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Estimating Market Power in the Swiss Petrol Retailing Industry – A New Empirical Industrial Organisation Approach

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Several competition authorities have accused petrol retailers of engaging in collusive conduct, which results in alleged "excessive" prices as well as simultaneous price setting across filling stations. However, petrol retailers must exert a substantial amount of market power if they are to dampen competition. Therefore, we propose a method within the spirit of the New-Empirical-Industrial-Organisation, which allows estimating market power held by petrol retailers in terms of a conduct parameter. Based on data for Switzerland, our empirical results suggest a low level of market power held by Swiss petrol retailers.

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JEL-Codes: L41, L71

1 Introduction

Petrol prices get substantial public attention, especially during periods characterised by pronounced increases. As a consequence, competition authorities frequently receive complaints about "excessive" petrol prices and collusion believed to exist among retailers initiating in depth antitrust enquiries in several countries during the last 10 years. The findings were quite different and can roughly be categorised into three groups. Some authorities such as that of Switzerlands Wettbewerbskommission or the British Office of Fair Trading concluded that their petrol markets are competitive, meaning that price changes and differences in prices among regions and filling stations reflect market conditions. Others, such as the German Bundeskartellamt or the Dutch Mededingingsautoriteit found infringements with regard to vertical constraints, applied by petrol companies operating on several stages of the chain of petrol-production. Only few authorities identified cartels, in the sense of horizontal agreements on prices. Examples include

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the French Conseil de la Concurrence, the Italian Autorita Garanta della Concurrenza e del Mercato and especially the Swedish Konkurrensverket, which found compelling evidence of five companies agreeing among themselves on price levels during the late 1990s, when it swooped on companies' offices.

While assessing the competitive conditions in an industry, market power lies at the core of any enquiry launched by competition authorities, regardless if one deals with abuses of a dominant position, collusion, or merger control. In general, firms must have both the willingness and the ability to exert market power if they are to substantially distort competition. Anticompetitive behaviour would otherwise be subject to erosion of business towards incumbent firms or even prompt market entry by potential competitors.

Competition authorities usually distinguish between market power held non-cooperatively by a single firm and overt or tacit collusion among several firms. We use the term "market power" in its comprehensive sense, referring to the ability of firms to unilaterally or collusively raise price above competitive levels. Then, market power can be interpreted as an indicator for the intensity of competition.

The mere fact that competing filling stations charge similar or even identical prices, does in the present scenario not necessarily imply that collusive agreements exist within the industry. Rather, due to the high degree of price transparency and product homogeneity, identical prices may result under competitive as well as collusive conditions. Hence, a simple comparison of price setting strategies by different retailers will not provide useful insight for testing hypotheses about market power. Therefore, the motivation underlying the present paper consists of developing a more sophisticated technique in order to obtain an empirical estimate for market power held in the petrol retailing industry. Importantly, standard oligopoly models will serve as theoretical underpinning for our empirical results, meanwhile discrepancies between theoretically expected and empirically estimated market power provide a clue for collusive conduct.

Our results rest on the example of the Swiss petrol retailing industry and relate closely to the corresponding enquiry lead by the Swiss Competition Commission (WETTBEWERBSKOMMISSION 2002). In principle however, the present approach may be reapplied to any other geographic (petrol) retailing market.

In early studies looking at the petrol retailing industry, (MARVEL 1976, 1978) finds collusive price setting on regional petrol markets in the United States. Within a dynamic framework, SLADE (1992) investigates the daily pricing-strategies of filling stations in Vancouver. BORENSTEIN and SHEPARD (1996) found market conduct consistent with tacit collusion in their study comparing American cities. Previous examples looking at Switzerland include KIRCHGÄSSNER (1994), who applied co-integration techniques to Rotterdam prices for oil and petrol, taxes, and consumer prices for petrol and heating oil uncovering anti-competitively high impacts from tax increases.

Our methodology draws on GENESOVE and MULLIN (1998), who analyse the United States' sugar industry. They rely on the hypothesis of static oligopoly behaviour and work with data from 1890 to 1914, which enables to validate the approach before and after the trusts dominating this industry broke down. It is worth stressing that, contrary to our case, GENESOVE and MULLIN (1998) knew ex ante about existing overt collusion on the sugar market, which puts them in a position to directly verify the market outcome predicted by their model and confirm the reliability of their method.

The paper is organised by moving from general to specific as well as from theoretical to empirical issues. The next section briefly presents the structure of the Swiss petrol industry. Section 3 presents a static oligopoly model augmented with conjectural variations to analyse the petrol retailing market and to serve as theoretical underpinning for the empirical results within a framework of New-Empirical-Industrial-Organisation (NEIO). Turning to the actual assessment of market power, section 4 presents the analysis of the demand and supply side and finally combines the corresponding results into a conduct parameter measuring industry market power whilst taking into account econometric issues such as endogeneity or the non-stationary character of the data. The final section provides some concluding remarks.

2 The Swiss Petrol Retailing Industry

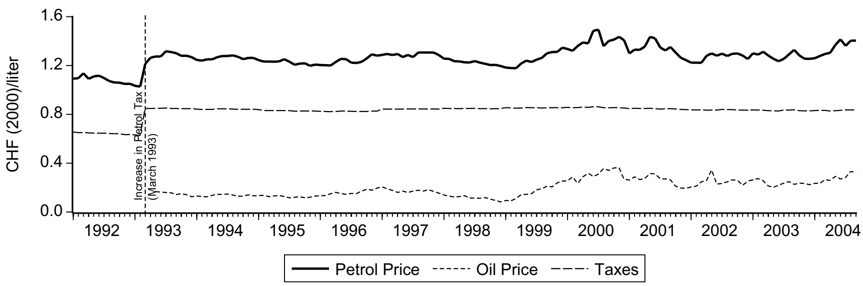
Owing to the lack of worthwhile exploitable oil, Switzerland is completely dependent on importing oil from abroad. Oil and oil products are typically imported via the ports of Genoa, Marseille, and most of all Rotterdam. Moreover, with a limited capacity of 2 refineries, which cover less than one third of consumption, most oil products consumed in Switzerland are refined around Rotterdam or somewhere along the Rhine (figures: ERDÖLVEREINI-

GUNG 2005). Consequently, the spot market for petrol products in Rotterdam serves as reference for pricing decisions taken in Switzerland.

In the year 2004, about 18 companies competed in petrol retailing on the Swiss market. However, only 8 retailers reach market shares between 5%–15% as measured by the number of outlets relative to the total number of about 3'500 filling stations. Furthermore, there existed around 700 independent "white pumpers" selling non-branded petrol (figures: ERDÖLVEREINIGUNG 2005). Compared with other European countries, the Swiss petrol-retailing industry is less concentrated. Furthermore, the density of petrol stations is exceptionally high, even though the last few years saw a decline especially in terms of white pumpers and stations in remote areas. Nevertheless, after adjusting for the comparatively modest tax burden, pretax prices are not higher compared with neighbouring countries.

Figure 1 depicts average petrol prices from January 1992 until September 2004 revealing their close relationship with corresponding oil prices on the Rotterdam spot market. Noteworthy is the substantial tax increase in 1993 with inflation tending, however, to decrease the real tax burden slightly throughout the remaining period. Still, in terms of levels, taxes account for about two thirds of the final price. Conversely, changes in average petrol prices result from fluctuations in oil prices and exchange rates, rather than taxes.

Figure 1: Price Structure for Petrol



In respect to the – for antitrust litigation crucial – step of market definition, petrol retailing undoubtedly constitutes the product market in the present case. Conversely, as regards the geographic dimension in retailing, the national market might be broken down into several regional sub-markets. However, even though the actual demand of final consumers is typically linked on their residence and therefore regionally restricted, most competition authorities focus heavily on the competitive conditions on the national market for the following two reasons. Firstly, regional markets regularly overlap, which can lead to so called "chains of substitution" across wider areas with somewhat blurred boundaries. Consequently, an exact market definition based on regions is out of scope. Secondly, petrol-retailers compete as suppliers of national distribution networks. Hence, reducing the focus on stations across the road would leave major competitive forces of any retailing industry unattended. For example, regional markets are in general easily contestable, as barriers preventing entry from neighbouring markets are typically low. Conversely, entering a national market is a riskier project involving considerably more investment. Due to these considerations, the following analysis will deal with market power on a national basis.

3 New Empirical Industrial Organisation and the Structural Model

The present study has been conducted within the spirit of the NEIO, where market power is inferred from conduct rather than attributed to industry structure, and price cost margins are considered to be unobservable since marginal costs cannot be extracted directly from accounting data. Instead, information on marginal costs is inferred indirectly by observing firms' conduct on related upstream markets. Meanwhile, standard oligopoly models serve as structural underpinning for empirical results.[1]

With about eight out of a total of 18 companies holding a distribution network of significant size, the market for petrol retailing in Switzerland has an oligopolistic structure. In particular, we consider a Cournot-Nash type of oligopoly augmented with conjectural variations, where retailers choose quantities as strategic variables and each retailer holds some wider conjectures about behavioural responses of rivals after adapting his own strategy. Following Kreps and Scheinkman's (1983) approach to the Cournot-Nash oligopoly, capacity constraints inherent in the available infrastructure to extract, refine, or retail oil as well as petrol serve as theoretical underpinning for considering quantities instead of prices as strategic variables. The advantages of introducing conjectural variations are twofold: firstly, the standard Cournot-Nash approach constitutes a special case, where conjectural variations equal 0, meaning retailers do not expect alterations in ri-

1 Aside from Genesove and Mullin's (1998) analysis of the sugar market, other studies within the spirit of NEIO include Fabra and Toro (2005) (electricity), Nevo (2001) (cereals), Porter (1993) (rail freight), or Breshnahan (1981) (automobile). Breshnahan (1989) contains an overview of the NEIO.

vals' behaviour. This is equivalent to ruling out cooperative or collusive conduct meaning petrol retailers would by assumption never attempt to jointly push price above competitive levels. Secondly, conjectural variations broaden up the cover of the model to the entire range of market performance from perfectly competitive to monopoly outcomes, which makes them suitable in guiding the specification of empirical research in industrial economics.

Petrol company *i* maximises its individual profit by retailing quantity q_i with corresponding cost $c(q_i)$:

$$(1) \quad \pi_i = P(Q(q_i, Q_{-i}))q_i - c(q_i) \qquad \text{for} \quad i = 1, \ldots, n$$

P is the market price for petrol, *Q* denotes the quantity retailed by the entire petrol industry meanwhile Q_{-i} reflects the quantity retailed by all companies but company *i*. The profit maximising first order condition[2] is given by

$$(2) \quad \frac{P - mc_i}{P} = \frac{s_i}{\mid \eta \mid}(1 + v_i) \qquad \text{for} \quad i = 1, \ldots, n$$

where η denotes the industry elasticity of demand, mc_i reflects marginal costs, which is assumed to be constant, and $v_i \equiv \frac{\partial Q_{-i}}{\partial q_i}$ is the conjectural variation, e.g. the quantity adjustment that petrol retailer *i* expects competitors to undertake in response to its own quantity adjustment. The above pricing-rule states that the mark-up a petrol retailer can impose in terms of its LERNER-index, depends positively on market share, s_i, and conjectural variations and negatively on the absolute value of the industry elasticity of demand. Rearranging (2) yields the following concise notation:

$$(3) \quad \theta_i = \frac{P - mc_i}{P} \mid \eta \mid = s_i(1 + v_i) \qquad \text{for} \quad i = 1, \ldots, n$$

The elasticity adjusted LERNER-index, as summarised in the conduct parameter θ_i, relates to market share (s_i) and the beliefs held about the behaviour of competing petrol retailers (v_i). As long as no specific assumptions are imposed on conjectural variations, there is an infinite number of possible market equilibriums. However, the COURNOT-NASH oligopoly as well as the limiting cases of perfect competition and perfect monopoly respectively perfect collusion provide useful references. Under monopoly or perfect col-

2 Second order conditions are met as long as profits are concave in quantities $\left(\frac{\partial^2 \pi}{\partial q_i^2}\right)$.

lusion the conduct parameter, θ_i, adopts its maximal value of 1. Then, either the monopolist controls the entire market ($s_i = 1$) and deviating competitors do not exist ($vi = 0$), or perfect collusion reproduces the monopoly outcome by agreeing on conjectural variations ($v_i = (1 - s_i)/s_i$), which bring about the highest feasible mark-up. In the COURNOT-NASH case with $v_i = 0$ by assumption, market power of petrol retailers declines with lower market share and a lower number of competitors. Under symmetric cost conditions this decline occurs at a rate of $s_i = 1/n$. After relaxing assumptions about symmetry, the drop in market power depends, furthermore, on the distribution of market share and cost within the industry. In the limiting case of perfect competition, petrol companies are unable to exert any market power, which is reflected in the conduct parameter θ_i adopting a value of 0. Here, each petrol retailer expects changes in quantities to be completely offset by the reactions of adapting competitors ($v_i = -1$).

Pre-multiplying both sides of equation (2) by market share s_i and adding up first order conditions over all petrol retailers $i = 1, \dots, n$ yields the industry pricing rule, bearing in mind that the sum of market share within an industry equals 1 and the sum of squared market share defines the HERFINDAHL-HIRSCHMAN concentration index $(HHI = \sum_i si^2)$:

$$(4) \quad \frac{P - \overline{MC}}{P} = \frac{HHI + \sum_i^n s_i v_i}{\mid \eta \mid} = \frac{\overline{\theta}}{\mid \eta \mid}$$

Generally, this pricing-rule relates the weighted average industry price cost mark-up (industry LERNER-index) to the interaction of industry concentration (HHI) and a summary measure of conjectural variations relative to market share. Again, these factors can be summarised into a conduct parameter ($\overline{\theta}$), which reflects market power as defined during the outset, in terms of the industries' ability to maintain price above competitive levels adjusted by the industry elasticity of demand ($|\eta|$). Equation (4) will serve as reference for the following empirical analysis.

4 Market Power among Petrol Retailers

Based on the structural model of section 3, we endeavour to estimate the conduct parameter $\overline{\theta}$ on the Swiss petrol retailing market.

Measuring market power in the Swiss petrol retailing industry requires first of all data on the consumption (Q) and prices of petrol at the filling stations (PPET). Aside from price, covariates affecting petrol demand include the number of registered passenger cars (CARS) and from a functional perspective on traffic, factors attributed to procurement (PROCUREMENT), leisure activities (LEISURE), and business related traffic (BUSINESS). The cost for petrol depends heavily on the price for crude oil (POIL). Furthermore, taxes (TAX) constitute the biggest cost factor whilst retailing petrol.

Table 6 of the appendix contains a detailed description of all time series including their sources, meanwhile table 1 reports summary statistics of the data set.

Table 1: Summary Statistics

Variable	Q	PPET	POIL	Cars	Business	Proc.	Leisure
Unit	Tons	CHF/l.	CHF/l.	Mio.	Index	Index	Mio.
Mean	290'734	1.28	0.20	3.45	52.8	817	2.69
Std.	40'279	0.06	0.07	0.21	6.03	84	0.73
Min.	202'224	1.18	0.18	3.11	39.7	690	1.23
Max.	370'498	1.49	0.36	3.81	65.6	1'070	4.23
N	131	137	137	130	117	134	114
	Correlation Matrix (Based on 93 Common Observations)						
	Q	PPET	POIL	Cars	Business	Proc.	Leisure
PPET	0.52						
POIL	0.58	0.87					
CARS	0.72	0.52	0.72				
BUSINESS	0.13	0.38	0.19	–0.16			
PROCUREMENT	0.32	0.17	0.18	0.29	–0.01		
LEISURE	0.13	0.09	0.11	0.13	0.08	–0.42	
TAX	0.58	0.53	0.40	0.48	0.51	0.13	0.13

Variable Definitions: Q: quantity consumed of unleaded petrol, PPET: petrol price, POIL: oil price, CARS: number of registered passenger cars, BUSINESS: purchasing managers index, PROCUREMENT: retail index, LEISURE: number of overnight stays in hotels, TAX: total taxes levied on petrol.

All variables have been collected on a monthly basis with time series starting in May 1993 and ending in September 2004 with a maximum of 137 observations. The reason for not collecting data further back in time lies firstly in a substantial tax increase of 0.2 CHF/l, which was introduced in spring 1993 (see figure 1). Secondly, Q and PPET relate exclusively to unleaded petrol, which has started to replace leaded petrol in Switzerland from about the end of the 1980s onwards. Therefore, by collecting data only after 1993 possible structural instability within time series may be mitigated against. Price and cost data have been converted into real Swiss Francs (CHF) by dividing through the consumer price index (May 2000 = 100) and the nominal exchange rate.

Econometric Issues

The following demand-supply system provides a stylised econometric model for the petrol retailing industry, with W and Z denoting factors shifting respectively demand and cost aside from prices for petrol (PPET) and oil (POIL):

$$\text{(5)}\quad \begin{array}{ll} \text{Demand} & Q = f^d(PPET, W) \\ \text{Supply} & PPET = f^s(POIL, Z) \end{array}$$

Whilst estimating (5), pitfalls arise from the simultaneity of the equation system and the widely non-stationary character of the variables involved.

Econometrically, the interdependence between demand and supply results in an identification problem, with price being an endogenous variable within a system of two simultaneous equations.[3] Hence, estimating the demand or supply relation in isolation could lead to correlation between stochastic components and deterministic regressors, which can be circumvented by employing instrumental variables (IV).

In general, explicit structural models of industry equilibrium, like the present Cournot oligopoly augmented with conjectural variations, provide estimated parameters with a clear economic interpretation and results dropping out of the theoretical framework serve as clues for shortcomings in adopted functional forms, parameterisations or variables. Yet, statistical testing may only provide limited support for choices about the parameterisation of demand (f^d) or supply (f^s) functions, since such a test could implicitly impose a simultaneous hypothesis upon the level of market power (VARIAN, 1983). Then one cannot distinguish rejecting a hypothesis about the functional form from rejecting a hypothesis about the level of market power. To overcome this dilemma and to perform robustness checks, we consider a variety of possible parameterisations for demand and supply functions.

Petrol and oil prices tend to wander about without any tendency to revert to a fixed mean. Moreover, the number of registered cars, petrol consumption, and the retail index increased steadily over time. Thus, present series are likely to be non-stationary exhibiting deterministic or stochastic trends. Indeed, AUGMENTED-DICKEY-FULLER (ADF) tests reported in table 2 do not allow rejecting the null-hypothesis of series containing a unit root (sto-

3 See BRESHNAHAN (1989) for an overview of problems on endogeneity and simultaneity while estimating market power.

chastic trend) for all series but CARS, where the trend can be attributed to a deterministic component. The bottom panel of table 2 reveals that for the remaining series taking differences produces stationarity, after implying variables to be integrated of order one (*I(1)*), e.g. series are stationary around their change. Some of the analysis beneath applies logarithmic transformations to factors attributed to the demand and supply for petrol. Aside from quantitative changes in test statistics, the spirit of the results reported in table 2 carries over onto such transformations. For the sake of brevity, the corresponding statistics are not reported here.

Table 2: AUGMENTED DICKEY FULLER Test (ADF)

Levels **Variable**	**Q**	**PPET**	**POIL**	**CARS**	**BUS.**	**PROC.**	**LEIS.**	**TAX**
Specification	Interc.	Interc. Trend	Interc.	Interc. Trend	Interc.	Interc. Trend	Interc.	
Lag	2	0	0	12	0	12	12	0
ADF Statistic	–2.87	–2.51	–1.57	–4.81	–2.64	–0.29	–1.16	–1.80
Critical Value	–3.45	–2.88	–2.88	–3.45	–2.88	–3.46	–2.89	–2.88
1st Diff. **Variable**	**ΔQ**	**ΔPPET**	**ΔPOIL**	**ΔCARS**	**ΔBUS.**	**ΔPRO.**	**ΔLEIS.**	**ΔTAX**
Specification	Interc.	Interc.	Interc.	–	Interc.	Interc.	Interc.	Interc.
Lag	1	1	0	–	0	10	12	0
ADF Statistic	–17.88	–10.08	–13.56	–	–11.56	–20.63	–3.43	–14.71
Critical Value	–2.88	–2.88	–2.88	–	–2.89	–2.89	–2.89	–2.88

Notes: The ADF tests for a unit-root as null-hypothesis. The number of lags is obtained via a general to specific approach minimising the SCHWARZ Information Criterion (SIC) and starting from a maximum of 12 lags.

Unless series are transformed into stationary ones, or the demand and the supply relationships are co-integrated, deterministic and stochastic trends in non-stationarity series may render regressions spurious. A vector time series containing individual factors of petrol supply and demand respectively is said to be co-integrated if there exists at least one linearly independent non-zero co-integration vector, c, transforming the vector time series into a stationary relationship, albeit its individual components are *I(1)*.[4] For example, consider a linear version of the demand-supply system (5), where superscripts d and s denote coefficients (β) pertaining to demand, or supply respectively, meanwhile the system has been solved for its stochastic error term ε:

4 The basic concepts in cointegration go back to ENGLE AND GRANGER (1987).

$$(6)\quad \begin{aligned} \epsilon_t^d &= Q_t - \beta_0^d - \beta_1^d PPET_t - \beta_2^d W_t \\ \epsilon_t^s &= PPET_t - \beta_0^s - \beta_1^s POIL_t - \beta_2^s Z_t \end{aligned}$$

The cointegrating vectors $c^d(1, -\beta_0^d, -\beta_1^d, -\beta_2^d)$

and $c^s(1, -\beta_0^s, -\beta_1^s, -\beta_2^s)$

provide candidates for linear combinations of variables, which might be stationary.

Whenever $\varepsilon = 0$, the cointegrating relationship (6) has reached its long-term equilibrium, whilst during the short-term, deviations from the equilibrium ($\varepsilon \neq 0$) might occur. However, co-integration requires the equilibrium error, ε, to be stationary, implying that the variables tend to drift together without any tendency of diverging from a long-term equilibrium over time. In this case, there would exist a long-term relationship that ties the demand-supply system for petrol together, meanwhile many developments can bring about permanent changes to individual prices, cost, or any other component. Given co-integration, transforming variables into stationarity, e.g. by taking first differences, would be counterproductive and disguise the underlying long-term relationship.

Tests on whether or not the present dynamic demand-supply system for petrol is co-integrated will be carried out in a bivariate setting (ENGLE AND GRANGER, 1987) resting on applying a test about stationarity on the residuals e^d respectively e^s of the cointegrating regression (6).[5] In particular, when there exists at least one cointegrating vector c, then e^d respectively e^s should be $I(0)$. Therefore, an ADF test similar to those reported in table 2 on whether or not the residuals of (6) contain a unit root, provides a test on the null-hypothesis of no co-integration.

5 More elaborate multivariate techniques based e.g. on the method of JOHANSEN would allow establishing the exact number of cointegrating relationships after representing the demand-supply-relationship for petrol as VAR. This approach will not be pursued here since many of the individual equations constituting such a VAR lack theoretical underpinning. Considering multivariate methods nonetheless does not overturn the essence of the undermentioned test results on cointegration.

Demand

Estimating the price elasticity of demand (η) constitutes the first step in evaluating industry market power after (4). Rewrite the demand function of (5) into the following generalised econometric model:

$$(7) \quad Q = \beta_0^d(\alpha^d - PPET)^{|\gamma|} + \beta_2^d W + \epsilon^d$$

Here, β_0^d measures the size of the market, α^d represents the maximum willingness to pay (if γ is positive) and γ is an index of convexity. Imposing restrictions on coefficients and parameters transforms the general functional form of demand into more specific ones (GENESOVE AND MULLIN 1998), including the exponential (α^d, $\gamma \rightarrow \infty$ and $\alpha^d/\gamma = constant$), the linear ($\gamma = 1$), the log-linear ($\alpha^d = 0$, $\gamma < 0$) and the quadratic ($\gamma = 2$) case with the error term ε_t^d incorporating idiosyncratic demand shocks:

$$(8) \quad \text{Exponential} \quad ln(Q) = ln\beta_0^d + \frac{\gamma}{\alpha^d} PPET + \beta_2^d ln(W) + \epsilon^d$$

$$(9) \quad \text{Linear} \quad Q = \beta_0^d(\alpha^d - PPET) + \beta_2^d W + \epsilon^d$$

$$(10) \quad \text{Log-linear} \quad ln(Q) = ln\beta_0^d + \gamma ln(PPET) + \beta_2^d ln(W) + \epsilon^d$$

$$(11) \quad \text{Quadratic} \quad ln(Q) = ln\beta_0^d + 2ln(\alpha^d - PPET) + \beta_2^d ln(W) + \epsilon^d$$

The log-linear and quadratic parameterisation exhibit a constant elasticity of demand along the entire range of the relationship. In particular, a ready to use estimate for the elasticity (η) accrues to the coefficient of logarithmic price. Conversely, under the exponential and linear demand function, elasticities differ along the demand relationship and cannot directly be obtained from the coefficients but have to be established e.g. at the respective mean of price ($\overline{PPET}$) and quantity ($\bar{Q}$). Furthermore, under a linear or quadratic parameterisation, the convexity (γ) is imposed rather than estimated. Finally, recall that the motivation for considering various functional forms of demand lies in the impossibility to distinguish a hypothesis about coefficients – especially those affecting the elasticity of demand (η) – from a hypothesis on the functional form of demand (VARIAN 1983). Therefore, the robustness of estimates can only be verified via considering various forms of (7).

In order to circumvent problems of endogeneity in respect to PPET attributed to the simultaneity with the supply relationship, an instrumental variable needs identifying. Prices for petrol relate closely to cost implying that suitable instruments may be available from cost functions within the industry. Indeed, aside from the fact that oil and petrol prices tend to be highly correlated, the fraction of oil products ending up in Switzerland is small relative to the size of the spot market in Rotterdam. Therefore, oil prices can be considered to be exogenous in the sense of being uncorrelated with any domestic demand shock (ε^d).

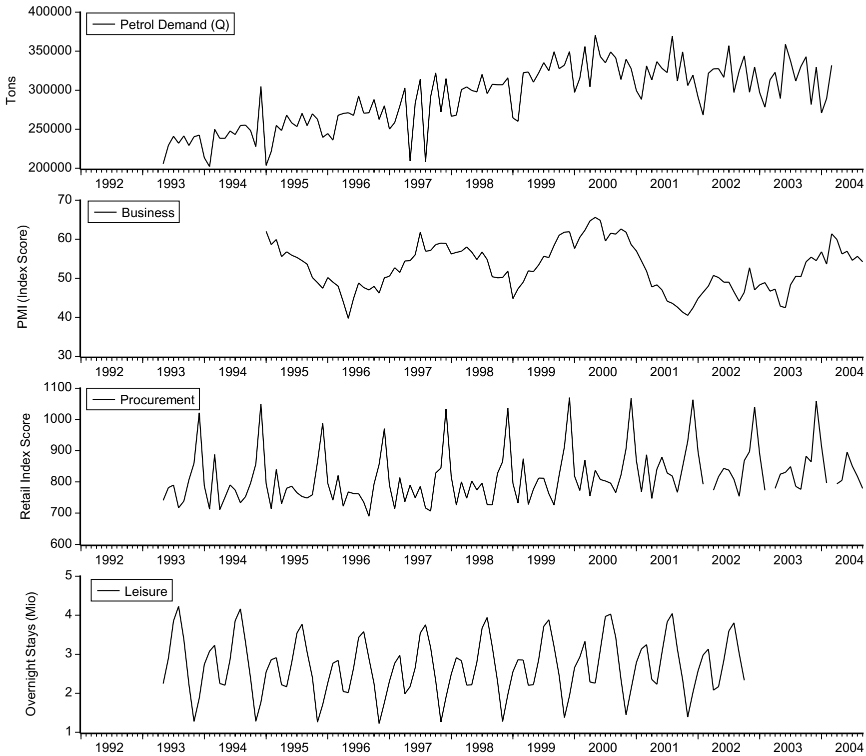
Control variables in *W* include disposable income. In particular, growth in disposable income likely results in a larger number of vehicles on the road (CARS), which have indeed increased – like income – steadily over the period under consideration.

The top panel of figure 2 reveals, however, seasonal fluctuations in petrol consumption, which plausibly relate to numerous factors such as the dates of public holidays, seasonal business cycles, or even climatic influences. The remaining panels of figure 2 graph control variables for seasonal fluctuations in petrol demand.

To control for the impact from business related traffic we employ the Purchasing Managers Index (PMI) compiled by Credit Suisse, which measures economic activities based on surveys about the monthly performance of Swiss industrial companies. Moreover, seasonal traffic due to leisure activities has been instrumented by the number of overnight stays in hotels (LEISURE), and traffic due to procurement is captured by a retail index (PROCUREMENT).[6]

6 Applying filters like the X11 or the HODRICK-PRESCOTT filter provides a way of simply smoothing out seasonality of the raw data on petrol price and quantity. Like this, some of the vulnerability of cointegration tests towards seasonality may be mitigated against. Still, for the sake of identifying the source of seasonality in petrol demand we prefer to introduce relevant covariates. Notably, applying seasonal filters instead does not alter the essence of the undermentioned results.

Figure 2: Seasonal Fluctuations and Petrol Demand



Columns (1) – (4) of table 3 report four estimates of the long-term implications for various parameterisations of the demand relationships given by equations (8) – (11). Since t-ratios with non-stationarity data do not necessarily follow a limiting normal distribution, some caution should be applied to the corresponding estimates of coefficient standard errors. To obtain valid standard errors when restricting attention to the long-term implications of non-stationary series, (Wickens and Breusch, 1988) suggest to introduce the differences of lagged dependent and independent variables into econometric equations arguing that then virtually all conventional diagnostic statistics remain valid. Corresponding coefficients and standard errors are reported in columns (5) – (8) of the bottom panel of table 3.

Results reported in table 3 shape up to expectations insofar as factors attributed to seasonal effects and an increased number of cars on the road impact positively upon petrol demand meanwhile high prices lower – as expected – the demand for petrol. Estimates across various demand specifications show similarities in terms of an insignificant price effect but a highly significant positive impact from the number of registered cars as well as widely significant entries of seasonable variables. Thus, income and to a somewhat smaller extent seasonal effects, appear to be the main driving force behind fluctuations in petrol demand.

As regards reported demand elasticities (η), outcomes differ slightly, which is not surprising given the differences in functional forms imposed upon demand. Yet, petrol demand appears to be rather price insensitive with an estimated elasticity between –3% and –6% under an exponential parameterisation, around –1% under a linear parameterisation, between –8% and –11% under a log-linear parameterisation, and between –4% and –5% under a quadratic parameterisation. These moderate elasticities can directly be conjectured from figure 1 by contemplating the effect of the 0.2 CHF/l increase in taxes of 1993, which is almost completely passed onto consumer prices. Moreover, the results are supported by a vast number of international studies typically finding rather low elasticities of demand for petrol. In particular, a survey conducted by (GRAHAM AND GLAISTER 2002) across countries suggests that short-term elasticities lie, on average, between –20% and –30% whilst in the long-term values may increase to up to –80%. Consistent with our findings, (GRAHAM AND GLAISTER 2002) report a rather low demand elasticity for Switzerland compared with other countries.

Residual based tests allow rejecting the null-hypothesis of no co-integration for all parameterisations and specifications of demand functions. This suggests the estimates of the demand relationship reported in table 3 to represent a long-term cointegrating relationship.

Estimates result in relatively modest values for the price elasticity of demand in the petrol-retailing industry regardless of specification and parameterisation. Taking into account the demand specifications and parameterisations considered, our results propose an elasticity within the range between –2% and –11%. Considering, furthermore, statistical uncertainties, the number of empirical models tested for, as well as the findings of international studies, demand elasticities for petrol in Switzerland are small with conservative inference making it very unlikely for values to exceed –40%.

Table 3: Demand for Petrol

Parameterisation	***Exponential*** (α^d, $\gamma\to\infty$) (1)	***Linear*** (γ = 1) (2)	***Log-linear*** (α^d = 0) (3)	***Quadratic*** (γ = 2) (4)
PPET	–0.05	–2'977	–0.11	–0.05
	(0.24)	(66'320)	(0.30)	(0.15)
CARS	0.59***	166'158***	2.07***	2.07***
	(0.11)	(31'302)	(0.39)	(0.39)
BUSINESS	0.005**	1'373**	0.24**	0.24**
	(0.002)	(612.3)	(0.11)	(0.11)
PROCUREMENT	(0.0002)**	69.4***	0.19**	0.19**
	(0.0001)	(25.7)	(0.08)	(0.08)
LEISURE	0.01	4'596	0.03	0.03
	(0.01)	(3'129)	(0.02)	(0.02)
Intercept	10.2***	–408'306***	7.83***	7.83***
	(0.26)	(73'244)	(0.83)	(0.83)
Lag Δ	No	No	No	No
η	–0.06	–0.01	–0.11	–0.05
N	93	93	93	93
Adj. R^2	0.54	0.56	0.54	0.54
ADF Statistic	–8.04	–7.97	–8.05	–8.05
Critical Value	–4.71	–4.71	–4.71	–4.71
Parameterisation	***Exponential*** (α^d, $\gamma\to\infty$) (5)	***Linear*** (γ = 1) (6)	***Log-linear*** (α^d = 0) (7)	***Quadratic*** (γ = 2) (8)
PPET	–0.02	–3'239	–0.08	–0.04
	(0.19)	(52'605)	(0.24)	(0.12)
CARS	0.43***	122'962***	1.62***	1.62***
	(0.11)	(31'791)	(0.40)	(0.40)
BUSINESS	0.003	817	0.15	0.15
	(0.002)	(521)	(0.10)	(0.10)
PROCUREMENT	0.0005	146	0.47*	0.47*
	(0.0003)	(93.8)	(0.28)	(0.28)
LEISURE	0.05*	14'409*	0.12*	0.12*
	(0.03)	(7'482)	(0.07)	(0.07)
Intercept	10.4***	384'709***	6.73***	6.73***
	(0.3)	(86'138)	(1.78)	(1.78)
Lag Δ	Yes	Yes	Yes	Yes
η	–0.03	–0.01	–0.08	–0.04
N	91	91	91	91
Adj. R^2	0.77	0.79	0.77	0.77
ADF Statistic	–5.05	–4.91	–5.01	–5.01
Critical Value	–4.71	–4.71	–4.71	–4.71

Notes: This table reports estimates for the demand of petrol Q after equations (8) – (11). The bottom panel calculated after WICKENS AND BREUSCH (1988) includes lagged differences of dependent and independent variables. Standard errors are in parentheses. They are heteroscedasticity robust and corrected for serial correlation by the method of NEWEY AND WEST. PPET is instrumented by POIL. Coefficients significant at the 10% level are labelled with *, at the 5% level with **, and at the 1% level with ***. η reports the estimated demand elasticities. When elasticities vary along the demand relationship (exponential and linear case), η is calculated at the mean of PPET and Q (comp. table 1). ADF-Statistic tests for a unit root within the residuals (test on cointegration). Critical values refer to PHILLIPS AND OULIARIS (1990, p.190), case 2 (demeaned without trend). The minimum of the SCHWARZ Information Criterion (SIC) determines the lag length in ADF tests.

Technology and Cost Function

Due to a lack of information, NEIO supposes that price-cost margins cannot be observed directly. Rather, the characteristics of marginal costs are inferred indirectly from firms' behaviour using information from closely related markets (BRESHNAHAN 1989). For example, cost conditions for petrol in Switzerland depend heavily on fluctuating prices on the spot market for oil in Rotterdam.

Real taxes provide another observable marginal costs shifter. However, compared with oil prices, real taxes fluctuate far less as tax increases and inflation were modest during the period under consideration. Furthermore, changes in taxes are typically permanent as opposed to transitory changes in oil prices.

The following function represents the structure of marginal costs in a concise manner:

$$(12)\quad \overline{MC_t} = Z + \kappa POIL + TAX$$

Following the notation of (5), Z denotes all variable cost other than taxes and the price of crude oil while κ is a parameter representing the available technology to transform the crude oil into petrol. E.g. adopting a value of 2 for κ would mean that 2 units of oil are required to produce one unit of petrol meanwhile the remaining unit of oil would have been wasted during the refining process.

As regards refining, oil can be transformed into a multitude of outputs including not only petrol but also diesel-oil, kerosene, heating-oil, lubricating-oil, and even tar-bitumen going on road surfaces. According to industry experts, crude oil can almost completely be transformed into marketable outputs.[7] Since the amount of waste produced during the refining process is

7 The refining process results in small amounts of about 0.1% of sulphur, which constitutes the only noteworthy non-marketable output (or waste).

negligible and the industry did not see substantial technological developments throughout the previous decade, we adopt a value of 1 for κ.

Market Power

Combining previous results from the demand and the supply side enables to infer the corresponding market power in terms of the conduct parameter ($\bar{\theta}$). In particular, substituting the industry specific marginal costs function (12) into the industry-pricing rule (4) and rearranging yields the following equation:

$$(13)\quad PPET_t = \underbrace{\frac{|\eta|}{|\eta| - \bar{\theta}}}_{constant} Z + \underbrace{\frac{|\eta|\kappa}{|\eta| - \bar{\theta}_{POIL}}}_{=\lambda_{POIL}} POIL + \underbrace{\frac{|\eta|}{|\eta| - \bar{\theta}_{TAX}}}_{=\lambda_{TAX}} TAX + \epsilon^s$$

Equation (13) represents the incidence inherent in the supply relationship in terms of impact of oil prices and taxes on petrol prices. E.g. under perfect competition ($\bar{\theta} = 0$) and horizontal marginal costs curves, changes in petrol prices will exactly match changes in marginal costs shifters (TAX and POIL if ($\kappa = 1$)) regardless of the value of the demand elasticity ($|\eta|$). Conversely, under a monopoly or perfect collusion ($\bar{\theta} = 1$) the demand elasticity crucially determines the magnitude to which marginal costs changes are passed onto petrol prices. In particular, the smaller the demand elasticity (η) and the higher the market power ($\bar{\theta}$), the more disproportionable prices respond at the filling station towards a shock in marginal costs.

The concept of contestable markets stresses the dynamic implications on equilibrium market power, which requires estimating the long-term effects of changes in taxes or oil prices on petrol prices. In order to disentangle long-term from short-term effects, (13) needs including lagged dependent and independent variables as a means to trace the model through time, which could economically be attributed to price inertia or petrol companies holding stocks purchased at past prices. Including differences of lagged dependent and independent variables provides an alternative way in dynamic modeling whilst estimating the long-term implications of non-stationary series (WICKENS AND BREUSCH 1988). Then, standard errors of coefficients retain their large sample properties and the coefficients of contemporaneous POIL respectively TAX indicate directly their long-term impact (λ_{POIL} respectively λ_{TAX}) upon PPET.

Table 4 summarises the results of estimates of (13) for various dynamic specifications with the long-term incidence of oil prices and taxes given by λ_{POIL} and λ_{TAX}.

Residual based tests allow rejecting the hypothesis of no co-integration for all dynamic specifications but specification (6) including lagged dependent and independent variables. Yet, all models show very similar long-term implications for cost shifting factors impacting upon the price for petrol (λ_{POIL} respectively λ_{TAX}).

Table 4: Supply in the Petrol Industry

	(1)	(2)	(3)	(4)	(5)	(6)
PPET(–1)			0.53*** (0.09)		0.61*** (0.11)	
POIL	0.68** (0.07)	0.21* (0.12)	0.21* (0.12)	0.21* (0.13)	0.25* (0.14)	0.70*** (0.07)
POIL(–1)		0.51*** (0.13)	0.14 (0.15)	0.50*** (0.16)	0.33* (0.18)	
POIL(–2)				0.01 (0.15)	–0.30* (0.18)	
TAX	1.78*** (0.50)	1.76*** (0.48)	0.90*** (0.34)	1.76*** (0.49)	0.79** (0.35)	1.72*** (0.48)
Intercept	–0.35 (0.41)	–0.33 (0.40)	–0.23 (0.24)	–0.34 (0.40)	–0.21 (0.23)	–0.30 (0.40)
LagΔ	No	No	No	No	No	Yes
λ_{POIL}	0.68	0.72	0.74	0.71	0.72	0.70
λ_{TAX}	1.78	1.76	1.91	1.76	2.03	1.72
N	137	136	136	135	135	136
Adj. R^2	0.72	0.76	0.84	0.75	0.85	0.79
ADF Statistic	–5.92	–5.16	–9.72	–5.18	–11.19	–3.08
Critical Value	–3.27	–3.73	–4.13	–4.13	–4.40	–3.27

Notes: The dependent variable of the supply equation (13) is PPET. Standard errors are in parentheses. They are heteroscedasticity robust and corrected for serial correlation by the method of NEWEY AND WEST. Coefficients significant at the 10% level are labelled with *, at the 5% level with **, and at the 1% level with ***. The long-term incidence λ is calculated by $\lambda = 1/(1 - \alpha^s)\Sigma\beta^s$ for estimates (1) – (5) with α^s and β^s denoting coefficients of lagged dependent and independent variables respectively. Estimates (6) calculated after WICKENS AND BREUSCH (1988) include lagged differences of dependent and independent variables with λ accruing directly to contemporaneous coefficients. ADF-Statistic tests for a unit root within the residuals (test on cointegration). Critical values refer to PHILLIPS AND OULIARIS (1990, p.190), standard case. The minimum of the SCHWARZ Information Criterion (SIC) determines the lag length in ADF tests.

The market power parameter ($\bar{\theta}$) can be extracted from equation (13) based on estimated long-term incidences λ_{POIL} in respect to changes in petrol prices, and λ_{TAX} in respect to changes in taxes. Rearranging yields:

$$\bar{\theta}_{POIL} = \frac{|\eta|(\lambda_{POIL} - \kappa)}{\lambda_{POIL}} \qquad (14)$$
$$\bar{\theta}_{TAX} = \frac{|\eta|(\lambda_{TAX} - 1)}{\lambda_{TAX}}$$

Against the background of low demand elasticities reported in section 4.2, high levels of market power would translate into disproportionably large differences between changes in marginal costs shifters and prices at the filling station.

However, even in the long-term, results of table 4 suggest oil price fluctuations to impact less than proportional upon changes of petrol prices with, depending on the exact specification, the incidence (λ_{POIL}) ranging between 0.68 and 0.74. Therefore, petrol retailers do not seem to be in a position to exert market power by exploiting fluctuations in oil price. The reason for changes in oil price being transferred less than proportional onto petrol price might lie firstly in price inertia when instantaneous adjustments at the filling station are costly. Secondly, the monthly character of the data might disguise the true variability of changes in oil prices to some extent.

Conversely, tax changes seem to trigger disproportionably high changes in petrol price with estimates suggesting a long-term impact up to the double of the original tax increase, which provides some evidence for the petrol retailing industry in Switzerland to exert market power through tacitly maintaining high petrol prices after increases in tax rates. In particular, petrol companies might not match the decreases inherent in real, as compared to nominal taxes, meaning in the long-term taxes are passed onto consumers in excess of the real increase. However, low elasticities of demand do not allow attributing this to excessively high levels of market power. Rather, for various parameterisations and specifications of demand and supply functions of tables 3 and 4, results reported in table 5 suggest modest values for ($\bar{\theta}_{TAX}$).

Table 5: Market Power after changes in Taxes

	Exponential	Linear	Log-Linear	Quadratic
Market Power $\bar{\theta}_{Tax}$	0.01–0.03	0.004–0.005	0.03–0.06	0.02–0.03

Notes: This table calculates market power based on tax incidence after the formula $\bar{\theta}_{TAX} = |\eta|(\hat{\lambda}_{TAX}-1)/\hat{\lambda}_{TAX}$ according to four functional forms of demand. Demand elasticities η rest on estimates reported in table 3 and estimates for λ_{TAX} are taken from table 4.

Due to their permanent character, changes in taxes provide a more natural test for the extent to which petrol companies are able to maintain price above competitive levels. Yet, average industry conditions yield values for the market power parameter $\bar{\theta}_{TAX}$ between 0.004 and 0.06 suggesting that consumers face sufficient possibilities to substitute among petrol companies respectively filling stations, or the threat of market entry remains viable. In particular, even with a high value of 0.06, market conduct of petrol retailers coincides theoretically with a COURNOT-NASH oligopoly with 17 symmetric companies, which comes close to the actual number of 18 retailing networks active on the Swiss market in 2004. Furthermore, under highest conceivable demand elasticities ($|\eta|$) of about –40% and when the magnitude of increases in petrol should exceed original tax increases by double ($\lambda_{\mathrm{TAX}} = 2$), the market power parameter ($\bar{\theta}_{TAX}$) does still not exceed a value of 0.2 meaning petrol companies compete like 5 symmetric COURNOT firms.

5 Concluding Remarks

Based upon average conditions in the Swiss petrol-retailing industry between 1993 and 2004, the present empirical analysis has shown that the observed market conduct is consistent with competition rather than collusion. Market power held within the industry seems to be relatively modest. Especially, we do not find any inconsistency between changes in oil prices, which constitute the main source of marginal costs fluctuations, and competitive pricing of petrol. Conversely, in the long-term taxes are passed onto consumers in excess of the real increase. Although this does not reflect perfectly competitive behaviour, low demand elasticities do not allow attributing this to substantial levels of market power. Nonetheless, tax increases, which are typically perceived as permanent in contrast to transitory changes in oil prices, do apparently provide a focal point, on basis of which the petrol industry in Switzerland manages to exert some limited market power.

Our results hold for the long-term and do not exclude the possibility of regions showing heterogenous competitive conditions or even during the short-term occasional (tacit) collusion among filling stations. However, the purpose of competition policy is to prevent collusive conduct that substantially and sustainably lessens competition. Conversely, adopting a dynamic perspective suggests that such anticompetitive conduct can currently not be sustained within the Swiss petrol retailing industry, be it due to deviating actual competitors or the potential threat of market entry.

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Data Appendix

Table 6: Description of the Data Set

Variable	Description	Coverage	Source
Q	Average monthly consumption of unleaded petrol (RON 95) in Switzerland in tons.	May 1993– Mar. 2004	Swiss Petrol Association (Erdölvereinigung).
PPET	Average monthly real price for unleaded petrol (RON 95) in Switzerland termed in Swiss Francs per litre (CHF/l). Nominal prices have been converted into real ones by dividing through the Swiss consumer price index (May 2000 = 100).	Jan. 1992– Sept. 2004	Federal Office of Statistics (BfS), Consumer price index: Swiss National Bank (SNB).
POIL	Average monthly real price for crude oil (Quality Brent 38) on the spot market in Rotterdam termed in Swiss Francs per litre (CHF/l) free on board (FOB). Oil prices are converted from nominal US$/bbl into real CHF/l by multiplying with an average monthly nominal exchange rate and dividing by the number of litres in one oil barrel (158.98l = 1bbl). Nominal prices are converted into real ones by dividing through the Swiss consumer price index (May 2000 = 100).	Jan. 1992– Sept. 2004	Nominal oil prices: Swiss Petrol Association (Erdölvereinigung), Consumer price index and the nominal exchange rate: Swiss National Bank (SNB).
CARS	Number of registered passenger cars per month in mio. Data are compiled by adding up the yearly published figures on the vehicle stock with the number of newly registered cars per month.	Jan. 1994– Sept. 2004	Vehicle Stock: Federal Office of Statistics (BfS), Newly registered Cars: Association of Swiss Car Importers (Auto-Schweiz) and Federal Vehicles Licensing Statistics (MOFIS).
BUSINESS	Economic activity within the Swiss industrial sector as measured by the purchasing managers index (PMI). The index is based upon surveys among 200 purchasing managers assessing whether their activity level was higher, lower or unchanged compared with the previous month.	Jan. 1995– Sept. 2004	Credit Suisse.
PROCUR-MENT	Index measuring the turnover in the retailing industry with 1949 = 100.	May 1993– Sept. 2004	Swiss National Bank (SNB).
LEISURE	Total number (in mio.) of overnight stays recorded in Swiss Hotels per month.	May 1993– Oct. 2002	Federal Office of Statistics (BfS).
TAX	Real tax burden levied on petrol in CHF (May 2000 = 100) per litre compiled by adding up value added taxes, tariffs resp. importation fees and surcharges. Value added taxes at a rate of 6.5% replaced the «Warenumsatzsteuer» of (6.2%) at the beginning of the year 1995. Increases in tax rates occurred at the beginning of the years 1999 (to 7.5%) and 2001 (7.6%). The tax on petrol products (Mineralölsteuer) replaced previous duties at the beginning of the year 1997. An increase in tax rate occurred at the beginning of the year 2000. In Sept. 2004, the rate stood at 0.7312 CHF/l including a surcharge of 0.3 CHF/l. Importation fees mainly consist of relatively modest contributions to maintain sufficient stocks of petrol and other fossil fuels.	Jan. 1992– Sept. 2004	Federal Tax Administration (Eidgenössische Steuerverwaltung), Federal Customs Administration (Eidgenössische Zollverwaltung), Swiss Petrol Association (Erdölvereinigung).