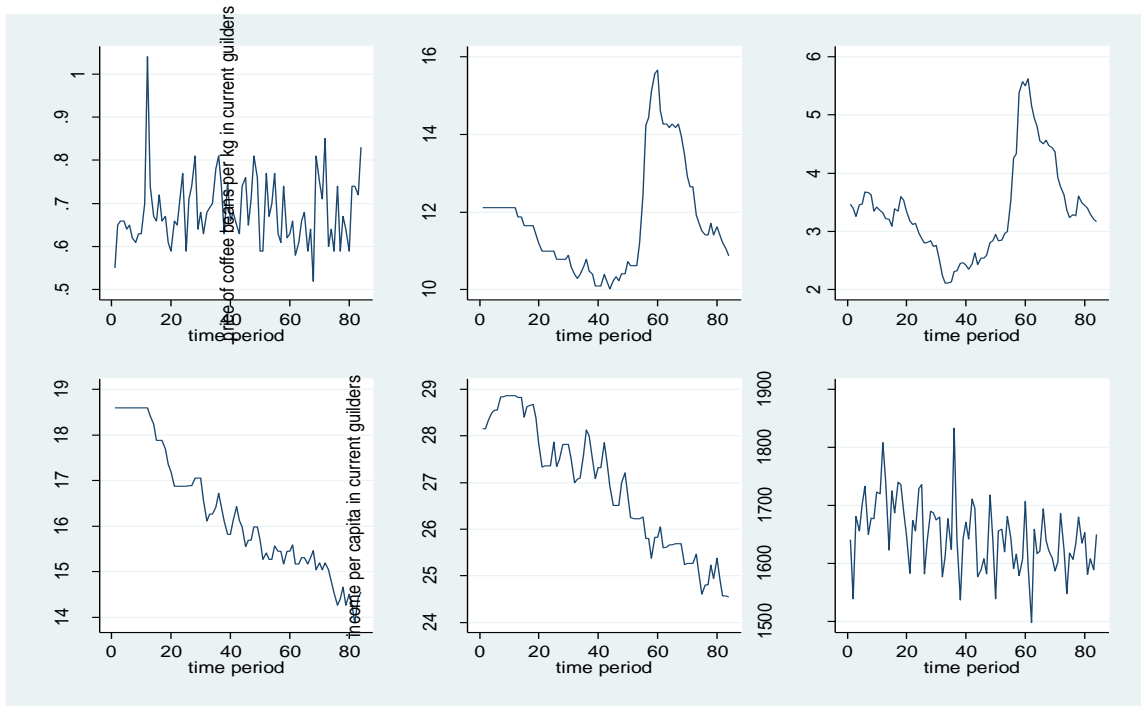


FIGURE 1 Estimation of the relationships over 1990-1996

In Figure 1 the developments of all relevant variables over time are presented. All variables have been divided by a price index to account for inflation to increase comparability between them. As expected the price of roasted coffee seems to follow the price of coffee beans very closely and the correlation analysis yields a correlation coefficient of 0.9595, confirming a strong relationship. Furthermore there was a sharp increase in both prices, too steep to be natural and is assumedly due to the bean freeze in Brazil in 1994 (Bettendorf and Verboven, 1998). When it comes to seasonality, both prices are fairly stable throughout the year even though the quantity consumed, or demand, is somewhat higher in the fourth quarter, 0.74 kg compared to around 0.67 kg in the other three quarters.

The only other relationship of that magnitude was found between the price of tea and price of labor with a correlation of 0.9480. They also follow a sharp negative trend throughout the time period, meaning that both the relative price of tea and the relative cost of labor have decreased. The low correlation between tea and coffee hints at a situation where the two are not substitutes, i.e. that one would not switch from coffee to tea if the price of coffee increases and vice versa.

If we take a look at consumption and income we see that although they fluctuate substantially they seem to have a fairly stable mean, maybe a slight negative trend in purchasing power.

Specifically,

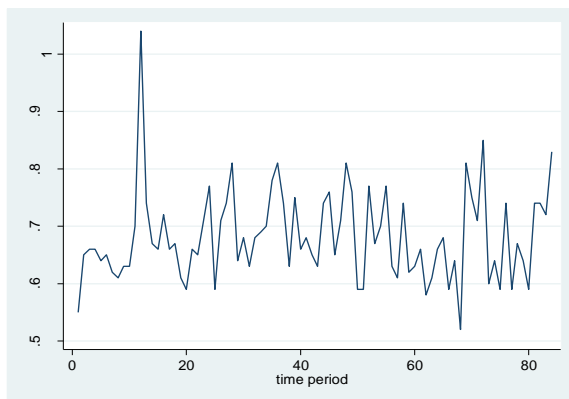


FIGURE 2 Consumption of coffee in kg over 1990-1996 (Left)

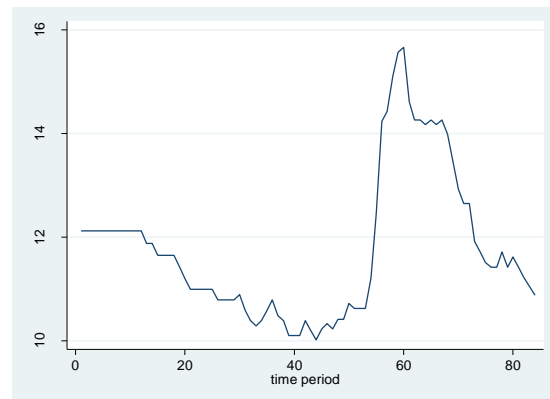


FIGURE 3 Price of roasted coffee per kg in current guilders over 1990-1996 (Right)

Figure 2 shows the consumption of coffee over 1990-1996. This varies a lot, which implies that the consumption of coffee has a strong seasonal attribute. Also, looking at the summary statistics over the four different seasons (dummy variables) we see that consumption of roasted coffee in kilos, per capita, varies. Going from spring to winter we see that consumption goes from 0.65 kg to 0.74 kg per capita.

Figure 3 in the right shows the price of roasted coffee during sample period. What we see here is that price has been steadily going down, until we have a sharp rise in price. This could be due to both cost having risen and demand having risen.

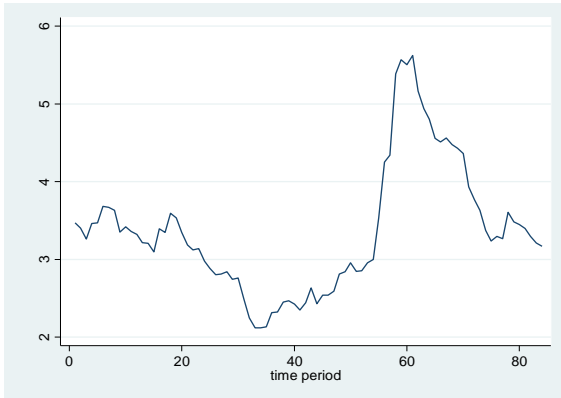


FIGURE 4 Price of coffee beans per kg in current guilders over 1990-1996 (Left)

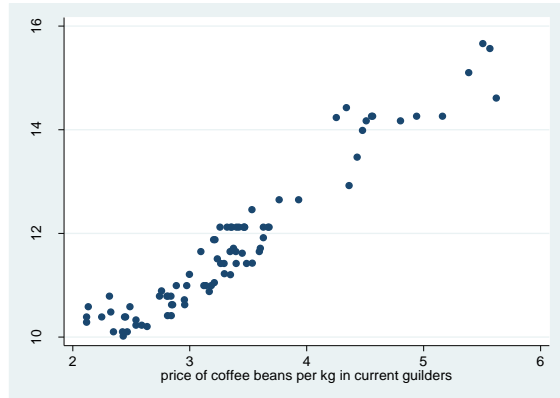


FIGURE 5 Correlation between coffee beans and roasted coffee prices over 1990-1996 (Right)

Figure 4 shows the price of coffee beans over time. Since we see the same sharp rise in the price of coffee beans as in the price of roasted coffee beans we must assume that the cost is the reason for the price of roasted coffee has gone up. Also, the correlation coefficient is 0.9595 showing an almost perfect relationship, telling us that prices follow very closely to each other. Figure 5 also shows that price of roasted coffee and price of coffee beans follow each other closely. So a big increase in cost of beans has most probably shifted the supply.

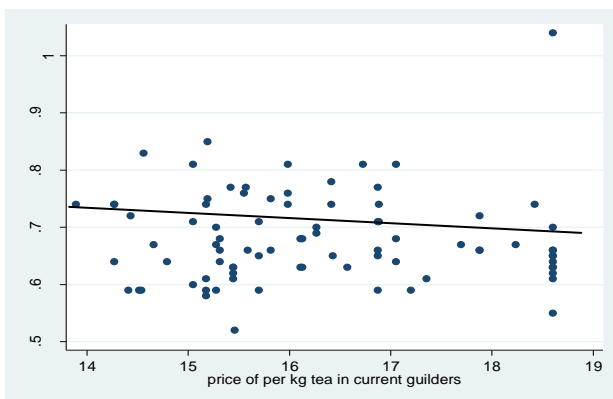


FIGURE 6 Correlation between consumption of roasted coffee and tea price over 1990-1996

Figure 6 is a scatterplot over consumption of roasted coffee and price of tea over the years 1990 to 1996. Tea is normally regarded as a substitute to coffee. They are both hot beverages that are consumed in the same setting. What one might think is that if the price of tea should go down then the consumption of coffee should go up. However, the scatter plot of Figure 6 does not show this pattern. Thus, the assumption about tea and coffee being close substitutes

does not seem to hold. Also, looking at the correlation coefficient is -0.0159 telling a very weak relationship. Thus, price of tea does not influence consumption of roasted coffee.

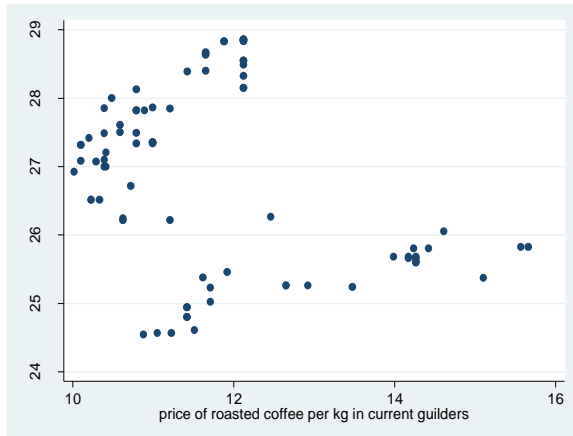


FIGURE 7 The relationship between labor price and roasted coffee price (Left)

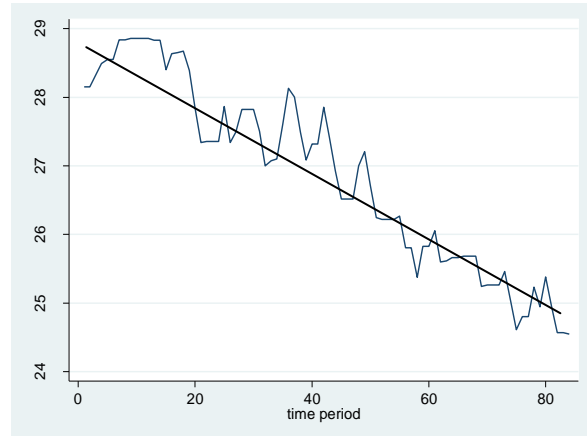


FIGURE 8 Price of labor per man hours over 1990-1996 (Right)

In Figure 7, we see a scatterplot of the relationship between price of labor and price of roasted coffee. The scatterplot does not imply any strong relationship between these two variables. Price of labor over time, 1990-1996 shown in Figure 8. Compared with the trend of the price of consumption of roasted coffee, the trend of labor price follows a similar way. Looking at the correlation coefficient we have a value of -0.3005 , telling us that to some extent the price of roasted coffee and the price of labor do influence each other.

Figure 9 presents a scatterplot over price of tea and price of roasted coffee. There is no particular pattern, telling us that price of roasted coffee and price of tea does not seem to affect each other. The correlation coefficient is -0.1188 , indicating a weak or no relationship between price of roasted coffee and price of tea. In Figure 10, it shows price of tea over sample period. Compare to the figure 3, there does not seem to be any particular relationship. We do see a “trend”, that both prices seem to be more or less falling over time. The reason for these prices following the same trend may not be so much that their prices influence each other, but because of the fact that exogenous factors is effecting them separately but in the same direction. For instance coffee prices are mostly influenced by coffee bean prices, and secondly price of labor.

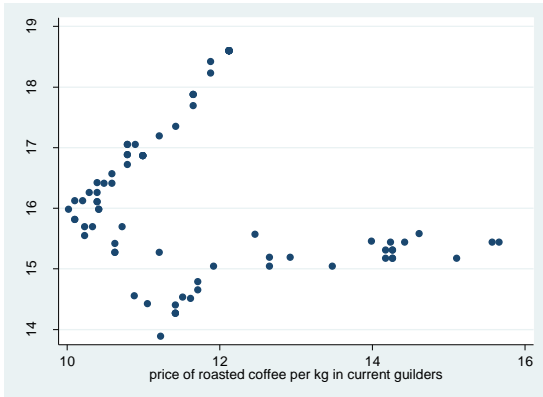


FIGURE 9 A correlation between price of tea and price of roasted coffee over 1990-1996 (Left)

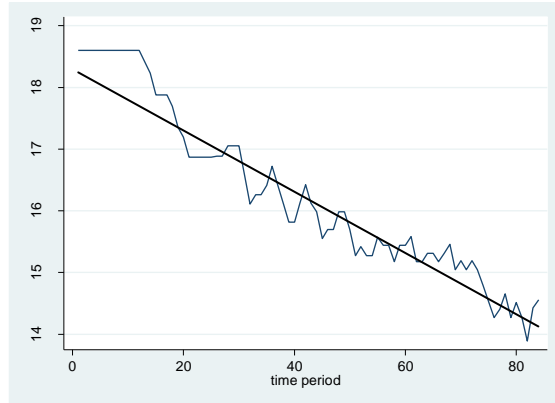


FIGURE 10 Price of per kg tea in current guilders over 1990-1996 (Right)

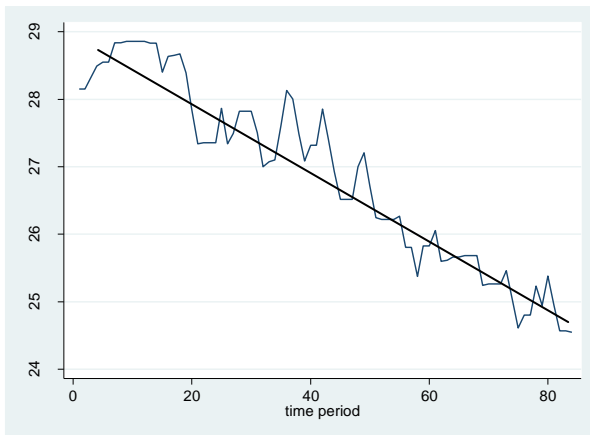


FIGURE 11 Price of labor per man hours over 1990-1996 (Left)

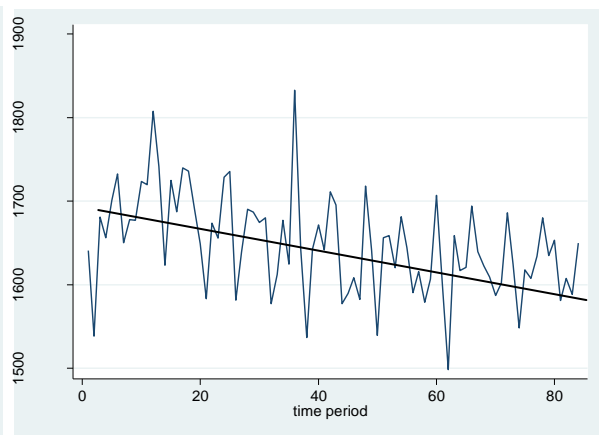


FIGURE 12 Income per capita in current guilders over 1990-1996 (Right)

These graphs of price of tea (Figure 10) and price of labor (Figure 11) show a strong relationship. Also the correlation coefficient is 0.9480, implying that price of labor and tea follows each other closely.

Figure 12 presents income per capita over time. As in the previous case, one possible reason why price of tea has come down is that it has needed to adjust to the income of consumers in order to keep up the output. The correlation coefficient is 0.4703, showing a strong relationship between income per capita and tea prices. So the factors that affect tea are mostly price of labor and then income per capita.

V. ESTIMATION

In this section, it states the model and observes the estimation of demand, then estimated price elasticity of demand. It also provides estimations of the Lerner index, adjusted Lerner index and the conduct parameter to explore the oligopoly behavior on the Dutch coffee market over the entire period.

Model

Demand is easiest to think about in case of homogenous goods. With the implications we mentioned in section 3, a log-linear model used to estimate demand can be described by the following equation,

$$q_t^d = \beta_b + \beta_1 \cdot p_t + \beta_2 \cdot q_1 + \beta_3 \cdot q_2 + \beta_4 \cdot q_3 + \varepsilon_t \quad (1)$$

where the q_t^d is a natural logarithm of demand of roasted coffee, Q_t^d ; p_t represents the natural logarithm of price of roasted coffee, P_t ; q_1, q_2, q_3 are the quarters, as the seasonal dummy variables; ε_t and β are the parameters.

In this model, it is to treat demand and supply simultaneously. Supply equation is necessary here, and we cannot estimate demand separately from supply since price is an equilibrium result of interaction between demand and supply for goods. This creates an endogeneity problem, having as consequence the biased and inconsistent estimation of the coefficients in some regressions. The coefficient on price would therefore not be a correct estimate of the true price elasticity of demand, but can nonetheless be interpreted in terms of sign, indicating the direction of the impact of a price change on demand. Since we expect a positive correlation between the coffee price and the error term, our endogeneity problem, it is expected that the estimated coefficient is upward biased. OLS could be applied to gain consistent estimates, and then use IV to “purge” the price of endogeneity.

Demand Estimation

The estimation procedure is the following: using OLS perform the reduced-form regression of our endogenous variable (price of coffee) on all instrument variables (price of coffee beans and labor price) and other exogenous variables (seasonal dummies, income, tea price) and obtain the estimates of price of coffee. Then replace actual values of price of coffee by its new predicted values and apply again OLS to the demand equation. Using Instrument Variable technique, we see how the price change attributable only to shocks on the supply side corresponds to the volume of production and consumption.

Table 4 presents the results of demand estimates. Regression (1) with the log of consumption of coffee per capita on the log of price of roasted coffee, the coefficient is statistically significant at a 5% significant level. The coefficient of roasted coffee price is interpreted as price elasticity. The sign illustrates when price increases, consumption per capita of coffee will go down. This implies a negatively sloped demand curve. The coefficient is around 0.238, which implies that the demand for coffee is inelastic. The elasticity is bounded between zero and one, where one is perfectly elastic.

In regression (2), controlling for seasonality by including additional explanatory variables in three dummy seasonal variables, decreases (increases in absolute value) the estimated coefficient on log price, the price elasticity, to -0.254 , but does not solve the endogeneity problem. The coefficients here are interpreted as the percentage difference to the fourth quarter. Specifically, the coefficient for the dummy variable q_1 takes a value of -0.127 . This predicted that in Season 1 people on average drink 12.7% less coffee per capita than in Season 4. For Season 2 people drink 9.2% less coffee than in Season 4 and for Season 3 the percentage difference is 11.8%.

A 2 Stage Least Squares Regression (2SLS) is performed in table 4. Using the IV regression, it estimates two stages regressions. In the first stage, it illustrates how labor price ($wprice$) and coffee bean price ($bprice$) shifts the price elasticity of roasted coffee demand ($cprice$).

Wage is significant at 10% significance level as well as bean price is significant at 5% significance level, which shows a valid and perfect instruments, respectively. So, estimated *cprice* then put into the model of the second step. In regression (4), the coefficient for the natural logarithm of the price of coffee is significant at a 5% significance level, which is still positive and the effect has increase since the instruments have been added ($-0.277 < -0.254$).

TABLE 4 Demand estimation of roasted coffee in the Dutch market

	(1)	(2)	(3)	(4)
	Bivariate	Multivariate	2SLS	2SLS
	Regression	Regression	First stage	Second stage
	Coef.	Coef.	Coef.	Coef.
	(Std. Err.)	(Std. Err.)	(Std. Err.)	(Std. Err.)
Consumption (qu)				
Coffee price (cprice)	-.238 (.104)	-.254 (.094)		-.277 (.099)
Quarter 1 (q1)		-.127 (.030)	-.009 (.012)	-.127 (.030)
Quarter 2 (q2)		-.092 (.030)	-.014 (.012)	-.092 (.030)
Quarter 3 (q3)		-.118 (.030)	-.003 (.012)	-.118 (.030)
Labor price (q4)			.160 (.089)	
Beans price (bprice)			.473 (.019)	
R-squared	0.0598	0.2648	0.8993	0.2642
No. of obs.	84	84	84	84

Note: Standard errors are in parentheses. It takes log on the variables and with dummy variables for different seasons.

Estimated Price Elasticity of Demand

Using IV regression we estimate the model (1) and obtain the correct price elasticity of demand since have estimated demand and supply simultaneously. The price elasticity of demand is estimated at -0.277 (see Table 4), which means that if there exists a 100% increase in the price, the demand for coffee consumption will decrease by 27.7%, all other factors constant. It indicates fairly low price sensitivity for demand of coffee and it is inelastic in price. Thus, the consumption will decline only slightly when the price of coffee increases, and vice versa.

The Elasticity-Adjusted Lerner Index

Having obtained consistently the price elasticity of demand and having the data on the price of roasted coffee, we simply observe the elasticity-adjusted Lerner index, L_η , with computation of the corresponding formulas. The estimated value c_0 of 4 guilders, and k estimated at 1.19 kg of beans. Keeping technology and the price of coffee beans, constant over the analyzed period, it obtains an average marginal cost of 8 guilders, with a standard deviation of 0.98.

Table 5 gives the evaluation on Lerner indices and estimated separately by season. Accordingly, it gives the average value of the Lerner index over the sample, 0.3197 (with an s.d of 0.0236), suggesting that, on average, the price is 32% higher than the marginal cost. The median value over the sample of the computed monthly Lerner indexes is 0.3158, implying that 50% of the monthly markups have values representing 31% or less of the final sales price. The overall distribution is normal, since the median and mean are close in value. The Adjusted Lerner index, computed by scaling the Lerner index by the estimated price elasticity of demand (0.277), has an average value of 0.0886 (with an s.d. of .0065), and a median value of 0.0875.

TABLE 5 Summary of Lerner Index

LERNER INDEX SEASONALITY						
SEASON	LERNER INDEX			ADJUSTED LERNER INDEX (CONDUCT PARAMETER)		
	MEAN	MEDIAN	STANDARD DEVIATION	MEAN	MEDIAN	STANDARD DEVIATION
Quarter I	0.3190	0.3189	0.0220	0.0884	0.0883	0.0061
Quarter II	0.3172	0.3160	0.0151	0.0879	0.0875	0.0042
Quarter III	0.3217	0.3132	0.0278	0.0891	0.0868	0.0077
Quarter IV	0.3209	0.3141	0.0286	0.0889	0.0870	0.0079
Average	0.3197	0.3158	0.0236	0.0886	0.0875	0.0065

Notes: Lerner Index estimated separately by season over 1990-1996.

Seasonality is also observable in the average values computed for both the Lerner index and the Adjusted Lerner index. The Lerner index has the highest average value in quarter 3, 0.3217, and the lowest average value in quarter 2, 0.3172. That is, it ranges from 31.7% in quarter 2 to 32.1% in quarter 4. The Adjusted Lerner index follows a similar pattern, which has the lowest average values of 0.0879 in quarter 2 and the highest average value of 0.0891 in quarter 3. The fact that Quarter 3, corresponding to summer months July, August and September, entails the higher of both indices would have been explainable if the consumption in q3 would have been the lowest. In that case, by consuming the lowest quantity in q3, the consumers were also less affected by price increases. Thus producers would have a higher market power, being capable of setting prices higher than usual above the marginal cost. However, the consumption of coffee in q3 is slightly higher than in q1, which makes the interpretation not straightforward. Meanwhile, compared to the average adjusted and unadjusted Lerner indices, the median adjusted and unadjusted Lerner indices show a different story. Look at the median values, it could be seen that firms have more market power in the really cold months of January to March and less market power in the hot summer months.

As a consequence, it could be concluded that the largest amount of coffee is consumed during the cold season and the lowest in the hot season, hence this is probably cause of a slightly lower market power as per the Lerner indexes. This is because of it is hot during summer, and people want cooling beverages, making people more price sensitive, since they are more reluctant to switch to a cool beverage. It thus leaves less “room” for firms to charge prices over marginal cost.

Estimation of Conduct Parameter

We state price equation (2) that price as the dependent variable and cost as the explanatory variable (no constant included).

$$P_t^c = \beta_1 \cdot cost_t + \beta_2 \cdot q_1 + \beta_3 \cdot q_2 + \beta_4 \cdot q_3 + \varepsilon_t \quad (2)$$

Then consistently estimated the price elasticity of demand, at 0.277, it can be estimate θ as being equal to: $\hat{\theta} = \frac{\hat{\eta}(\hat{\beta}-1)}{\hat{\beta}}$.

Table 6 shows the results of estimation of price equation (2).

TABLE 6 Estimation of price equation

	Regression 1	Regression 2
Coffee price(cprice)	Coef. (Std. Err.)	Coef. (Std. Err.)
Cost	1.469 (.006)	1.466 (.011)
Quarter 1		.003 (.126)
Quarter 2		-.008 (.125)
Quarter 3		.084 (.126)
R-Squared	0.9988	0.9988

Note: Estimation of price equation over 1990-1996.

From Table 6, the estimated parameter on cost from the simple regression of price on cost is 1.469, significantly different from 0 at a 5% significance level. Added the seasonal dummies in the price regression (2), still with no constant, we obtain a value of 1.466 for the estimated beta parameter, which is significant at a 5% significance level. None of the seasonal dummy variables are statistically significantly from zero. A joint test of parameter significance indicates that we can reject the hypothesis, that is, they are simultaneously equal to 0, so we will maintain them in our regression. The remarkably high R^2 of both models are presented in Table 6. Even if this is not a measure of the quality of the model, it indicates and almost perfect fit of the data. The omitted variable bias is thus unlikely to be a problem in this case, hence we can proceed with the estimation of θ using the value of 1.466267 for $\hat{\beta}$.

Having obtained the coefficient for cost, we simply calculate the value of the conduct parameter and compute the number of identical firms, see in Table 7. The estimated value of θ is 0.092. A value of the conduct parameter equal to 0 is signaling perfect competition. The estimated parameter is thus very close to 0, but significantly different from 0 at 5% significance level. We therefore can reject the null hypothesis of perfect competition, the

result indicating intense (oligopolistic) competition on the Dutch coffee market with prices close to the marginal cost. Collusive behavior hypothesis is also rejected, with the conduct parameter significantly different from 1 at a 5% significance level. The relatively intense competition inferred from the conduct parameter is somehow in contradiction with our previous findings, where the Lerner index of market power was relatively high. The reason for this might be the very inelastic demand, and also the fact that the estimated conduct parameter is at aggregated level. Thus there might be deviations between the firms, making the estimate to be skewed. That is, one of the firms possessing significant market power, and “pulling” the Lerner index upwards. Another explanation is that our cost estimation is too simple to take in all factors that affect price.

TABLE 7 Conduct parameter and number of identical firms

Conduct parameter (θ)	.0924484
Number of identical firms (n)	10.82 \approx 10

Notes: Here n is compute by $n = 1/\theta$.

Assuming that all firms are identical in their cost structure, having equal marginal costs, the conduct parameter is equal to the inverse of the number of firms on the specific market, who are engaged in the Cournot type competition, which described in the literature as the “Cournot-equivalent number of firms”. From our data we can infer that the Dutch roasted market behaves as if there are around 10 identical Cournot-competing firms on the market ($n = \frac{1}{\theta} = \frac{1}{0.0924} = 10.82 \approx 10$ firms). The hypothesis of a perfectly competitive market of the roasted coffee is thus hard to accept, while relatively competitive oligopolistic interdependence is more plausible in this study.

VI. RESULTS DISCUSSION

In a regression with the log of consumption of coffee per capita on the log of price of roasted coffee, the coefficient is statistically significant at a 5% significance level. The coefficient is interpreted as price elasticity. Since we have a small number this tells us that even if we have a large increase in price, quantity will not decrease as much as price has risen. This is positive for the firms in the market, since this is a strong sign of firms having market power over consumers. For IV regression, the estimates are reasonable. It estimates the model (1) and obtains the correct price elasticity of demand since we have estimated demand and supply simultaneously. The Price elasticity of demand is estimated at -0.2772. It indicates fairly low price sensitivity for demand of coffee and it is inelastic in price: when the price of coffee increases, the consumers do not reduce their coffee consumption proportionally and when the price of coffee falls, consumers' demand for coffee does not proportionally increase to any great extent. Thus, the consumption will decline only slightly when the price of coffee increases, and vice versa. That is to say, some regular coffee drinkers will still keep drinking coffee even though prices have been raised.

Possible explanations for the fairly low price elasticity of coffee demand include the fact that roasted coffee is regarded as a necessity good in consumers' daily life, potentially due to habit formation and addiction, and obviously is a non-durable good. However, the share of coffee in consumers' budget is not large. The greater the proportions, the higher the price elasticity of demand. It is worth mentioning that there are more factors that imply inelastic demand for coffee.

The presence of competitors or substitute products can affect demand. The more substitute products, the more elastic demand for this product. Regarding coffee there are not many substitutes on the market. Demand can be inelastic due to the changed price level being invisible to the customer, or just due to the price being considered to be reasonable. Conservatism of consumers' tastes which makes consumers averse to changing food habits

and behaviour are also factors making demand less price elastic. Therefore, according to all these factors it is reasonable that price elasticity for coffee should be quite low. Compared with the elasticity in Durevall (2006), it is similarly shown a low elasticity in the Swedish coffee market.

As we above mentioned, I also use 2SLS to measure and have control the tea price and income (both in logarithmic form) as additional explanatory variables in the new model to investigate the influences. The estimation results are shown in Table 8 (See Appendix). It can be found that the tea price, the income and the variable for other food prices are not statistically significant, hence they have no real effect on consumption of roasted coffee. Since adding these variables do not give any additional information, these variables were dropped. Therefore, it can be concluded that, as a consequence, the price of the roasted coffee and the seasons are the factors that influence the demand for coffee.

In addition, the econometric approach uses a direct measure of marginal cost and estimated demand elasticity to find that there are about 10 firms in the market. Firms have more market power in the summer (July to August) because demand is lower, but this should be the opposite. When it is cold, consumers want to drink more coffee and therefore are willing to pay more money for coffee, so firms can charge a higher price. However, the regression results show that the average adjusted Lerner index is the highest in the third quarter and that is difficult to explain. Then, looking at the median adjusted and unadjusted Lerner indices could help to analysis.

The median values show a different story than the mean values: possibly because in some years over the period 1990 to 1996, the Lerner index was unusually higher during the summer years than in other years. In that case, the average will be “biased” upward, but the median will not be biased because it tells us what the Lerner index was during most years during your sample period.

For example, when the “bean freeze” happened in Brazil in 1994, the total supply of coffee must have decreased, making it more expensive to buy roasted coffee. When did the freeze happen? It happened in the middle of 1994 (around July).³ This means that during the summer months of 1994, the price of roasted coffee increased a lot because of the freeze (a supply-side shock). Even though we control for “quarterly” seasonality, it is impossible to control for unusual “years” like 1994, so the Lerner index for that year is probably unusually high and that is one probable reason why the average Lerner Index is higher than the median Lerner index for the period 1990 to 1996.

Therefore, we conclude that seasonality indeed affects the indices since it can be clearly seen that firms have higher market power (from Lerner indices) and face higher price elasticity (i.e. adjusted Lerner indices are higher with higher elasticity) in colder seasons. Therefore, the higher the price elasticity, given the Lerner index, the higher the adjusted Lerner index (Conduct parameter). When market power is adjusted for coffee price elasticity, I realize that firms in the Dutch coffee market have small market power. Therefore, it is hard to accept the hypothesis of a perfectly competition in the roasted coffee market, while relatively competitive oligopolistic interdependence is more plausible in our study.

³ Link address: <http://www.nytimes.com/1994/07/11/business/new-frost-hits-brazil-coffee.html>

VII. CONCLUSION

The objective of this paper is to analyze the degree of market power in the Dutch roasted coffee market over the period 1990 to 1996. The theoretical structure in this study is motivated by Genesove and Mullin (1998). The empirical model estimates the degree of competition using an oligopoly model. Directly measures the marginal cost and estimated demand elasticity to obtain competition information in the Dutch roasted coffee market. This allows us to construct Lerner index, and estimate with a free conduct parameter.

The results indicate a fairly low elasticity in price for roasted coffee demand. Meanwhile, the significance of controlling for seasonality cannot be overstated. The highest amount of coffee is consumed during the winter season and the lowest is during the summer. This is the probable cause of the slight seasonal difference in the Lerner indexes.

Using aggregate data, I find that there are about ten firms observed in the Dutch coffee market, which implies small market power over 1990 to 1996. The hypothesis of a perfectly competition in market of the roasted coffee is hardly to be accepted. Instead, the related competitive oligopolistic interdependence is more plausible to illustrate the oligopolistic behavior.

The estimation of static oligopoly pricing rules in the roasted coffee industry is well suited for the application of NEIO techniques. Other industries with a similar production technology and information structure could employ to simulate the methodology further. My study has, however, some limitations. Controlling for the short-run and long-run are not considered in my analysis. In addition some roasters might also be able to exercise regional market power, not revealed with aggregate data. Furthermore, my study ignores the differences between producers and retailers in the analysis.

APPENDIX

TABLE 2 Sample statistics

Variables	Full Sample		Season 1		Season 2		Season 3		Season 4	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Consumption (qu)	.68	.07	.65	.06	.67	.05	.65	.07	.74	.09
Coffee Price (cprice)	11.76	1.41	11.68	1.30	11.61	1.24	11.85	1.45	11.89	1.69
Tea Price (tprice)	16.27	1.35	16.50	1.38	16.37	1.43	16.14	1.32	16.07	1.33
Labor Price (wprice)	26.86	1.34	27.07	1.28	27.04	1.37	26.77	1.29	26.57	1.43
Beans Price (bprice)	3.36	.83	3.33	.87	3.30	.68	3.38	.75	3.43	1.02
Income (incom)	1648.43	59.68	1624.26	66.94	1673.39	39.64	1630.99	39.30	1665.07	72.85
Number of observations	84		21		21		21		21	

Notes: All prices are reported per kg in current guilders. All quantities are reported in kg.

TABLE 3 Correlation between the variables

	Consumption (qu)	CoffeePrice (cprice)	Tea Price (tprice)	Labor Price (wprice)	Beans Price (bprice)	Income (incom)
(qu)	1.0000					
(cprice)	-0.2243	1.0000				
(tprice)	-0.0159	-0.1188	1.0000			
(wprice)	0.0169	-0.3005	0.9480	1.0000		
(bprice)	-0.2368	0.9595	-0.1978	-0.3774	1.0000	
(incom)	0.2353	-0.1069	0.4703	0.5145	-0.1658	1.0000

Note: Correlation between the variables during 1990-1996.

TABLE 8 Demand model with additional explanatory variables: price of tea and income

$$q_t^d = -2.355 - 0.271p_t - 0.104tp_t + 0.405y_t - 0.114q_1 - 0.093q_2 - 0.109q_3$$

(-0.90)	(-2.69)	(-0.67)	(1.08)	(-3.49)	(-3.03)	(-3.47)
[0.373]	[0.009]	[0.503]	[0.285]	[0.001]	[0.003]	[0.001]

$$R^2 = 0.2755, \text{Adj } R^2 = 0.2191, N = 84, F(6, 77) = 4.96 [0.0002]$$

Note: Estimated equation for demand using IV regression over 1990-1996.

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