Competition in the Dutch Coffee Market

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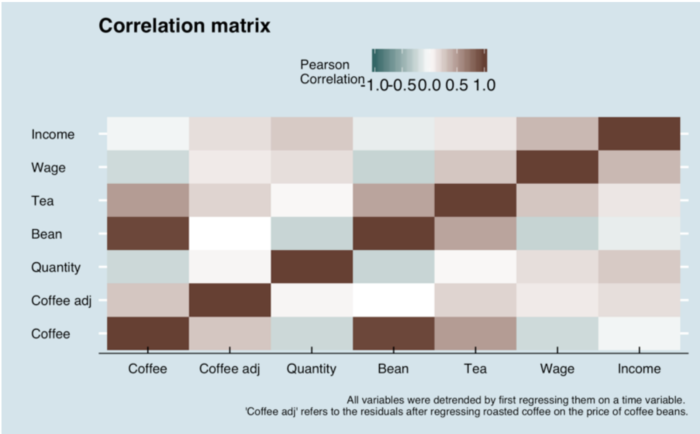
Introduction

This report evaluates the Dutch coffee market on behalf of the Directorate-General for Competition at the European Commission. Our analysis is based on monthly aggregate data for the Dutch coffee market during the period 1990-1996.

We begin by presenting some summary statistics, visually inspecting the time series data, and exploring some 'naive' correlations. We then produce an estimate of price elasticity of demand. We conclude by using this elasticity estimate to estimate the average firm's market share. (Note that we only have aggregate time-series data. Using a simple Cournot model, however, we infer market share indirectly by exploiting its positive relationship with markups for a given price elasticity of demand, even in a market with homogenous products and firms.)

Market summary

To introduce the data, we provide summary statistics over the most relevant variables in Table 1. Roasted coffee is generally cheaper per kg than tea (though may not be consumed at the same rate). We also note that coffee prices and consumption have the greatest spread over the period observed, and skew right, with outlying maximum values.



Graph 1

The correlation matrix provides a broad insight into the relationships between our (detrended[1]) variables. We include the additional variable "coffee adj", which we define as the residual series of a regression of the roasted coffee price on the bean price, a component of marginal cost whose extremely strong correlation with the roasted coffee price may be obscuring other details. By partialing out the bean price, a positive relationship between the residual roast coffee price and the wages of coffee roasters is revealed, while consumption marginally change sign.

Table 1:

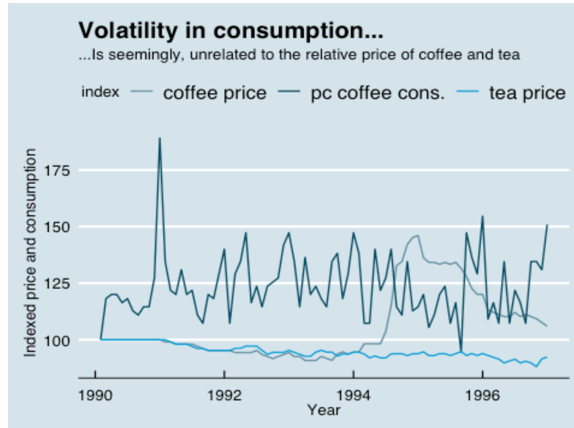
	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
Quantity (kg/capita)	0.52	0.63	0.66	0.68	0.74	1.04
Roasted coffee (f/kg)	11.01	11.45	12.12	12.83	13.50	17.70
Tea (f/kg)	16.39	17.30	17.56	17.65	17.93	18.60
Wage (f/h)	28.15	28.98	29.19	29.19	29.43	30.08
Coffee bean (f/kg)	2.28	3.00	3.41	3.68	3.98	6.35

[1] Assuming the variables are trend stationary and not unit root processes.

These correlations are merely illustrative – a more sophisticated analysis is needed to draw more certain conclusions. We now turn in more detail to coffee consumption, and then the prices of inputs and substitutes.

Consumption of roasted coffee

From the correlation matrix, we note that both the coffee price and the coffee price adjusted for bean prices are barely correlated with consumption of coffee. This view is further strengthened by Graph 2, which shows how the consumption of coffee cannot be said to react drastically to the price hike in coffee, even as tea prices are left unchanged. It therefore seems like the consumption of coffee is not sensitive to the price of coffee, or its substitutes.



Graph 2

Substitutes to coffee and variable input costs

While the bean price comprises a small fraction of the overall price of roasted coffee, it drives the vast majority of the variation. 1994's 90% spike in bean prices fed a 40% increase in the roasted price (N.B. the absolute increase was considerably larger for roasted than for beans). This spike, caused by a frost in Brazil[2], provides a natural experiment in the form of an exogenous price shock.

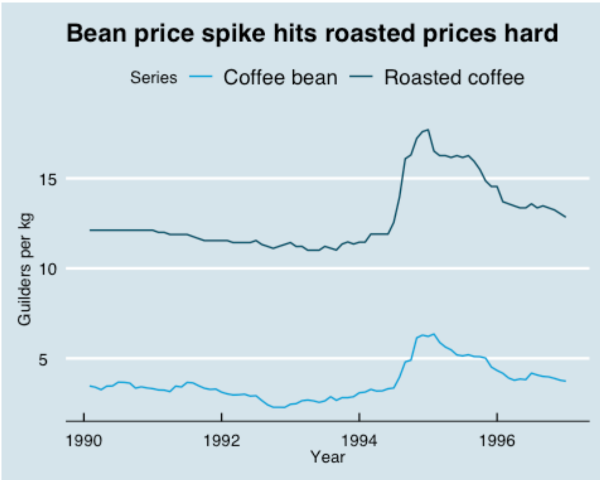
The other main input price is the wage, which shows a weak positive correlation with the adjusted coffee price. This corroborates our contention that, although wages are considered more a fixed than a marginal cost component, we should expect them to have a positive causal impact on the coffee price at least in the long run.

We also observe a moderate positive correlation between the detrended prices of tea and roasted coffee (both unadjusted and, to a lesser extent, adjusted). This is consistent with our expectations of two substitutable goods.

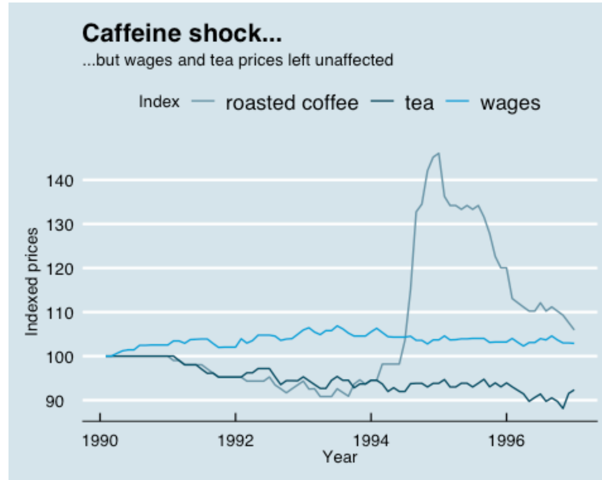
Since neither the price of tea, nor the wages, were not discernibly affected by the price hike in coffee (see Graph 4) we conclude that the price of coffee does not have a substantial causal effect on these two price variables and that the markets for coffee and tea are different. Moreover, the functional similarities between coffee and tea and the lack of evidence for coffee prices causing tea prices lead us to believe that the reverse causality is not present neither.

Again, one should be careful to draw strong conclusions: it still a correlational analysis.

[2] *Futures markets a second frost in brazil sends coffee prices higher*: https://www.nytimes.com/1994/07/12/business/futures-markets-a-second-frost-in-brazil-sends-coffee-prices-higher.html



Graph 4



Graph 3

Demand estimation

Our regressions are based on inflation-adjusted data for all of the monetary variables, so we are comparing real rather than nominal prices.

We specify four different OLS regressions, each with a separate set of control variables specified in Table 2. We regress logged values against logged values which allows us to interpret the coefficient estimates as constant demand elasticities. That is, the effect of a percentage increase in price on quantity consumed in percent. However, this interpretation requires us to assume that the estimates are unbiased and that the elasticity of demand is constant.

We believe that estimates for certain specifications are biased since they fail to include variation that is correlated with both quantity demanded and prices, conditional on other covariates in the specification. In particular, the naïve regression without any controls may suffer from not controlling for variables already known to be important controls, such as tea, being a substitute, and income, via the income effect. In addition to the four specifications estimated using OLS, we provide two specifications estimated using 2SLS, all presented in Table 2. We note that the magnitude is increasing with more controls and is highest when estimated using 2SLS controlling for a linear time trend, which is deemed the most reliable estimate. All estimates point towards an inelastic demand, which means the suppliers would increase total revenue by raising prices, which does not occur because of competition amongst them.

Table 2:

	Dependent variable:					
	log(Quantity)					
	OLS				*IV*	
	(1)	(2)	(3)	(4)	(5)	(6)
log(Coffee)	-0.238^{**}	-0.254^{***}	-0.255^{***}	-0.270^{***}	-0.288^{***}	-0.382^{***}
	(0.104)	(0.094)	(0.095)	(0.095)	(0.101)	(0.124)
Quarterly dummies	No	Yes	Yes	Yes	Yes	Yes
log(Tea)			-0.015	0.200	0.201	1.027
			(0.133)	(0.205)	(0.205)	(0.677)
log(Income)				0.513	0.521	0.309
				(0.374)	(0.374)	(0.409)
Time	No	No	No	No	No	Yes
Observations	84	84	84	84	84	84
R^2	0.060	0.265	0.265	0.282	0.282	0.293
Note:				$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$		

Shifters of supply and demand

From the data available, we intuitively expect the demand curve to be shifted by the price of substitutes (tea) and consumer income. That the price of tea shifts the demand curve for coffee stands in contrast with what we observed earlier, namely that a significant change in the coffee price had no effect on the price of tea and by the logic that there is no fundamental reason that the reverse should behave any differently. Either way, since we do not observe data on tea consumption, it is possible that the coffee price hike had an effect on tea consumption, and therefore, that a price hike in tea would have an effect on coffee consumption, i.e. shift the demand curve for coffee. Income is noted to be positively correlated with coffee consumption, making it a contender for being a demand shifter. This assumes that the wages of coffee roasters behave independently from the overall income level in the consumers' market or that the wages of coffee roasters don't significantly shift the supply curve.

On the supply side, we expect the supply curve to be shifted by prices of inputs such as the coffee beans, which directly determines marginal costs; the price of labour, which affects costs; and season which might affect yield but not consumption.

Analysis: Overcoming endogeneity

Because estimates from the regressions estimated using OLS may fail to account for variation correlated with both the price of roasted coffee and the quantity consumed, the estimates might be biased. Examples of variables related to both quantity and the price may be related to the quality of the product which might vary over the time period considered, or other factors determining demand.

To overcome the plausible issue of having endogeneity in the error term, we use the logarithm of bean prices together with the logarithm of wages, both potential supply shifters as discussed earlier, as instruments for the logarithm of the price of roasted coffee. The idea is that if these two variables are unrelated to quantity demanded, they can serve as instruments in a 2SLS specification.

We believe that these two instruments fulfill both the relevance and the validity conditions required of excluded instruments. That the bean price is a relevant instrument is clear by figure and we also note that there is a correlation between wages and roasted coffee after partialling out variation stemming from the bean price. Either way, it is noted that the first stage F statistic is 222, which means there are no concerns of having weak instruments.

Arguing for validity is more involved. Having valid instruments means that the quantity consumed is unrelated to the price of coffee beans and to the wages of coffee roasters, conditional on the set of control variables included in the regression specification. This could be violated if, for instance, the price of coffee beans is driven by consumer changes and trends in consumer demand (i.e. "reverse causality"); or if higher wages of workers was associated with a change in coffee consumption (for example if coffee workers comprise a large proportion of the consumer base). On the other hand, investigating what caused the spike in the bean prices (the single largest cause of variance in the coffee price variable), it becomes evident that this event was driven by a series of severe frosts in Brazil (normally accounting for 25-35% of the world's coffee) during June and July 1994. The weather in Brazil is conceivably independent of the quantity of coffee consumed. Additionally, with the Sargan statistic being insignificant ($p = 0.987$), we cannot reject that the two excluded instruments converge to the same point estimate in the limit, strengthening the case that the instruments provide consistent estimates of the elasticity of demand. Note that we do not use the demand shifters as instruments since those shift the demand curve that we want to pin down.

The estimated elasticity is inelastic at about 0.38, which means consumers are insensitive to price changes. This is likely observed because coffee constitutes a small share of consumers income, yet fairly addictive and distinct in its flavor. As stated earlier, the inelastic demand makes a price increase profitable for a hypothetical monopolist, which points towards the market being competitive.

Degree of competition

Next, we move on to further quantify the degree of competition. Since the technology of the process of converting raw beans into roasted coffee is relatively simple, we have knowledge of the marginal cost facing each firm, which is calculated as 4 + 1.19*Price of beans, meaning we can directly calculate markups.

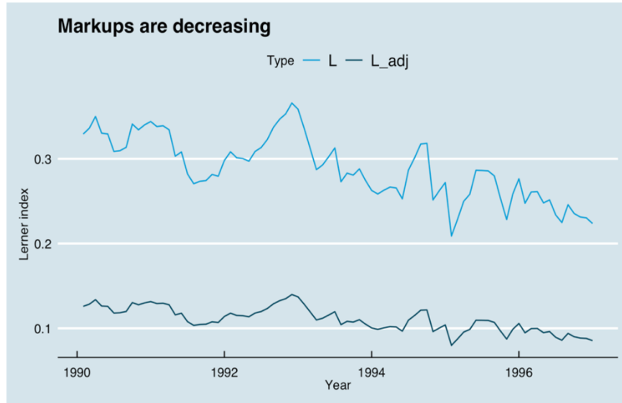
Adjusted and unadjusted Lerner indices

Markups are calculated using: $L = \frac{P-c}{P}$, with P denoting the price of roasted coffee, and c is the marginal cost to the supplier. These estimates are presented in Graph 5.

Table 3:

Quarter	mean L	mean L_η	std L	std L_η
Q1	0.291	0.111	0.042	0.016
Q2	0.288	0.110	0.027	0.011
Q3	0.290	0.111	0.034	0.013
Q4	0.286	0.109	0.046	0.017

To obtain an estimate of the adjusted Lerner index, we use the estimate of the elasticity from the IV specification (column 5 in Table 2) despite the fact that the Wu Hausman indicates that the efficient estimate from the OLS is not significantly different from the relatively less efficient 2SLS estimate (p = 0.39). This is motivated by a concern of low power in the Wu Hausman statistic so that the OLS estimate may still be biased. The adjusted Lerner index is calculated as the markup times the elasticity estimate: $L_{\eta} = \frac{P-c}{P}\hat{\eta}$.



Graph 5

For both indices, we provide average quarterly levels in Table 3 and conclude that there are no seasonal effects in the Lerner index. From Graph 5, we observe that markups are trending downwards and is therefore getting more competitive over time.

Conduct parameter

Finally, we move on to estimate the market conduct. Start with the following relationship: $P = \frac{\eta c}{\eta - \lambda}$ describing the relation between prices and elasticities, marginal costs, and the market conduct parameter. Next, separate out the marginal cost and define $b = \frac{\eta}{\eta-\lambda}$, such that $P = bc$. Having information on both P and c, we can estimate b in a regression. Specifically, we estimate:

$P_{coffee,t} = b * cost + \beta' Q + \ \varepsilon_t$, Where Q is a vector of three quarterly dummies. From the regression, we obtain $\hat{b}$ = 1.38 which is plugged into the formula: $\lambda = \frac{\hat{\eta}(\hat{b}-1)}{\hat{b}}$ = 0.105. Assuming that the firms in the market are identical and competing as Cournot oligopolists, the market can be said to be composed of $\frac{1}{\lambda}$ = 9.5 equally sized firms.

A market with almost ten Cournot oligopolists is deemed competitive, which is reflected in Graph 5 and in the inelastic demand. This likely happens because roasted coffee is an undifferentiated, commoditized product. Inspecting the elasticity of demand facing each firm at the mean of the price of beans and roasted coffee, we see that each firm faces an elastic demand of 2.9, which translates into customers being sensitive to individual firms charging higher prices.[3]

Conclusion

In this report, we have investigated the characteristics of the Dutch coffee market between 1990 and 1996. We conclude that the market is, overall, competitive.

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[3] The elasticity of demand facing individual firms was obtained by using the first order condition in a Cournot oligopolist's profit function, multiplying by P(q) to obtain an expression with the elasticity, plugging in actual costs and prices and solving for the elasticity.