Competition in the Swedish Coffee Market

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Abstract

It is a widespread belief that multinationals are exploiting their market power in national coffee markets by keeping consumer prices too high and thereby limiting demand for coffee beans. The purpose of this study is to test if this is case in the Swedish market for roasted coffee. In the Swedish market there are a few very large roasting companies and many small ones; a market structure that is typical of many consumer markets for coffee. To analyze the degree of market power, an oligopoly model is estimated using market time series data. The econometric approach is to first test for long-run relationships between the variables with cointegration analysis, and then to estimate a system of equations for demand and pricing behavior. Our major finding is that there is no evidence of market power in the long run, and only some in the short run.

Keywords: Coffee market; Market power; Multinationals; Oligopoly; Sweden

JEL classification: L13, L66, L81

1. Introduction

Coffee bean prices started to decline rapidly during 1998 and by 2002 they had dropped by 60 to 70 percent. An example is Santos coffee beans that dropped to 45 cents per pound, the lowest price since the end of the 1960s in nominal terms.[1] Not surprisingly, such low world prices of coffee beans cause widespread poverty among coffee farmers in the developing world. At the same time, consumer prices are perceived to remain high, or decrease too slowly. This has spurred interest in the question of market power of the roasting companies, since a small number of multinationals are active in most, if not all, consumer markets in the developed world. Some claim that multinational are abusing their market power by keeping prices too high and thereby limiting demand for coffee beans. For instance, Talbot (1997) argues that market power of the multinational companies enabled them to maintain the level of retail prices of coffee while world market prices for green coffee were falling in 1987 and plummeting in 1989. Others are equally straight forward, such as the former president of the WTO, Michael Moore (2002), Dicum and Luttinger (1999) and Gooding (2003), while others are more careful in their wording but nevertheless seem to support this view (see Fitter and Kaplinsky 2001; Oxfam, 2002; Ponte, 2002).

The purpose of the study is to test for market power in the Swedish market for roasted coffee. Since a few large roasting companies dominate the market, it is likely to be a good representative of consumer coffee markets: The market share of the four largest companies was 87 percent in 2002, and two multinationals (Kraft Foods and Nestle)

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[1] The prices are from the International Financial Statistics database of the IMF and refer to the New York market.

had 57 percent together.[2] Moreover, coffee is expensive in Sweden. According to the European Commission (2002a), Sweden had the highest EU prices for roasted coffee, with the exception of Great Britain, Ireland and Greece, which primarily consume tea and instant coffee. Swedish prices were 7 percent above the EU average.

We use an econometric oligopoly model to test for market power with quarterly data over the period 1978:1 to 2002:4. The model is based on Bresnahan (1982) and Lau (1982) and has been used in many other studies; some recent examples are Bettendorf and Verboven (1998, 2000) and Koerner (2002), who applied it to the coffee markets in the Netherlands and Germany, respectively, and Genovese and Mullen (1998) who studied sugar in the U.S. However, our approach is more in the sprit of Steen and Salvanes (1999) who extended the model to include short and long run dynamics.

Roasted coffee is treated as a homogenous good since aggregate market data are used. Although not ideal, this assumption makes it possible to model the dynamics and long-run equilibria with time series techniques. It is important for the analysis that coffee is a simple product with a low degree of value added, so differences in quality are largely reflected in the cost of imported coffee beans, which we control for. Moreover, ground coffee sold in retail outlets in Sweden is made of high-quality beans and differences in quality are much smaller than in many other countries where low-quality beans are common.

To estimate the model we first test for unit roots and cointegration using the Johansen

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[2] See Durevall (2003), Clarke et al (2002) and Sutton (1991) for information of market shares in various countries.

maximum likelihood procedure (Johansen 1988). Then we develop an empirically constant autoregressive distributed lag model for demand and pricing, which is tested in order to make sure that the assumptions regarding its stochastic properties and empirical stability are fulfilled. Our major findings are that there is no evidence of market power in the long run; in other words, the downward trend in coffee consumption observed during the past 25 years is not due to high prices. The most likely explanation is that preferences among those born about 1960 and later are different compared to those of the older cohorts. Roasting companies have some market power in the short run but it is very small, and the mark-up, measured as the Lerner index, is only 10 percent.[3]

The paper is structured as follows. The next section describes the economic model that forms the basis for the empirical analysis. Section 3 provides a short description of the Swedish market for roasted coffee. Section 4 first uses graphs to describe the data and then report results from estimation of the model and the test for market power. Section 5 summarizes the results and concludes the paper.

2. Theoretical Background

The model consists of a demand and a supply side.[4] The supply side is based on the assumption that companies maximize their profits by choosing the quantity. For firm *i* (*i*= 1…n), the profit π_i is given by,

$$\pi_i = \frac{1}{1+\tau} P(Q)Q_i - C_i(Q_i, w) \tag{1}$$

[3] Our data does no allow us to distinguish between roasters and retailers so the mark up may be due to market power at the retailer level.
[4] See Bresnahan (1989) for a thorough description of different approaches of measuring market power.

where τ is value added tax, Q the total industry output, Q_i output of firm i, $P(Q)$ the inverse demand function, $C_i(Q_i, w)$ the cost function and w a vector of input prices. Differentiating Equation (2) with respect to Q_i gives the profit-maximizing condition, perceived marginal revenue is equal to marginal costs,

$$\frac{1}{1+\tau}[P + P'(Q)Q\theta_i] = \frac{\partial C_i}{\partial Q_i} \tag{2}$$

where P'(Q) is the derivative of $P(Q)$ with respect to Q , P is the real price of coffee, and $\theta_i = (\partial Q / \partial Q_i)(Q_i / Q)$ can be interpreted as the conjectural variation elasticity of total output with respect output of the ith firm, or simply as an index of market power. The conjectural variation varies between zero (perfect competition) and one (perfect collusion or monopoly).

To get a model for the market we aggregate all the individual supply relations assuming that marginal costs are constant and equal across firms (see Appelbaum, 1982). The market supply relation is obtained by multiplying Equation (2) by Q_i/Q and aggregating over all firms,

$$\frac{1}{1+\tau}[P + P'(Q)Q\theta] = MC(w) \tag{3}$$

where $MC(w)$ is the marginal cost function, and $\theta = \sum_i \theta_i (Q_i / Q)$ is a measure of the average degree of competition in the market. By re-writing Equation (3) we get an equation that describes the static long-run supply relation,

$$P = (1+\tau)MC(w) \text{ - } P'(Q)\theta Q. \tag{4}$$

According to Equation (4), the price of a good depends on three factors; marginal cost, including VAT, the degree of market power and demand. Price is equal to marginal costs when θ is zero, and when θ>0, price exceeds marginal costs by an amount that depends on the degree of market power and the response of demand to price changes. A large θ and low price elasticity in absolute terms, give a large mark-up. It is easy to show, using Equation (4), that θ cannot be larger than the absolute value of the price elasticity since that would imply negative marginal costs. Hence, by estimating the demand function we get some information about the size of θ.

To estimate Equation (4) we must specify an approximation to the marginal cost function and estimate a demand function to obtain values for $P'(Q)$. The roasted coffee production process is relatively simple; to make 1 kg of roasted coffee approximately 1.19 kg beans are required. Other costs include labor, packaging, energy and capital costs, each of which usually stands for less than five percent of total costs. In coffee roasting there are few economies of scale, which allows us to assume that companies have similar cost functions, in spite of being of different sizes (Sutton, 1991). This leads to the following marginal cost function, also used by Bettendorf and Verboven (2000),

$$MC(w) = \beta_0 O + \beta_1 IP + \beta_2 W \tag{5}$$

where O stands for all other costs, IP is the real import price for coffee beans, W are real labor costs. β_0, β_1, β_2 are parameters. We have observations for IP in terms of coffee bean prices, and for W, labor costs, but not for O. Hence, we assume that other costs follow the general price evolution and thus are included in the constant in the econometric analysis. Genovese and Mullen (1998) made the same assumption in their analysis of the US sugar market. This is probably an innocuous simplification since fluctuations in IP are the dominant source for changes in P.

Demand for non-durable consumer goods is usually assumed to depend on income, the price of the good modeled and the prices of substitutes. When modeling demand over several years, population and changes in population structure should also be considered. Equation (6) shows a static linear demand function[5] supposed to represent the long-run equilibrium relation for coffee demand in Sweden,

$$Q = \alpha_0 + \alpha_1 P + \alpha_2 Y + \alpha_3 G, \tag{6}$$

where, P is the relative (real) consumer price of coffee, Y real income, and G is a variable capturing demographic change, and α_0 $\alpha_{1,}$ α_2 and α_3 are parameters.

We assume that the demand for coffee is determined by the coffee price in relation to the price of the basket of goods included in the consumer price index. We could also have added relative prices for more specific coffee substitutes, e.g. tea, but it is unlikely that they influence coffee demand in Sweden.[6] Within the range of price changes observed in our sample, it seems more probable that coffee-price increases primarily lead to better utilization of already purchased coffee. As reported by Bettendorf and Verboven (1998) market studies have show that as much as 25 percent of purchased coffee is not actually drunk.

The second variable in the demand function is income. Normally an increase in income leads to an increase in consumption. Nonetheless, this might not be the case in

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[5] The functional form of the demand function estimated in other studies varies but linear and log-linear models seem to be the most common ones. When non-linear models also are estimated, the linear version seems to be preferred in the end (see Bettendorf and Verboven, 2000; Genovese and Mullen, 1998). Durevall (2004) estimated demand models with different functional forms. The average price elasticities turned out to be quite similar and the linear and log-linear models did equally well. For simplicity the linear form is preferred here.

[6] Studies showing that the price of tea has no effect on coffee demand include Bettendorf and Verboven (2000) for the Netherlands and Feuerstein (2002) for Germany. Koerner (2002), however, finds that Coca Cola is a complement to coffee in Germany.

the Swedish coffee market since it is likely to be saturated; even if a consumer can afford to consume more coffee he/she will not.

A common assumption is that a growing population generates higher demand, given prices. However, consumption patterns can differs significantly between different age groups. According to the Swedish coffee industry, there has been a slowdown in coffee consumption due to a change in preferences; people born around 1960 and later do not drink as much coffee as those born before the 1960, who quite often consume about six cups per day.[7] This process seems to have started at the end of the 1970s, and continues as the share of those born before 1960 declines. We measure the generation effect with the variable *G.*

3. The Market for Roasted Coffee in Sweden

The Swedish coffee market is small compared to the world market. In 2003 total consumption in Sweden was 97 320 ton of coffee beans, which is only about 1.5 percent of world consumption. However, in per capita terms, coffee consumption in Sweden is one of the highest in the world. Currently Sweden is in the fifth place; Finland is the leader followed by Denmark, Norway and the Netherlands.

As described by Sutton (1991), in most markets for roasted coffee there are a few large firms and many small ones. His description fits the Swedish market well. Table 1 shows the market shares of Swedish roasting-houses in 2002. Kraft Foods, owned by Philip Morris, is the market leader with a 44 percent market share. Its brands are Gevalia, Maxwell House and Blå mocca. Löfberg Lila is the second largest

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[7] See Durevall (2004) for an analysis of coffee demand and the generation effect for the period 1968 – 2002.

with a market share somewhat below 20 percent, followed by Nestlé, with the Zoega brand, and Arvid Nordquist with the Classic brand, with market shares of 13 and 12 percent, respectively. Together, the largest four coffee producers thus had 87 percent of the market in 2002, while the small roasting-houses each held 3 percent or less of the market. As in many other European markets the multinationals play an important role. In 2002, two out of the four large roasting houses were multinational companies and their market share was as large as 57 percent.

Table 1: Market Shares of Roasting Houses for Roasted Coffee

Company	Brand	Market share %
Kraft Foods	Gevalia, Maxwell House, Blå mocca	44
Löfbergs Lila		18
Nestlé	Zoega	13
Arvid Nordquist	Classic	12
Lindvalls Kaffe		3
K W Karlberg		1.7
Kahls Kaffe		1.5
Bergstrands		1
Guldrutan		0.7
Others		5.1

Source: ACNielsen, published in Företagaren Direkt (2002).

The market structure has not changed much during the period studied, 1978 – 2002.[8] The most important events are Nestlé’s acquisition of Zoégas Kaffe AB in 1986 and Kraft Foods’ purchase of Cirkel AB 1994, and their subsequent removal of the brand Cirkelkaffe from the market. General Foods acquired Gevalia, the largest Swedish brand, already in 1971. A recent change is the increase in the number of own brands, which might be affecting the margins of the roasters. The own brands of the two largest retailers, ICA and COOP, had together a market share of about 6 percent of retail sales of roasted coffee in 2003. The coffee is roasted in Finland and Denmark, respectively.

An important characteristic of the Swedish coffee market is the high quality of the coffee consumed. The quality of coffee is primarily driven by bean type. There are two main types, Arabica and Robusta. The Arabica bean is more expensive and mainly used in high quality coffee, while Robusta is used in cheap, low quality coffee, instant coffee, and in espresso due to its high caffeine level. Robusta accounts for only about 3 percent of Swedish imports and is not used in coffee roasted for retailing outlets.

4. Empirical Analysis

The empirical analysis is in the spirit of Steen and Salvanes (1999) who studied the market power of Norwegian salmon exporters to France by estimating error correction models that take stochastic trends in the variables into account. In this approach, the long-run solutions of the econometric models are assumed to depict the static states of the theoretical model.

The data analysis is performed in several steps. Since the mean and variance of at least some variables are not constant over time, we first use the Johansen (1988) method to test for integration and cointegration, that is, whether variables are stationary or not, and if the non-stationary variables have stochastic trends that can be removed by linear combinations. We start by analyzing the cointegrating relationships separately for demand and pricing, and then we estimate an autoregressive distributed

[8] For instance, in 1982 General Foods had 25%, Cirkel AB 23%, Löfbergs Lila 16%, Zoégas Kaffe 8% and Arvid Nordquist had 4%. Information for other years can be found on the homepage of the

lag system for demand and pricing in which all variables are stationary or can be written as stationary variables. The system is tested to make sure that the assumptions regarding its stochastic properties are fulfilled, and then it is reduced in order to obtain a parsimonious and empirically constant model. Finally, the stability of the model is investigated using recursive estimation.

The next sub-section describes the data. It uses graphs to show some characteristics of the variables and give intuition as to why the formal results hold. Sub-section 4.2 analyzes the stochastic properties of the variables formally and Sub-section 4.3 develops the model of demand and pricing and reports the tests for market power.

4.1 A Look a the Data

The data are quarterly and the period analyzed is 1978:1 – 2002:4. We use quarterly data because of paucity of monthly data for labor costs and imports. The analysis starts in 1978 since there was turbulence in the market in the mid-1970; drought in Brazil led to a rise in the price of roasted coffee from 20 kronor per kg in the first quarter of 1976 to 44 kronor in fourth quarter of 1977. Moreover, imports of coffee beans were exempted from import tax in 1976. To include the mid-1970s would require extending the time period back to the 1960s but labor costs are only available from 1974. Details about the data are given in Appendix I.

Three potential core variables explaining demand for roasted coffee are population growth, income and the relative price of coffee. In Figure 1, total coffee consumption in 1000 tons is depicted together with (mean and variance adjusted) total income,

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Swedish National Coffee Association, (www.kaffeinformation.se).

measured as household consumer expenditures.[9] It is evident that coffee consumption has declined since the end of the 1970s, while income has grown almost continuously. It is thus obvious that income does not determine coffee consumption in the long run. The reason is that already by the end of the 1960s the level of income was so high that the vast majority of the population could buy all the coffee it needed, and since then income has increased while consumption has decreased.

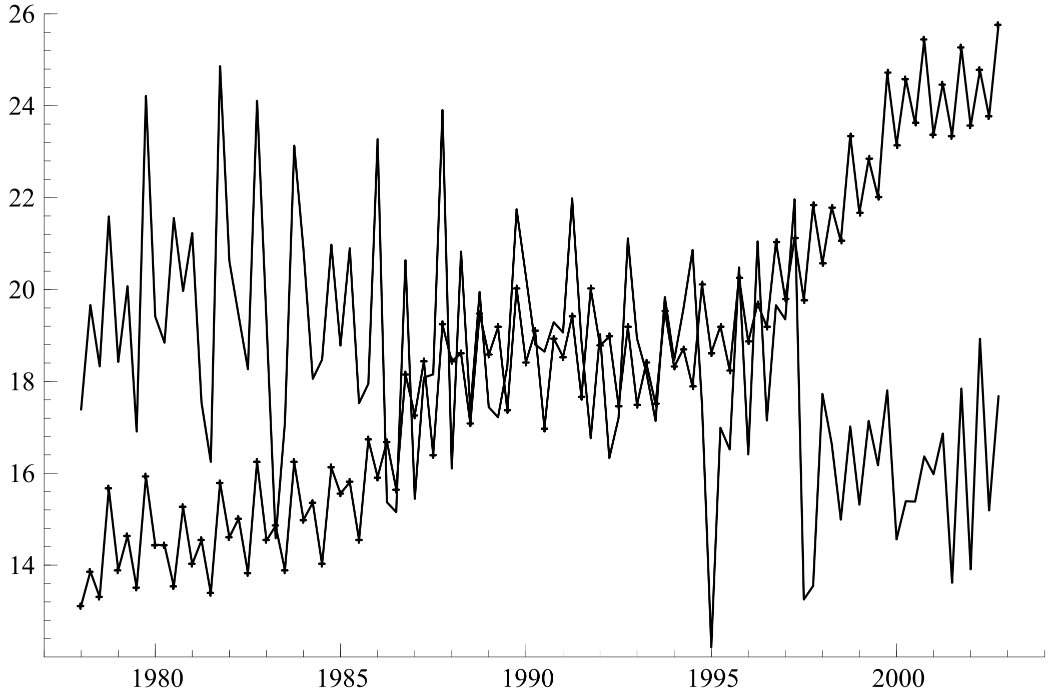

Figure 1: Coffee consumption, 1000 kg per quarter, —— and mean and variance adjusted income +—+—+.

Since the adult population of Sweden has grown since the 1970s, per capita coffee consumption has declined even more than what is indicated by Figure 1. This development cannot be attributed to rising prices, as show by Figure 2. The price per kilo, measured in constant 1995 SEK, fluctuates much more than consumption, and

[9] Since there is no quarterly data on consumption of roasted coffee, the Denton method was used to combine annual consumption data with quarterly import data (see Appendix I).

from the mid 1980s it declined without generating any noticeable increase in consumption.

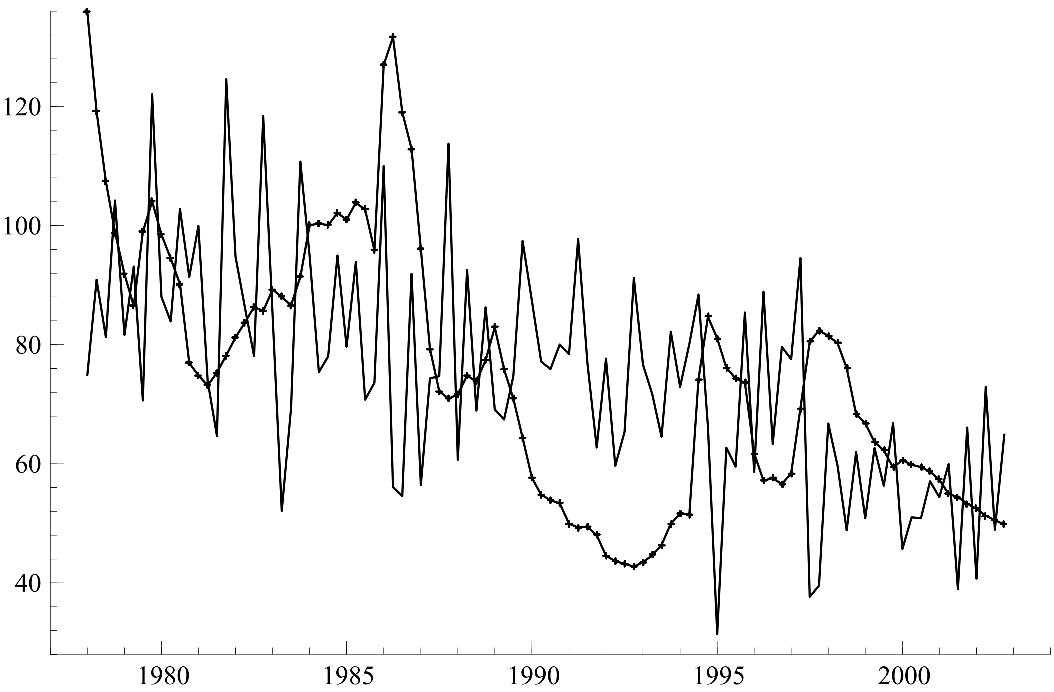

Figure 2: Coffee consumption per adult ——, and price of coffee in 1995 SEK +—+—+. Coffee consumption is mean and variance adjusted.

According to the industry, the slowdown in coffee consumption is due to a change in preferences (see Durevall 2004). People born around the 1960s and later do not drink as much coffee as those in the old generations, who quite often consume about six cups per day. This generation effect started at the end of the 1970s, and continues as the share of those born before 1960 declines. Over the period 1978 to 2002, the change in age distribution is simply a negative deterministic trend. To illustrate its importance, Figure 3 depicts consumption and a regression line, representing the generation effect. It explains the downward trend in coffee consumption well. As shown in the econometric analysis, when controlling for this demographic trend, the relative price of coffee is negatively correlated with consumption.

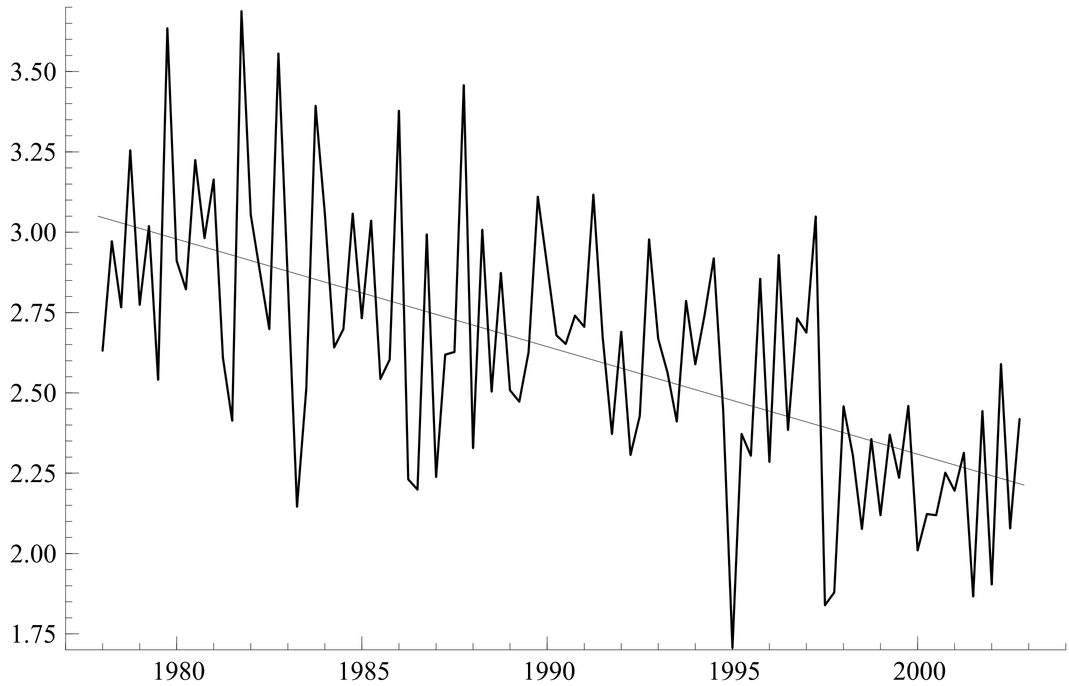

Figure 3: Coffee consumption per adult and a regression line representing the share of those born after 1959 in total population aged 15 and above.

Coffee beans are the by far most important input in production of roasted coffee. Figure 4 shows this by graphing consumer prices and import prices, where the bean price is the per-kilo value of imported green beans, adjusted for value added tax (see Equation 4). Both price series are in constant 1995 SEK. There is no doubt that fluctuations in bean prices and to some extent, in the SEK – US dollar exchange rate, explain the variability in the consumer price. Note also that the two price series seem to be non-stationary due to a level shift during the latter half of the 1980s, and that they probably co-break, that is, a linear combination of the two variables is stationary.

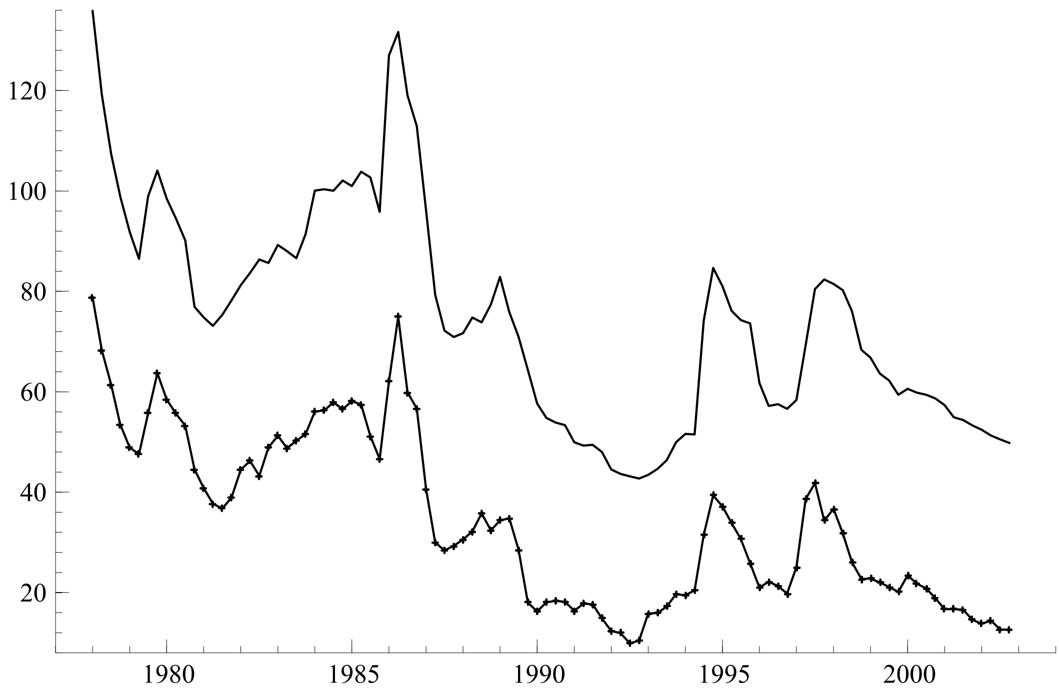

Figure 4: Price of roasted coffee ——, and VAT-adjusted import price of coffee beans +—+—+. Both series are in constant 1995 SEK.

Figure 5 plots real coffee prices and (mean adjusted) real hourly labor costs. Labor cost data are for blue-collar workers in food and beverages manufacturing, adjusted for value added tax. Since labor costs rose during most of the sample period, while prices declined, there is no positive long-run relation between the two variables. The reason for this is that increases in labor productivity have compensated for the rise in real labor costs; probably making real unit labor costs a stationary variable. Unfortunately we do not have data on real unit labor costs for coffee roasting but the series for manufacturing as a whole is available. It has a negative trend, which probably is not the case for coffee roasting, as indicated by the close relationship between consumer and import prices. In the econometric analysis we use the first difference of real labor costs to capture changes in real unit labor costs.

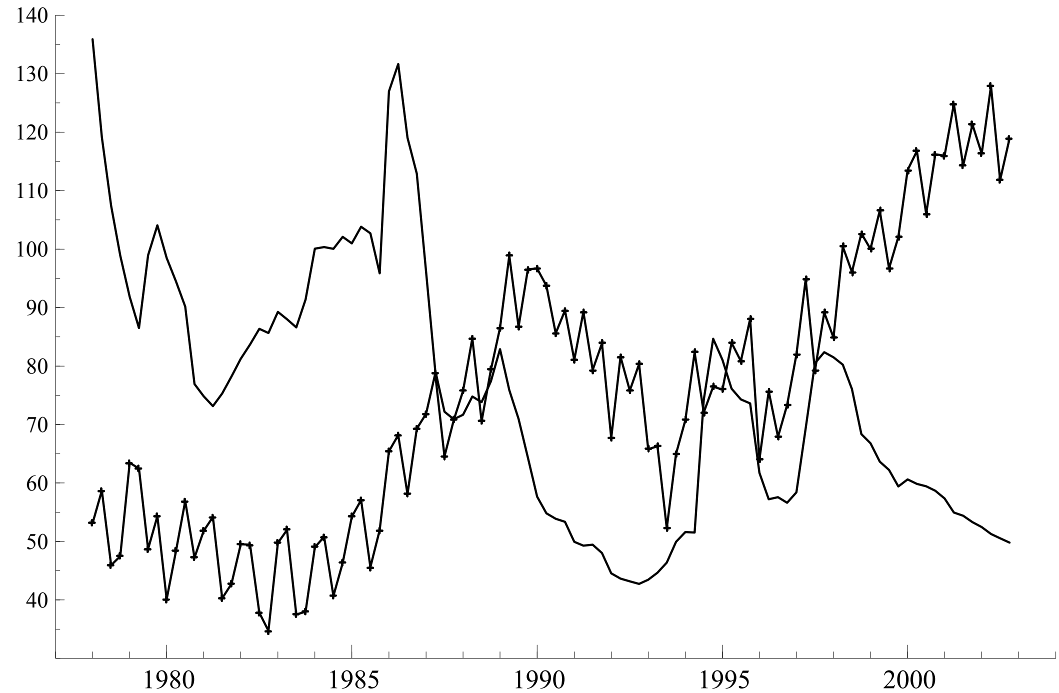

Figure 5: Real coffee price ——, and VAT-adjusted labor costs +—+—+. Labor costs are mean and variance adjusted.

4.3 Integration and Cointegration Analysis

In this section we analyze the data by testing for integration and cointegration. The purpose is to test for long-run relationships and ensure that the econometric model of demand and supply relations is stable, that is, there are no unit roots. In principle it is advisable to do the cointegration analysis for all the variables at the same time. However, in our case some of the important variables do not appear to have unit roots, and the results are more clear-cut when partial models are tested

First we confirmed that coffee consumption (*Q*) is stationary around the ratio between those born before 1960 and total population at the age of 15 years and above (*G*), a variable that is unity up to mid-1970s and then declines towards zero, which it reaches when nobody born before 1960 is alive. The results from the application of Johansen's maximum likelihood procedure for finite order vector autoregressions, here estimated with five lags and centered seasonal dummies, are summarized in

Table 2.[10] Since the age ratio behaves as a negative trend, the distribution for a restricted deterministic trend was used when testing for cointegration. The null hypothesis of non-stationarity is clearly rejected, as shown by the significance of the trace test. This conclusion is supported by the estimates of the eigenvalue of the long run matrix (0.22) and the largest root of the companion matrix (0.5). Moreover, a likelihood ratio test for the exclusion of the *G* from the stationary vector is also rejected. The long run equation is $Q = 10.37G$, implying that, for example, a drop in *G* from 0.6 to 0.5 leads to a decline in *Q* by 1037 ton of roasted coffee. Table 2 also reports several tests, showing that there is no evidence of misspecification.

Table 2: Q and G - Trace Test, Characteristic Roots and Misspecification Tests

		Vector misspecification tests		*p*-value
Eigenvalue of Π-matrix	0.22			
Trace test, $r \geq 0$	24.98	AR 1-5 test	$F(5,85) = 0.733$	0.600
p-value	0.000	Normality	$\chi^2(2) = 0.328$	0.848
Largest root of process	0.498	ARCH	$F(4,82) = 1.464$	0.220
LR test for excluding G, $\chi^2(1)$	16.04	Hetero	$F(12,77) = 0.913$	0.537
p-value	0.0001	Hetero-X	$F(27,62) = 1.092$	0.377

Standardized eigenvector β'

	Q	*G*
$\hat{\beta}_1'$	1	−10.365

Note; Five lags and centered seasonal dummies were used. The critical values for the trace test statistic are based on the distribution for unrestricted constant and restricted trend.

Including income (*Y*) in the model does not produce another stationary relation, as should be evident from Figure 1; re-estimating the model with *Q, G* and *Y* and testing for two stationary relations gave a trace test statistic of 5.95 with a probability value of 0.477. Hence, we conclude that in the long run demand for roasted coffee is driven by population dynamics in combination with a change in consumer preferences. The fact that consumer prices of coffee do not affect coffee consumption in the long run is

[10] See Johansen (1995) for details about cointegration analysis and tests implemented in this section. The cointegration tests and all other numerical results were obtained with PcGive. For the misspecification and diagnostic tests see Doornik and Hendry (1994).

an indication that competition prevented price rises during the period of our study, and that roasters did not have any long-run market power.

Table 3 reports the results for the analysis of *P* and *IP*. The autoregression consists of five lags on *P* and *IP*, unrestricted constant, centered seasonal dummies, impulse dummies for 1986:1 and 1994:3, and the first difference of 1+VAT; the level of 1+VAT is not significant and we do not report the results since it requires different critical values. The two dummy variables capture large increases in *P* and *IP.* As indicated by the misspecification tests, there is some non-normality left in the residuals. We had to accept this since it would have been necessary to use many more impulse dummies to remove all the outliers.

Table 3: *P* and *IP* - Trace Test, Characteristic Roots and Misspecification Tests

Eigenvalues of Π-matrix			Vector misspecification tests		*p*-value
Rank = 1	0.219		AR 1-5 test	$F(5,150)=1.438$	0.113
Rank = 2	0.092		Normality	$\chi^2(4) = 22.50$	0.0002
Trace test	*p*-value		Hetero	$F(60,188) = 0.655$	0.971
r ≥ 0	0.000		Hetero-X	$F(195,54) = 0.776$	0.891
r ≥ 1	0.002				
Largest roots of process	0.937	0.773			

Note: Five lags of *P* and *IP*, centered seasonal dummies, an unrestricted constant, the first difference of the (1+VAT), and impulse dummies for 1986:1 and 1994:3 were included in the model.

The trace test clearly rejects a rank of one, so both variables appear to be stationary. However, the largest root is 0.94, which is fairly high, and *P* and *IP* do not look stationary. Figure 6 reveals what is going on. It shows the two cointegrating vectors net of the short-run dynamics. Both series are stationary apart from the level shift at the end of the 1980s. Hence, *P* and *IP* appear to be non-stationary due to a structural break and do not have unit roots. Furthermore, they seem to co-break, that is, have the same structural break so a linear combination of the two variables creates a stationary series. Since real labor costs has an upward trend during most of the sample period and probably contains a unit root, it is clear that it cannot be positively correlated with P, as predicted by Equation (5) (see Figure 5). It is thus reasonable to assume that only changes in real labor costs affect coffee prices, given import prices. The model estimated in Sub-section 4.4 provides support for this assumption.

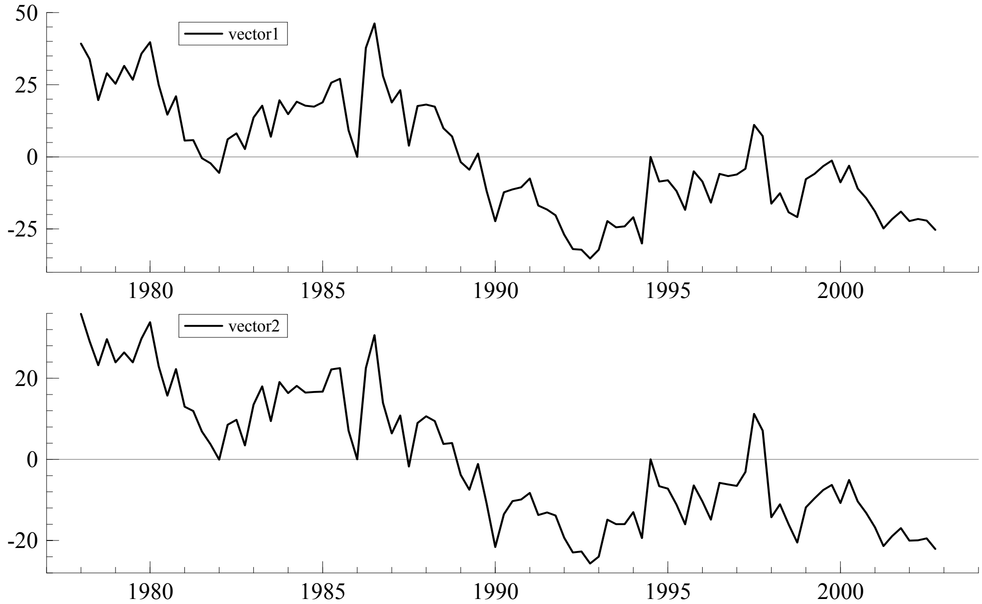

Figure 6: The two 'cointegrating' vectors cleaned of short-run dynamics.

4.4 The Empirical Model

This section reports on the development of the empirical model of coffee demand and pricing. First a general semi-reduced dynamic model is estimated and tested in order to make sure that the assumptions regarding its stochastic properties are fulfilled. The general model was specified as:

$$Q_t^* = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} Q_{t-i}^* + \sum_{i=1}^{k} \alpha_{2i} P_{t-i} + \sum_{i=1}^{k} \alpha_{3i} DP_{t-i} + \sum_{i=0}^{k} \alpha_{4i} Y_{t-i} + \varepsilon_{Qt} \qquad (7)$$

$$P_t = \beta_0 + \sum_{i=1}^{k} \beta_{1i} P_t + \sum_{i=1}^{k} \beta_{2i} Q_t^* + \sum_{i=0}^{k} \beta_{3i} IP_t + \sum_{i=0}^{k} \beta_{4i} W_t + D_t + \varepsilon_{Pt} \qquad (8)$$

where Q^* is coffee consumption net of the age effect, $Q^* = Q - 10.37G$. This formulation ensures that consumption is a stationary variable. The other variables are: P, the real price of coffee, DP,[11] an interaction dummy for P aimed at capturing the level shift occurring at the end of the 1980s, Y is income, IP, the import price of coffee multiplied by $1+VAT$, W, is labor costs per hour for manual workers multiplied by $1+VAT$, and D stands for two impulse dummies that have the value of unity in 1986:1 and 1994:3, respectively, and zeros elsewhere. The two dummy variables correct for events when sharp increases in IP created unusually large increases in P. Both equations contain intercepts and seasonal dummies, included in α_0 and β_0. The error terms, ε_Q and ε_P, are assumed to be white noise process with zero mean and constant variance.

The model is in semi-reduced form since we do not want IP to enter the function for Q*. This is because IP and P are highly correlated and IP works well as the consumer price. Note also that according to Equation 5, $1+VAT$ should enter as a separate variable in the pricing equation but we could not find that it had any explanatory power in levels or first differences. Changes in VAT have probably affected the CPI and the nominal price of coffee more or less by the same magnitudes.

Since we would like all the variables to be stationary, or be written as a mean zero stationary variables, W and Y were restricted to enter in first differences only because they have unit roots. Furthermore, DP is included in the demand equation to remove the non-stationarity from P; in the pricing equation P and IP co-break. The model was estimated with the maximum likelihood estimator, and five lags on each variable were used.

The results from the estimation are reported in Table A1 in Appendix II. Statistically the general model appears well specified; there is no evidence of vector serial correlation or vector heteroscedasticity and the residuals appear to have normal distributions. Moreover, the largest eigenvalue (modulus) of the companion matrix is 0.7, which indicates that the model is stable.

The parameters are not estimated very exactly but in the demand equation two variables have significant parameters, the first lag of the price and the change in income. Both have the expected signs. In the pricing equation, there are many more significant parameters. The contemporaneous import price has a t-value over 9, and both changes in labor costs and lagged prices have several significant parameters. Output also seems to affect pricing; the fifth lag is positive and almost significant at the 1% level. The correlation between the residuals is negative but close to zero, -.08, indicating that there is little simultaneity between *Q** and *P*.

The reduction of the general model was carried out in steps by removing the longest lag of each variable with low t-values, and then using likelihood-ratio tests and various information criteria to ascertain that no relevant information was lost. The number of parameters was reduced from 53 to 26, while the Schwartz criterion went from 10.23 to 9.20; the likelihood ratio test statistic for the reduction was $\chi^2(27)=26.33$, which has a *p*-value of 0.50 (see Table A2 in Appendix II). Hence, our

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[11] *DP* is zero from 1978:1 to 1988:4 and is the same as *P* from 1989:1 to 2002:4.

simplification seems to be statistically valid. To enhance interpretability three transformations were made in the price equation: the second and third lag of *P* were replaced by the first difference of the second lag of *P*, lagged import prices were aggregated with the relative weights of 2 to 1 (as simple Almon polynomial), and the labor cost variables were aggregated using the weights 0.15, 0.05, 0.25, 0.25, 0.15, and 0.15, which are based on the estimated coefficients.

Table 4 reports the final model and diagnostic tests, but not the seasonal dummies since they are of no interest (see Table A3 for details).[12] The demand equation shows that changes in income have a contemporaneous impact on the deviation of consumption from its trend. Moreover, a price increase reduces demand and there is a significant change in the coefficient around 1988. On average the price elasticity is -0.38 and its standard deviation is 0.14, which is roughly what studies on similar coffee markets have found.[13] The interaction dummy maintains the elasticity fairly constant across the two periods; it is -0.41 for the 1978:1 - 1988:4 and -0.37 for 1989:1 -2002:4. One piece of interesting information provided by the price elasticity is that the maximum average value of the degree of market power, θ, is 0.38, ignoring the variance of the estimate.

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[12] There is very little simultaneity in the model as evident from the correlation between the residuals; it is only –0.036 in the parsimonious model. Consequently entering *P, DP* and *Q** contemporaneously has a minor effect on the results. However, P_t has positive coefficient that is just about significant at the 5% level. Including it reduces the estimated parameter for P_{t-1}, leaving the average value of the coefficients for *P* approximately the same. DP_t and Q_t* are insignificant.

[13] Bettendorf and Verboven (2000) reported a price elasticity of -0.20 for the Netherlands and Feuerstein (2002) reported -0.18 for Germany, which is close to what other studies on German data have found. However, Koerner (2002) obtained price elasticities that varied between -1.12 and -0.59, depending on the model estimated. This was possibly because her analysis was for a period after the unification of Germany.

The pricing equation is complicated and contains more dynamics than the demand equation. There is some inertia in the pricing process since lagged consumer prices enter the model. The coefficient on the first lag is 0.62, which affects the interpretation of the other coefficients because we have to solve for P_{t-1} to find the long-run effect of a particular variable; the lagged changes in consumer prices, which enter lagged two periods, only affect the short-run dynamics. Import prices have a strong contemporaneous impact on the consumer price, but some of the increase is moderated by a negative coefficient on lagged import prices. In the long run a rise in the import price by 1 krona leads to an increase in the consumer price by 1.14 kronor, which is close to the technical ratio between beans and roasted coffee, i.e., 1.19. Changes in real labor costs also raise the consumer price but the process runs over several quarters; if growth in labor costs per hour increases by 1 krona, the consumer price will have risen by 1.6 kronor after five quarters. The impact of a permanent increase in the growth of real labor costs by 1 krona is 4.32, which should be related to the average growth that is 0.36 kronor per quarter.

For the evaluation of market power, the parameter of Q^* is of primary interest. It is clearly significant, its t-value is 3.2, and positive as expected if there is market power. To calculate θ we first solved the price equation for the lag to obtain the static state (long run) solution. This gave a coefficient of 0.66 for Q^*. The degree of market power for 1978:1 - 1988:4 is thus 0.042 x 0.66 = 0.028 and for 1989:1 -2002:4 it is 0.061 x 0.66 =0.040. With information on the price elasticity and the degree of market power we can calculate the Lerner index. It shows that the mark-up over marginal costs is about 10%. This is clearly less than what we would expect for Cournot competition; the Lerner index estimated with actual market shares is 0.17.[14]

Table 4: Final Model

$$Q^*_t = -\underset{[0.011]}{0.042}P_{t-1} - \underset{[0.008]}{0.019}Pdum_{t-1} + \underset{[0.38]}{0.9}\Delta Y_t + \underset{[1]}{14} + \underset{[1.8]}{2.2}S_{1t} + \underset{[0.92]}{0.27}S_{2t} + \underset{[1.8]}{1.1}S_{3t}$$

$$P_t = \underset{[0.077]}{0.25}Q^*_{t-5} + \underset{[0.037]}{0.62}P_{t-1} - \underset{[0.045]}{0.25}\Delta P_{t-2} + \underset{[0.032]}{0.71}IP_t - \underset{[0.022]}{0.17}\left(\frac{2}{3}IP_{t-3} + \frac{1}{3}IP_{t-4}\right) + \underset{[0.23]}{1.6}\Delta Ww + \underset{[2]}{24}Dum861$$

$$+ \underset{[2.1]}{11}Dum943 + \underset{[1.5]}{9.5} - \underset{[0.61]}{0.26}\,S_{1t} - \underset{[0.56]}{1.1}\,S_{2t} + \underset{[0.59]}{1.1}\,S_{3t}$$

Note: $\Delta Ww = 0.15\Delta W_t + 0.05\Delta W_{t-1} + 0.25\Delta W_{t-2} + 0.25\Delta W_{t-3} + 0.15\Delta W_{t-4} + 0.15\Delta W_{t-5}$

Estimation method: FIML, Estimation sample: 1978:1 – 2002:4

Vector AR 1-5 test: $F(20,160) = 0.686$ [0.836]
Vector Normality test: $\chi^2(4) = 0.806$ [0.937]
Vector Hetero test: $F(144,120) = 0.899$ [0.729]

Test of model reduction; General to Final model: $\chi^2(34) = 29.76$ [0.676]

Information Criteria:

Model	SC	HQ	AIC
General	10.225	9.403	8.844
Final	8.957	8.662	8.462

Correlation and standard deviations of residuals

	Q*	P
Q*	1.911	-0.036
P	-0.036	1.916

Note that we have assumed constant returns to scale, i.e., that marginal cost does not depend on Q^*. Although commonly made, the assumption could be wrong. In our case this would bias our estimate of market power upwards, which is not a problem since we found it to be low. Hence, we can conclude that the degree of market power

[14] The Lerner index for Cournot competition was calculated as $\frac{\theta}{\varepsilon_{QP}}H$ where H is the Herfindahl index and ε_{QP} is the absolute value of the price elasticity of demand (see Martin, 2002, p. 338)

in the Swedish market for roasted coffee seems to be small. Moreover, it is short- run in the sense that it does not affect the trend in coffee consumption.

4.5 Diagnostic Tests

To evaluate the statistical properties of the model, several tests were implemented. Table 4 reports test statistics on the residuals and none of the tests for autocorrelation, heteroscedasticity and non-normality is significant. Furthermore, the likelihood ratio test for reducing the number of parameters by 34 is insignificant.

By estimating the model recursively its empirical constancy was assessed. The output from this exercise is summarized in graphs for the period 1988:1 – 2002:4. In the upper panel of Figure 7 the one-step residuals and their ±2 standard errors are depicted; since all the estimates are within the standard error region there is no indication of outliers. In the right corner of the upper panel, the log-likelihood value divided by the number of observation is graphed. It declines smoothly. The other three panels in Figure 7 reports test statistics from three Chow tests, 1-step, break-point and forecast Chow tests on each equation and jointly for the model. They are graphed such that the straight line matches the 5% significance level. No Chow test statistic is significant at the 5% level.

Finally we re-estimated the model over 1978.1 – 1998:4 and carried out dynamic forecasts up to 2002:4. The forecasts together with ±2 standard errors are depicted in Figure 8. All forecasts lie within their 95% confidence intervals. Hence, we conclude that the stability of the model is satisfactory.

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version)

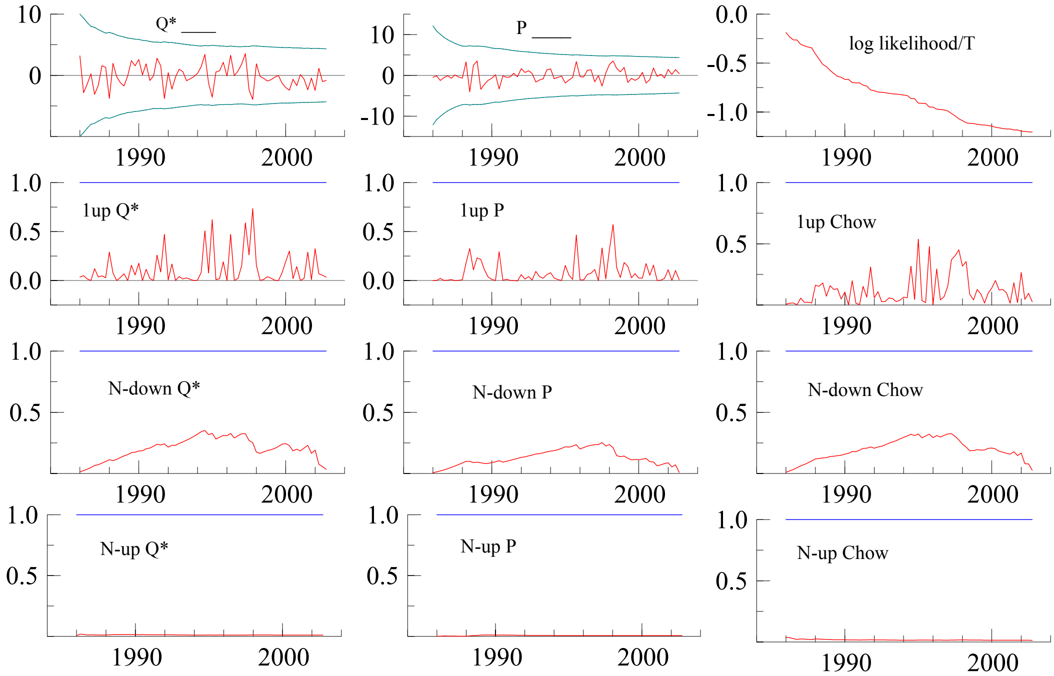

Figure 7: One-step residual with ± 2 estimated standard errors, the log-likelihood value divided by the total number of observation, one-step (1-up), break-point (N-down) and forecast (N-up) Chow statistics for each equation and for the whole model scaled with their 5% critical values. The straight line at unity shows the 5% critical level.

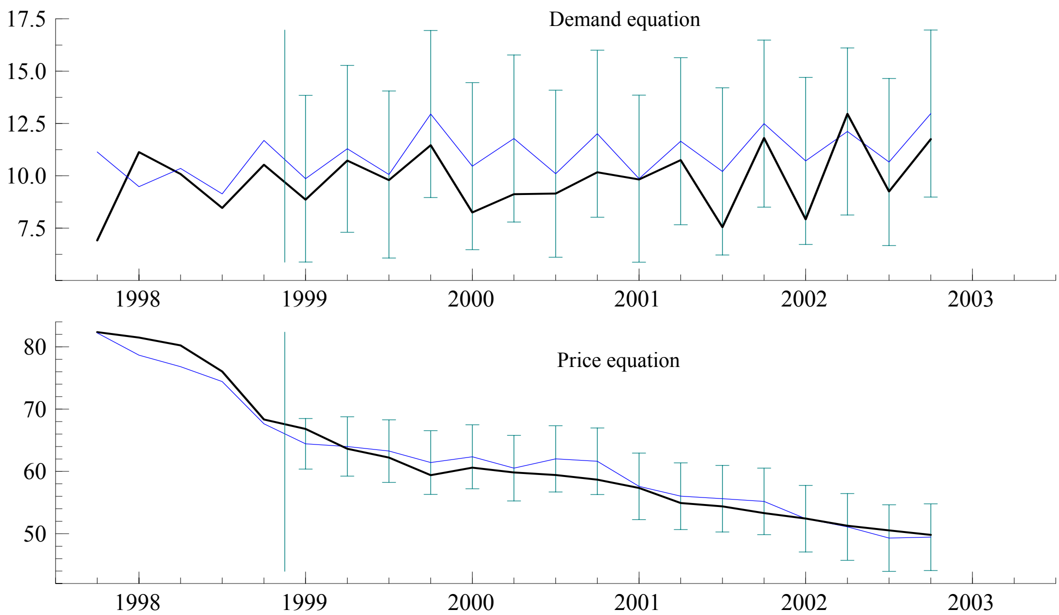

Figure 8: Dynamic forecasts over 1999:1 -2002:4 with ± 2 estimated forecast standard errors. Forecast —— Actual data ——.

8. Concluding Remarks

The objective of this study was to estimate the degree of market power in the Swedish market for roasted coffee. To this end, a dynamic model of coffee demand and pricing was developed and its long-run solution was interpreted in the light of the static model of conjectural variation. The resulting model is parsimonious and empirically stable, and has parameters that make sense economically. It should be noted, however, that the stability was achieved with the inclusion of two impulse dummy variables capturing unusually large increases in the consumer price in response to exceptionally large increases in the import price of coffee beans.

Our key finding is that coffee roasters do not have any market power in the long run since the price of coffee did not influence the trend in coffee consumption over the period analyzed, 1978:1 – 2002:4. If there had been firms with long-run market power, they would have made sure prices had affected demand, and the estimated price elasticity would not have been zero. Long-run demand for roasted coffee appears to be determined by population dynamics in combination with changes in preferences across cohorts.

We did find some evidence of market power in the short run, however. The degree of market power is estimated to about 0.03 to 0.04, which is low since a value of unity corresponds to monopoly power. The Lerner index, which measures the mark-up over marginal costs, was estimated to be about 10%. It was calculated using the average price elasticity, -0.38, obtained when controlling for population dynamics. For a comparison, the Lerner index based on Cournot competition and actual market shares was calculated to be 17%. Hence, we do no find evidence that large actors in the market for roasted coffee in Sweden have a substantial amount of market power.

There are some weaknesses in this study that are worth mentioning. First, it does not distinguish between producers and retailers, and it is possible that the finding of market power is due to lack of competition among the retailers, and not among the roasters. Second, since advertising and branding is common in markets for roasted coffee there should be some short-run market power at least, and this may not be captured by an analysis that treats coffee as a homogenous good. Third, some roasters might be able to exercise market power in regional markets, which is might not be detected with aggregate data. Unfortunately time series data on prices and quantities for individual brands, regional sales, etc, needed for addressing these issues are difficult to obtain. Finally, the analysis is based on a theoretical model that might not capture the characteristics of the coffee market adequately (see Corts, 1999). However, the data analysis provides information that is of interest independently of the theory-based interpretation. In any case, it seems reasonable to believe that disaggregated data applied to other models would not alter the general thrust of the analysis of market data.

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Appendix I: Description of Data

The following variables have been used in the empirical analysis:

Imports and exports of coffee, green and roasted in volume and value terms
The data are from the International Coffee Organization and Statistics Sweden.

Income
Income is measured as household expenditures. Source: International Financial Statistics database of the IMF.

Consumer price of coffee
Price per kilo of roasted coffee. The price is based on 500-gram packets. Source: Statistics Sweden.

Consumer price index (CPI)
CPI is from the International Financial Statistics database of the IMF.

Consumption of Roasted Coffee
The quarterly series was obtained with the Denton technique by combining the yearly data on consumption from the Swedish Board of Agriculture with quarterly observation on net imports of coffee beans and weight-adjusted roasted coffee. See Bloem et al (2001) for details on the Denton technique.

Labor costs
Labor cost per hour for manual worker in the food and beverage industry. Source: Statistics Sweden

Population
The demographic data are from The International Data Base (IDB), U.S. Bureau of the Census. The yearly data was interpolated to obtain quarterly observations.

VAT
Data from the European Commission (2002b)

Appendix II: Regression Results

Table A1: General Model

Eq. for *Q**	Coeff.	Std. Errr	t-value	Eq. for *P*	Coeff	Std. Err	t-value
Q*_1	0.024	0.121	0.201	Q*_1	-0.070	0.135	-0.519
Q*_2	-0.068	0.116	-0.585	Q*_2	0.037	0.127	0.289
Q*_3	-0.001	0.116	-0.006	Q*_3	-0.119	0.122	-0.978
Q*_4	0.046	0.097	0.474	Q*_4	0.023	0.111	0.209
Q*_5	0.016	0.094	0.170	Q*_5	0.262	0.103	2.540
P_1	-0.093	0.043	-2.180	P_1	0.726	0.080	9.080
P_2	0.040	0.074	0.542	P_2	-0.294	0.093	-3.150
P_3	0.050	0.076	0.652	P_3	0.307	0.092	3.330
P_4	-0.089	0.071	-1.260	P_4	-0.227	0.104	-2.180
P_5	0.051	0.041	1.230	P_5	0.093	0.071	1.310
ΔY	1.075	0.483	2.230	IP	0.686	0.069	9.960
ΔY_1	-0.086	0.482	-0.178	IP_1	-0.074	0.108	-0.690
ΔY_2	0.007	0.478	0.015	IP_2	-0.062	0.110	-0.565
ΔY_3	-0.560	0.454	-1.240	IP_3	-0.088	0.104	-0.851
ΔY_4	-0.085	0.450	-0.190	IP_4	-0.010	0.088	-0.116
ΔY_5	-0.288	0.463	-0.622	IP_5	0.006	0.073	0.077
PDUM_1	-0.028	0.024	-1.150	ΔW	0.301	0.076	3.960
PDUM_2	0.022	0.033	0.668	ΔW_1	0.121	0.082	1.470
PDUM_3	-0.002	0.033	-0.057	ΔW_2	0.377	0.084	4.490
PDUM_4	0.028	0.034	0.827	ΔW_3	0.323	0.087	3.710
PDUM_5	-0.038	0.024	-1.560	ΔW_4	0.308	0.080	3.840
Constant	13.982	3.748	3.730	ΔW_5	0.223	0.078	2.850
S_1	5.491	4.251	1.290	Dum861	23.220	2.500	9.290
S_2	0.569	1.215	0.468	Dum943	11.046	2.318	4.770
S_3	5.085	4.048	1.260	Constant	11.453	3.835	2.990
$\hat{\sigma}$ = 1.957				S_1	0.228	1.209	0.189
				S_2	-2.104	0.915	-2.300
				S_3	2.558	1.239	2.060
				$\hat{\sigma}$ = 1.988			

Method of estimation: FIML, Sample: 1978(1) to 2002(4)

No. of observations 100, No. of parameters 53

Correlation of structural residuals (standard deviations on diagonal)

	Q*	P
Q*	1.957	-0.080
P	-0.080	1.988

Vector EGE-AR 1-5 test: F(20,126)= 1.0573 [0.4026]
Vector Normality test: Chi^2(4) = 2.5750 [0.6313]
Vector hetero test: F(210,3) = 0.049978 [1.0000]

Largest four eigenvalues (modulus) of companion matrix: 0.704, 0.704, 0.696, 0.691

Table A2: Parsimonious Model

Eq. for: Q*	Coeff	Std.Err	t-value	Eq. for *P*	Coeff	Std.Err	t-value
P_1	-0.042	0.011	-3.860	Q*_5	0.220	0.085	2.600
ΔY	0.903	0.390	2.320	P_1	0.627	0.062	10.100
PDUM_1	-0.018	0.008	-2.350	P_2	-0.258	0.066	-3.940
Constant	14.252	1.023	13.900	P_3	0.217	0.056	3.890
S_1	2.186	1.883	1.160	IP	0.698	0.043	16.100
S_2	0.274	0.944	0.291	IP_3	-0.132	0.056	-2.330
S_3	1.163	1.811	0.642	IP_4	-0.083	0.035	-2.370
$\hat{\sigma}$ = 1.954				ΔW	0.298	0.070	4.260
				ΔW_1	0.128	0.078	1.630
				ΔW_2	0.409	0.078	5.270
				ΔW_3	0.397	0.078	5.080
				ΔW_4	0.322	0.076	4.220
				ΔW_5	0.276	0.072	3.810
				Dum861	23.848	2.174	11.000
				Dum943	10.559	2.173	4.860
				Constant	11.000	2.031	5.420
				S_1	-0.463	0.996	-0.465
				S_2	-1.646	0.806	-2.040
				S_3	1.533	1.023	1.500
				$\hat{\sigma}$ = 1.925			

Method of estimation: FIML, Sample: 1978(1) to 2002(4)

No. of observations 100, No. of parameters 26

Correlation of structural residuals (standard deviations on diagonal)

	Q*	P
Q*	1.955	0.006
P	0.006	1.926

Progress to date

Model	parameters	SC	HQ	AIC
General Model	53	10.225	9.403	8.844
Parsimonious Model	26	9.245	8.842	8.567

Tests of model reduction,

General to Parsimonious: $\chi^2(27)$= 26.335 [0.500]

Table A3: Final model

Eq. for *Q**	Coeff.	Std.Err	t-value	Eq. for *P*	Coeff	Std.Err	t-value
P_1	-0.042	0.011	-3.960	Q*_5	0.254	0.077	3.270
ΔY	0.899	0.381	2.360	P_1	0.619	0.037	16.600
PDUM	-0.019	0.008	-2.430	ΔP_2	-0.250	0.045	-5.500
Constant	14.275	1.000	14.300	IP	0.705	0.032	22.100
S_1	2.171	1.840	1.180	IP34	-0.171	0.022	-7.910
S_2	0.268	0.922	0.291	ΔWw	1.611	0.227	7.100
S_3	1.149	1.770	0.649	Dum861	24.395	2.041	12.000
$\hat{\sigma}$ = 1.911				Dum943	10.777	2.067	5.210
				Constant	9.509	1.546	6.150
				S_1	-0.255	0.612	-0.417
				S_2	-1.136	0.560	-2.030
				S_3	1.066	0.591	1.800
				$\hat{\sigma}$ = 1.916			

Notes: $\Delta Ww = 0.15\Delta W_t + 0.05\Delta W_{t-1} + 0.25\Delta W_{t-2} + 0.25\Delta W_{t-3} + 0.15\Delta W_{t-4} + 0.15\Delta W_{t-5}$ and $IP34 = 2/3IP_{t-2} + 1/3IP_{t-3}$

Method of estimation: FIML, Sample: 1978(1) to 2002(4)

No. of observations 100, No. of parameters 19

Correlation of structural residuals

	Q*	P
Q*	1.911	-0.036
P	-0.036	1.916

Vector EGE-AR 1-5 test: F(20,160) = 0.686 [0.836]

Vector Normality test: $\chi^2(4)$ = 0.806 [0.938]

Vector hetero test: F(144,120) = 0.899 [0.730]

Progress to date

Model	parameters	SC	HQ	AIC
General Model	53	10.225	9.403	8.844
Parsimonious Model	26	9.245	8.842	8.567
Final model	19	8.957	8.662	8.462

Tests of model reduction,

General to Parsimonious: $\chi^2(27)$ = 26.335 [0.500]

General to Final: $\chi^2(34)$ = 29.756 [0.675]

Parsimonious to Final: $\chi^2(7)$ = 3.421 [0.843]