Speed of Adjustment and Market Structure: A Study of the Gasoline Market in Germany

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EXECUTIVE SUMMARY

The purpose of this paper is to study the relationship between changes in costs and prices in the gasoline market in the Federal Republic of Germany (FRG) for the period 1980-90. We shall use an econometric model, and distinguish two stages in the transmission of cost changes to prices. The first is the adjustment of gasoline prices ex-refinery to changes in the price of crude oil, and the second is the adjustment of gasoline price (net of taxes) at the pump to ex-refinery prices.

A vast economic literature has accepted the view that a relationship exists between market forms and the speed of transmission of cost changes to final price.

The study of price adjustments to cost changes involves the analysis of two inter-related but different phenomena. The first is the speed of adjustment, defined here as the mean of the length of the time periods required for the transmission of the full effect of an exogenous shock from the independent to the dependent variable of the econometric model used in the analysis. The second relates to possible asymmetries in the response of prices to increases and decreases in costs. Both phenomena are closely related to the structure of the market. The common assumption in economic writing, is that the first - the length of the adjustment period - is negatively correlated to the degree of competition (i.e. the speed of adjustment is positively correlated to the competitiveness of the market), and that the second - the asymmetry of price responses - is an indication of the prevailing market structure.

The main findings of this paper are as follows:

a) at the refinery level there is only weak evidence of asymmetrical reaction; the average lag in case of crude price increases or decreases is about three months.

b) at the consumers' level, the speed of adjustment was lower when the ex-refinery price was declining than when it was rising; the adjustment lag was about 6.07 months when ex-refinery prices were declining and 5.37 months when they were rising.

CONTENTS

1 INTRODUCTION

The oil price collapse of 1986 revived once again the old interest in the process of price formation in the petroleum industry which has long attracted suspicions of anti-competitive behaviour. Indeed, the first and the most famous case to attract economists' attention after the adoption of the Sharman Act in 1870, the first example of anti-trust legislation in the USA, was that of Standard Oil, charged in 1911 with monopolizing the petroleum market by acquiring a large number of other companies. By this time, Standard Oil controlled some 90 per cent of the US oil industry, both upstream and downstream.[1]

In particular, the 1986 oil price collapse highlighted the need to understand in greater depth the relationship between the speed of price adjustments to changes in upstream supply costs and market structure in the downstream.

The purpose of this paper is to study the relationship between changes in costs and prices in a particular instance, that of the gasoline market in the Federal Republic of Germany (FRG) for the period 1980-90. We shall use an econometric model, and distinguish two stages in the transmission of cost changes to prices. The first is the adjustment of gasoline prices ex-refinery to changes in the price of crude oil, and the second is the adjustment of gasoline price (net of taxes) at the pump to ex-refinery prices.

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1 A thorough analysis of the Standard Oil case is to be found in Armentano D.T.(1986).

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b) at the consumers' level, the speed of adjustment was lower when the ex-refinery price was declining than when it was rising; the adjustment lag was about 6.07 months when ex-refinery prices were declining and 5.37 months when they were rising.

The paper is organized as follows. In Section 2 we examine the relationship between rigidity and oligopoly; in Section 3 we describe the refinery and distribution systems for gasoline in the FRG, and Section 4 presents and assesses the data and the econometric model used for the analysis, and the results of our study. Section 5 interprets these results in the light of the theoretical issues discussed earlier. The final section draws some conclusions.

2 PRICE ADJUSTMENT AND MARKET STRUCTURE

In the fully competitive market, prices will respond immediately to changes in input costs unless there are universal costs of adjustment.[2] The simplest explanation of sluggish adjustment is therefore the existence of costs in changing prices such as a "menu" of costs. If competition is not perfect, a variety of non-optimal "rules of thumb" may also survive. For example Coutts, Godley and Nordhaus (1978) emphasized the role of different accountancy rules used in pricing, and especially the valuation of inventories. In the short run, therefore, the speed of adjustment of prices may depend on accountancy (and other bureaucratic) norms.

There are two generally accepted ways of valuing products held by a firm, one based on historical costs and a second based on replacement costs. When a historical cost criterion (FIFO) is used to value inventories, which in turn represent the marginal cost of market supplies, the firm does not adjust output price immediately in the face of changes in costs but waits until stocks of inputs bought at the old prices have been exhausted. When the replacement cost criterion (LIFO) is applied, the firm adjusts its prices very rapidly in response to changes in input costs. Clearly the accounting convention of a firm can have an influence on the speed of adjustment: an equal application of a FIFO criterion results in longer lags than that of the (economically more rational) LIFO principle. This explanation, though based on the application of imperfect (and to some extent arbitrary) rules, was nevertheless shown by Coutts, Godley and Nordhaus in their study of industrial pricing in the UK to be of considerable practical importance.

Such norms of rigidity are likely to be even more important in monopolized markets. The profit-maximizing monopolist is under as much incentive to adjust prices as a producer in a fully competitive market. But monopolies do not have to be profit maximizers; as Hicks

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2 Arrow K. (1959),Bedrossian A., Moschos D. (1988), Domberger S. (1979, 1980, 1982, 1983), Eckstein O., Fromm G.(1968), Hannan L., Kay S.A. (1977), McFeltridge D.C.(1981), Shahling (1977), Winters A.L.(1981); nonetheless the evidence is far from being conclusive as yet; see for instance, Dixon R.(1983).

puts it, "the greatest of all monopoly profits is a quiet life". Moreover, large enterprises - which monopolies tend to be - are often complex organizations which operate through bureaucratic procedures as well as responding to market signals. One such rule may be to "pass on" cost changes above a certain threshold; another to "absorb" small changes.

If it is difficult to specify unambiguous differences in behaviour between perfectly competitive and monopolized markets, it is even more difficult to establish a simple gradient between these two extremes - though it is a very common presumption that price adjustment will become slower as the number of firms in the market decreases.

Where markets are broadly competitive, but there are imperfections arising from the collection and evaluation of information, prices may be sticky. For example, if consumers search the lowest price only periodically, and firms incur advertising costs, it may not be optimal to adjust prices downward following a small reduction in production costs (Kling, 1982). Inflexibility may also be caused by the combination of adjustment costs and uncertainty about the durability of cost changes. In many cases, the likelihood of price rigidity depends much more on the nature of the changes in costs and expectations than on any simple measure of competition such as industrial concentration.

When the number of competitors is small - true oligopoly - industrial concentration becomes even less useful as an indicator of both the intensity of competition and the inflexibility of prices. The "degree of competition" is a reflection of strategic behaviour rather than a market structure, and requires careful interpretation.

Schmalensee (1988) in his survey of industrial economics has written of "the Holy Grail of research in oligopoly theory ... where dozens of formal models ... have given us a multitude of possibilities rather than the Holy Grail. Indeed, collectively, they suggest that the Holy Grail may not exist."

Ginsburgh and Michel (1988) remarked that the various theories of oligopoly offer contradictory interpretations on the issue of price-cost adjustments. On the other hand Stigler (1964) argued that the higher the degree of competition, the more rapid is the speed of price adjustment to variation in costs. According to Stigler, when the

number of firms is small, price-cutting by one concern is easily detected by the others who tend to follow rapidly. For the same reason, when costs rise oligopolistic firms pass them through as soon as one firm raises its prices. On the other hand, a vast literature has defended the opposite view, that an oligopolistic market is characterized by slow price responses to variations in costs. The theoretical framework supporting this view was provided by the well known construct of the kinked demand curve.[3]

The most basic assumption in oligopoly theory is that each firm's management, realizing that it faces only a few rivals and that the behaviour of all is independent, assumes that rivals will respond to its own actions in ways which are least favourable to itself. This is the underpinning of the KDC theory of price adjustment.

Let us consider a simple duopoly. According to the KDC theory, the first firm assumes that it faces two demand curves: a curve which defines the quantities and the corresponding prices it will face when it changes its own price and a second firm does not retaliate, and a second curve which defines quantities and prices it will face when it changes its own price and the rival matches exactly these changes.

Figure 1

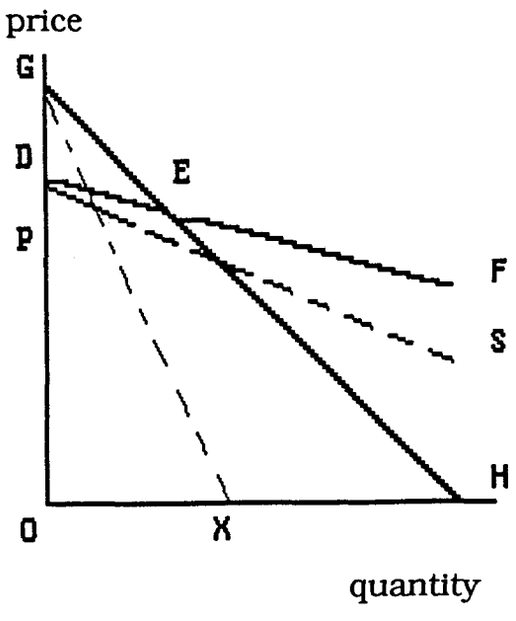
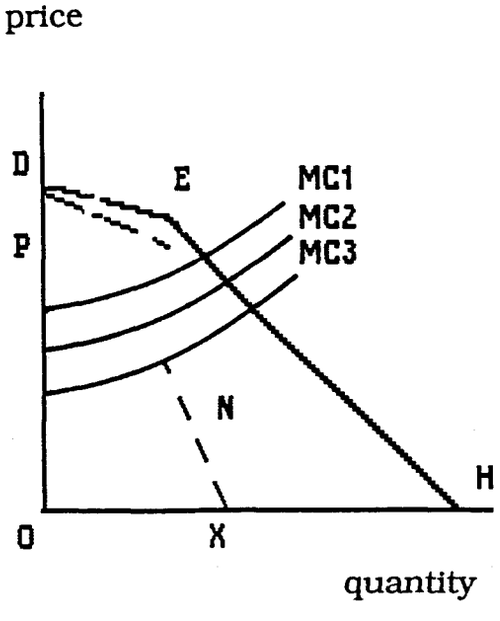


Figure 2



3 The KDC theory was developed and put forward in the same period by Hall R.L., Hitch C.J.(1939) and Sweezy P.M.(1939). For an interesting debate on this subject see Spengler J.J. (1965) and for some later development see Primeaux W.J., Bomball M.R.(1976)

Figure 1 describes a situation in which the market price is OP and the quantity produced is OX, DEF is the demand curve faced by the first firm when the rival does not retaliate, and GEH the demand curve when the rival responds to a change in the price of the first firm with an identical change. The demand curve DEF has a higher elasticity than the curve GEH.

Given these premises, the kinked curve DEH is the relevant demand curve for the analysis of oligopoly behaviour. Figure 2 traces this demand curve and the corresponding marginal revenue curve.

The existence of a kink in the demand curve creates a discontinuity in the marginal revenue curve that implies optimum levels of price and remains invariant in the face of certain changes in marginal cost. This theory, which offers a plausible explanation of price rigidity in the face of small cost variations, has been however widely criticized.

One important criticism is that the existence of a discontinuity marginal revenue curve implies that the initial price OP does not correspond to the price level that maximizes the joint profits of the oligopolistic curves. Total profits are maximized when the MC curve intersects MR at point N in Figure 2. As Scherer (1980) puts it "the price must initially have been set below the profit-maximizing level if the subsequent emergence of a kink makes the price rigid against both upward and downward cost curve shifts."[4]

The kinked demand curve theory only truly explains upward rigidity. Nevertheless, the fear that downward adjustment of price might spark a "price war" and move all players in the market away from "tacit" agreement on a monopoly or near-monopoly price is quite justifiable. Indeed, the rationality of downward rigidity has been shown recently in a number of simple but reasonably realistic models of "market games". For example, a model constructed by Maskin and Tirole[5] is based on the assumption that firms must maintain prices for

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4 The empirical evidence put forward by Scherer has been thoroughly criticized: see Sylos Labini P. (1979) and Kling A.(1982).

5 Maskin E., Tirole J. (1988a, 1988b); for a simple version see Tirole J.(1988).

number of firms is small, price-cutting by one concern is easily detected by the others who tend to follow rapidly. For the same reason, when costs rise oligopolistic firms pass them through as soon as one firm raises its prices. On the other hand, a vast literature has defended the opposite view, that an oligopolistic market is characterized by slow price responses to variations in costs. The theoretical framework supporting this view was provided by the well known construct of the kinked demand curve.[3]

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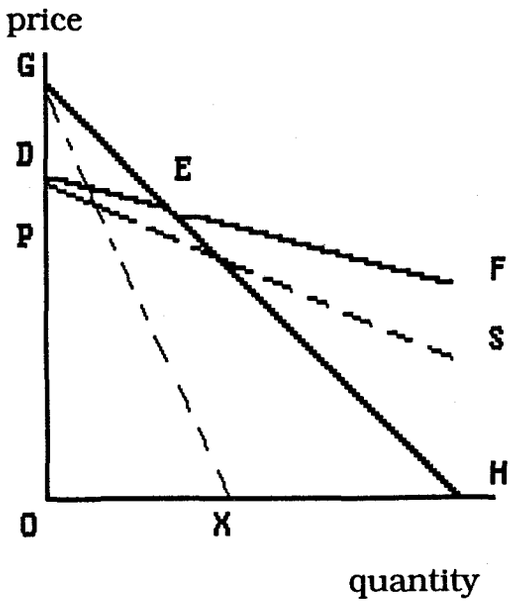
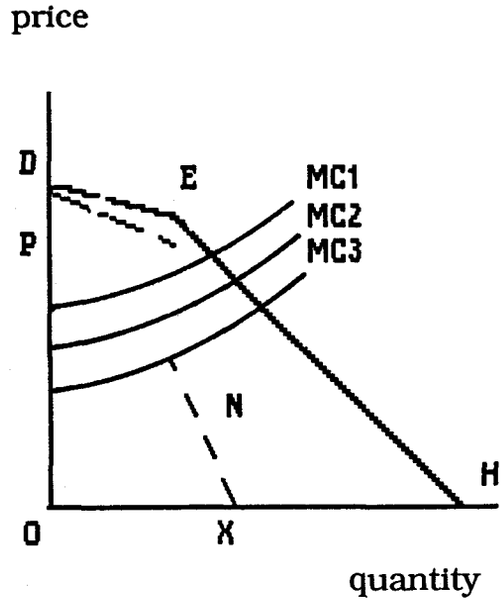


Figure 2



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two periods and adjust them asynchronously.[6] Each, in deciding whether to cut price, attempts to trade off the immediate advantages of a gain in the market share against the longer-term one of becoming locked in to low prices following a price war; and a subsequent "war of attrition" in which both firms want to return to a higher focal price but each is reluctant to incur the loss of share which a first move implies. The two decision phases are interdependent. Both upward and downward rigidity are therefore explored in the model but its principal implication is that it is quite rational to refuse downward flexibility in order to avoid a "war of attrition" (in which each is locked in by upward inflexibility).

Many such models of oligopolistic behaviour suggest that price rigidity may be greater in "booms" than in "busts" because upward movements always imply a loss in market share. This is essentially the KDC argument. But the more recent game-theoretic models can also provide convincing explanations for demand rigidity which do not merely represent "pessimistic assumptions" about market behaviour.

Furthermore, this theoretical framework explains why oligopolistic strategies involve holding a certain amount of excess productive capacity. Price wars are only possible when firms can satisfy the increased demand for their product brought about by reductions through the utilization of surplus capacity.[7]

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6 In their model there is a specific reference to Bertrand's oligopoly model which was originally developed as a form of criticism against the better known model of Cournot (1838). The oligopolists' game in the Bertrand model is characterized by the fact that it makes use of price as a strategic variable contrary to Cournot's which uses quantity instead. A deeper study of these models successively allowed a more consistent formulation of the oligopoly problem. It has been observed that the two models are not to be considered as alternatives but as complementary. The choices of oligopolists in Cournot's model concern quantity and are therefore to be regarded as long-term ones in an industrial system where instantaneous changes of productive capacity are not feasible. The decision variable in Bertrand model is instead price which is, by common assumption, a short-term variable.

Starting from these observations several models have been set up (Davidson C., Deneckere R. (1986), Kreps D., Scheinkman J. (1983)), which specify the oligopoly model as a two-stage game. In the first stage the oligopolists choose quantities (i.e. they decide on productive capacity) and the game follows Cournot's rules; in the second stage the firms compete on price in the short run with Bertrand's equilibrium rules.

7 The problem of productive capacities was examined by Edgeworth F.(1897) with a view to finding a solution to Bertrand's model. In some models it has been regarded as a possible oligopolistic strategy. Among others see Benoit J.P., Krishna

By contrast with the general expectation that upward price inflexibility is more likely than downward rigidity, many of the concerns expressed recently about price behaviour in the oil industry reflect precisely the opposite expectation - that prices will move downwards more slowly than they move upwards. Frequently, explicit collusion is suspected (rather than the "tacit collusion" which is the subject of the models described in previous paragraphs).

Whether upward or downward inflexibility is more prevalent depends on a number of factors related to the structure of costs, the transparency of information, the development of "reputations", changes in the environment of the industry and so forth. For example, large cost changes are likely to affect the industry as a whole (rather than reflecting a portion of one disadvantaged competitor) as well as perhaps threatening insolvency. In an inflationary environment, all upward cost increases may be followed (perhaps one-for-one to test the reaction of demand) in an attempt to maintain a "real price". Equally important is the atmosphere of the industry - the commonly understood strategies and reputations built up over its development.

In most instances, both theory and practice would suggest that price rigidity is a defensive strategy; an aggressively exploitive monopolistic or tightly collusive strategy would imply frequent (and if necessary co-ordinated) adjustment to the profit-maximization price. Under oligopoly, each case is a complex response to factors both internal and external to the industry. The Holy Grail cannot be found.

Yet some evidence about behaviour, taken in conjunction with macro-economic developments and changes in industrial structure, can be suggestive of intensity of competition:

1. Price flexibility is not unambiguous evidence of competitive pricing - it may reflect perfect competition or "perfect exploitation" (by a monopoly, or perfect collusion).

V.(1985), Davidson L., Deneckere R. (1986). Other important works on this topic include Barzel Y.(1970), Ohta H. (1977), Margolis S.E.(1985), Lieberman M.B.(1987).

2. Price rigidity, up and down, can, however, be rational under imperfect competition and is prima facie evidence of lack of competitive behaviour.

3. Given a degree of inflexibility, upward price flexibility combined with downward rigidity reinforces this prescription - as evidence of an "ordered market".

4. Given a degree of inflexibility, downward price flexibility, combined with upward inflexibility (the simple KDC case) suggest a (potentially) rivalrous oligopoly in which strategies are defensive. Profitability is probably lower than in 2.

5. All presumptions about competitiveness depend significantly on the industry and macro-economic context. (3) would be less pernicious in an inflationary climate; and any price adjustment is easier if it is in accord with the recent trend in prices in an industry.

6. Price behaviour reflects the strategies adopted by the various players as well as market concentration (though of course the latter affects the former). A change in price flexibility (or any other behavioural variable), accompanied by a change in number of competitors, may arise because the strategy of the new competitors alters the strategy of the incumbents, in that it changes the weights of various strategies played out in the market, because it introduces new strategies, or because it disturbs an "evolved" structure of market response.[8]

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[8] The impact of "crazy" strategies in modifying equilibrium is discussed in Tirole J. (1988).

3 THE FEDERAL REPUBLIC OF GERMANY: A BRIEF FRAME OF REFERENCE

The petroleum sector of the FRG has certain characteristics which make the analysis of price rigidity in the gasoline market particularly interesting. Prices to consumers of petroleum products are free of government control. This is an unusual state of affairs in Europe where the only other control-free markets are the United Kingdom and Switzerland. Furthermore, the FRG is situated at the centre of gravity of the important petroleum market of North West Europe. The absence of government intervention and the favourable geographical location enable the German consumer to obtain petroleum products at the best possible before-tax price in most circumstances.[9]

The FRG is the largest importer of finished petroleum products and the largest consumer in Europe. These reasons combined with the fact that German legislation is particularly favourable to investment in refineries have always ensured the active interest of multinational oil companies.

The reduction in oil consumption that occurred in the early 1980s, and changes in the structure of oil products demand have induced a significant transformation in the refinery industry of the FRG. This transformation has involved a progressive reduction in distillation capacity (it declined by 50 per cent in 1987 compared with 1978) and an increase in conversion capacity (its share of total refining rose from 15.3 per cent in 1978 to 38.4 per cent in 1987).

There have been, however, marked changes in the strategies of some companies. For example, Deutsche BP reduced drastically its refining capacity from 26 million tons in 1979 to 7 million tons in 1984 but at the same time invested considerable resources in conversion increasing its share of German conversion capacity from 11 per cent in 1979 to 15 per cent in 1987. Other companies preferred to withdraw completely from refining, retaining only their distribution and trading functions. ELF, for example, owned 4.5 per cent of refining capacity in 1979 but none in 1987.[10]

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9 Clarke I.(1989)

10 Schurman H.J. (1986)

The reorganization of the refining structure in the FRG is typical of changes that have occurred in Europe as a whole. It has involved:

- an increase in the share of imported petroleum products in consumption at the expense of domestic production

- and, a decrease in the share of oil imports from OPEC (from 96 per cent in 1973 down to 49 per cent in 1988) compensated for by an increase in imports of North Sea crudes.

In 1987-8, there was both an improvement in refining margins and an increase in the rate of utilization of refining capacity (the latter increased from 80 to 94 per cent between January and December 1988). Furthermore, investments in conversion continued to take place in order to meet the growing demand for light products.

In the FRG, most of the major oil companies have important refinery interests while smaller oil corporations including national companies have significant shares in distribution. In the latter sector, the market structure is fairly competitive, particularly in the north of the country where small firms dominate. The big oil companies are active in the north where they compete with smaller firms but are more dominant in the interior where we also observe that the average price of products is higher than in the north.[11]

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11 Hatem I.(1985).

4 THE DATA, THE MODEL AND THE RESULTS

Numerous attempts have been made to analyse the relationship between the price of the input (crude oil) and the price of the output (petroleum products). The product which has been most studied is gasoline because its share of petroleum consumption is large and because the wide geographical dispersion of sales (relative to the total volume sold) gives rise to a diversity of market situations within a single country.[12]

The present study of the FRG also concentrates upon the speed of cost-price adjustments in the gasoline market but examines the link between crude oil and gasoline price in two stages:

- from crude oil to ex-refinery gasoline price and,

- from ex-refinery to (net of tax) pump prices for gasoline.

We have considered the period 1980-90, and an econometric model has been developed using monthly data.

4.1 The Data

The consumers' price of gasoline, in DM/litre, is from *International Crude Oil and Product Prices* and we used the spot f.o.b. price in Rotterdam from *Platt's Oilgram Price Report* as a proxy for ex-refinery gasoline price. The choice of a crude oil price series, however, posed some problems. As mentioned before, the transformation of the refining structure in Europe involved, among other things, a reduction in imports from the Middle East as these were displaced by North Sea production. This change can probably be ascribed to the opportunities then available to refiners "to reduce their risks by increasing the

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12 Bacon R. (1986,1990), Allvine F.C., Patterson J.M. (1972), Marvel H.P. (1976, 1978), Powell G. (1986), Spiller P., Huang C.J. (1986), Slade (1987), Livingston S.M., Levit T. (1959), Fleming H.M. (1966).

amount of short-haul crude they purchased. This became particularly advantageous in the 1980s when price began to fall and long-term contracts were no longer an attractive option."[13]

Between 1978 and 1988 the share of crude oil imports in the FRG from the United Kingdom and Norway increased from 9 to 32 per cent.

Keeping the Arabian Light price in our model produced unsatisfactory results both in terms of goodness of fit and coefficient signs. A further difficulty with the Arabian Light price is its unavailability after April 1986 as spot trading was reduced to a trickle after that date. Most crude exports from Saudi Arabia were being made under term agreements and only few cargos were being resold on the open market.

An alternative approach would have been to construct a specific price series for the FRG as a weighted average of the prices of imported crude by origin. This solution would have had the advantage of avoiding problems associated with the choice of the reference crude, but its main drawback would have been a reduction in the number of observations, because import data by countries are only available on a quarterly rather than a monthly basis.

We therefore took Brent as the reference crude for the whole period.

4.2 The Model

The model is a system of two equations. In the first equation the ex-refinery gasoline price (in US dollars) is related to the spot crude oil price. In the second equation the consumer price of gasoline (net of tax) in DM is related to the ex-refinery price divided by the exchange rate. Both equations are in log form:

$$\ln(\text{spot}) = \alpha_0 + \beta_1 \ln(\text{crude}) \qquad (1)$$

$$\ln(\text{pump}) = \alpha_1 + \beta_2 \ln(\text{spot/exchange rate}) \qquad (2)$$

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13 OIES (1989), vol. 4, Bacon R, Chadwick M., Dargay J., Long D., Mabro R.(1990)

In order to test the model for asymmetric speeds of adjustment a "switching-regime" is adopted, by splitting the cost movements into increases and decreases by the following transformation. Starting from:

$$Y_{(t)} = \alpha + \beta(P) + (1 - \lambda)\, Y_{(t-1)},$$

Let Y be the log of the spot price and P be the log of the price of crude oil, then a dummy variable could be considered:

$$D_t = 1 \text{ if } P_t > P_{(t-1)}$$
$$= 0 \text{ otherwise}$$

In order to measure asymmetric speeds of adjustment the following composite variables can be used:

$$Z_{(1,t)} = Y_{(t-1)}\, D_t$$

$$Z_{(2,t)} = Y_{(t-1)}\, (1 - D_t),$$

and the final form is:

$$Y_{(t)} = \alpha + \beta_1 Z_{(1,t)} + \beta_2\, Z_{(2,t)} + (1 - \lambda)\, Y_{(t-1)} \qquad (3)$$

A similar technique is used to split the spot price in (2). Estimation is by 2SLS recognizing that the equation form is a recursive system and that there may be inter-equation error correlation.

4.3 The Results

The basic model was estimated for the period 1980:1 to 1990:6. In all regressions, considerable variations in the lag structure as well as in the functional form were tried. The results for the best fitting model, with all significant coefficients, are shown in Tables 1 and 2.

Table 1 Equation for Ex-refinery Gasoline Price

Variable	Coefficient	Student T
Constant	1.45386	(9.39209)
$Log(Crude)_{(t-1)}$	0.44694	(10.8387)
$Y_{(t-1)}$ for $Crude_{(t)} > Crude_{(t-1)}$	0.48461	(10.2636)
$Y_{(t-1)}$ for $Crude_{(t)} <= Crude_{(t-1)}$	0.47247	(9.9547)
Dummy 1986:5	0.27898	(4.08810)
RSQ	0.5241	
S.E.E	0.0675	
adjusted R_2	0.9489	
D.W	1.2131	

Table 2 Equation for Retail Gasoline Price

Variable	Coefficient	Student T
Constant	-1.01346	(4.15637)
Log(Spot)	0.14655	(4.11412)
$Y_{(t-1)}$ for $Spot_{(t)} > Spot_{(t-1)}$	0.77131	(15.2202)
$Y_{(t-1)}$ for $Spot_{(t)} <= Spot_{(t-1)}$	0.80294	(14.2479)
Log(Lexrate)	-0.14655	(5.13456)
RSQ	0.5195	
S.E.E	0.0669	
adjusted R_2	0.9481	
D.W	1.7394	

Through equation [3], both the hypotheses of asymmetric mean lag and asymmetric degree of passing on can be tested[14] and the results are shown as follows:

Table 3 Long-run elasticities and mean lags
(for variation of crude oil price in (1) and ex-refinery price in (2))

	LREPV(*)	LRENV(*)	MLPV(*)	MLVN(*)
Equation (1) for Ex-refinery Gasoline Price	.8672	.8472	2.94	2.89
Equation (2) for Retail Gasoline Price	.6408	.7436	5.37	6.07

(*)

LREPV	Long-run elasticity for positive variation
LRENV	Long-run elasticity for negative variation
MLPV	Mean lag for positive variation (months)
MLNV	Mean lag for negative variation (months)

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14 Considering a simple specification as:

$$Y = \alpha + \beta_1 Y_{(t-1)} + \beta_2 X_t$$

We have examined two different issues: i) asymmetric degrees of passing on; ii) asymmetric speeds of adjustment. The former requires that the X variable should be split into up and down. The latter requires that $Y_{(t-1)}$ should be split into up and down. So, the most flexible specification form would have been:

$$Y = \alpha + \beta_1 Y_{UP(t-1)} + \beta_2 Y_{DOWN(t-1)} + \beta_3 X_{UPt} + \beta_4 X_{DOWNt}$$

This specification was tried for both equations without finding any statistical difference between β_3 and β_4; then a more parsimonious specification form was adopted:

$$Y = \alpha + \beta_1 Y_{UP(t-1)} + \beta_2 Y_{DOWN(t-1)} + \beta_3 X_t,$$

forcing the degree of passing on to be different $\frac{\beta_3}{1-\beta_1}, \frac{\beta_3}{1-\beta_2}$;

The long-run elasticity of ex-refinery price to cost change is 0.86 for crude oil cost increase and 0.84 for crude oil cost decrease.

These values are different from the long-run unit elasticity. This may reflect the dampening impact of inputs other then crude oil used to produce gasoline in a refinery.

In the equation for retail price all coefficients are significant. The long-run elasticity is 0.64 for spot price increase and 0.74 for cost decrease. These low values are more surprising for the retail sector since the raw material is a major input of the final sale. Distribution costs must be important in explaining this result which shows a significant divergence from a long-run unit elasticity.

We would like now to examine whether the response of ex-refinery price and retail gasoline price to crude oil price changes are asymmetrical in case of price increases compared with decreases. We have noted in Section 3 that a well-disciplined oligopoly will quickly be able to translate higher costs into higher prices in order to maintain the mark-up and, acting with either tacit or active collusion, will be able to cushion prices against a fall when costs decline in order to obtain extra profits. By contrast, ill-disciplined oligopolies are more cautious about raising prices and more prone to outbreaks of price wars. This hypothesis was recently re-examined by the Monopolies and Mergers Commission with reference to the British oil market[15], and no evidence was found that the average delays of adjusting to cost increase and cost decrease were different.[16]

Examining the differences in lag structure in cases of rising and declining crude oil price suggests that:

a) at the refinery level there is very little evidence of asymmetrical reaction; the average lag in the case of crude oil price increase is about 2.94 months while in the case of a decrease it is about 2.89 months.

b) at the consumers' level, the speed of adjustment was lower when the ex-refinery price was declining than when it was rising; the

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15 See MMC (1990).

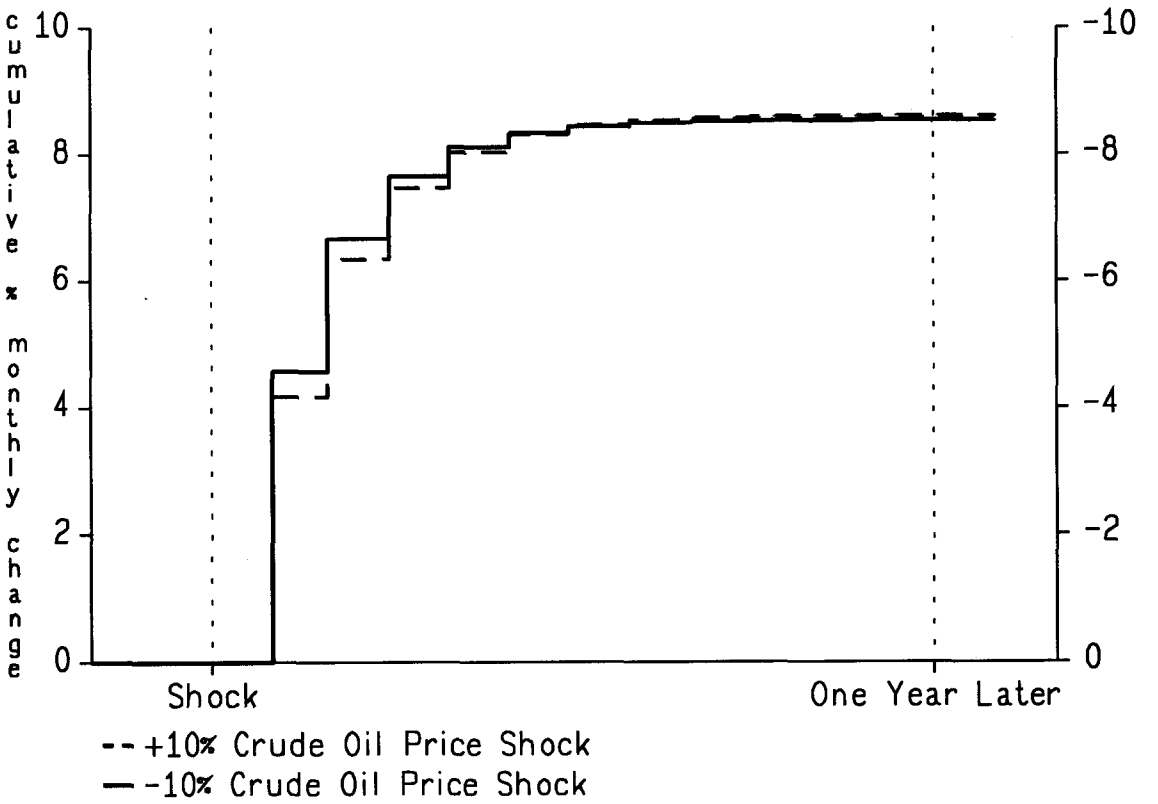
16 For another interesting paper on the asymmetrical path of adjustment, termed by the MMC "rockets and feathers", see Bacon [1990].

adjustment lag was about 6.07 months when ex-refinery prices were declining and 5.37 months when they were rising.

The result of a simulation exercise starting from a steady state and introducing a crude oil price increase of 10 per cent is shown in Figures 3 and 4. Figure 3 refers to ex-refinery gasoline price, while Figure 4 refers to the retail price.[17]

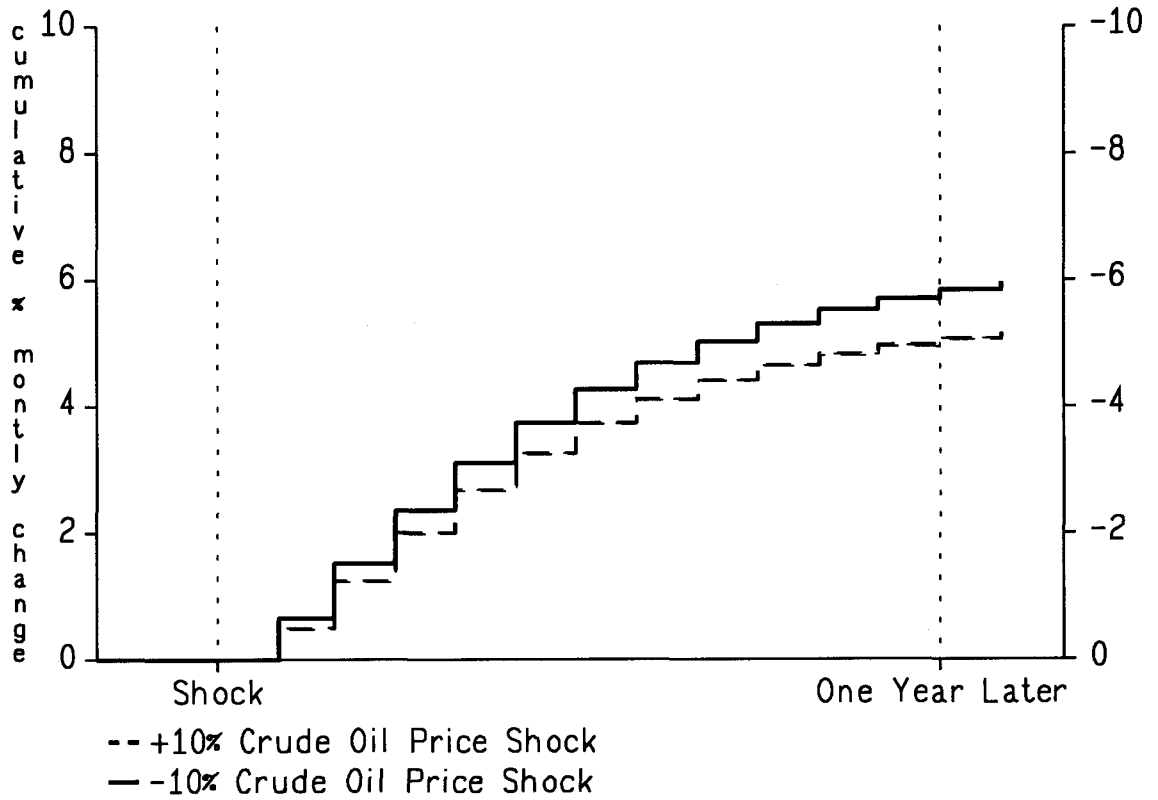
Figure 3

Cumulative distribution function of the impact of oil price shocks



[17] It should be noted that the measure of speed of adjustment here shown is not analytically derived from the result in Table 2 because in that case the main exogenous variable for the retail price is the ex-refinery price instead of crude oil price.

Figure 4



It appears clearly that the ex-refinery price absorbs the full shock and returns to a steady state at a price level 8.3 per cent higher than its pre-shock value and the adjustment paths are equal in the case of decrease or increase. As mentioned before, there are reasons to believe that the final change in ex-refinery prices will be less than the corresponding change in crude oil prices because the weight of crude in the production function of refining is less than one.

In Figure 4 we also estimated through a simulation the levels at which the consumer price settles in a steady state after a shock of 10 per cent in the crude price. Evidently, in this second equation the weight of crude oil is further reduced because of the presence of distributional costs. We estimated it to be 6.0 in the case of a crude oil price decrease and 5.6 in the case of an increase.

Some statistical sources (OPEC (1984)) provide an approximate, but valid, indication, of the cost structure of a standard

refinery in Europe. They suggest that crude oil represents 77 per cent of ex-refinery price and 58 per cent of consumer price (both net of tax).

5 CONCLUSIONS

As mentioned before a vast literature suggests that an oligopolistic market is characterized by slow price responses to variations in cost. Figures 5 and 6 show an example of this stickiness comparing the price response for retail price to the ex-refinery gate price.

Figure 5

A simulation of the impact of a positive 10 per cent crude oil price shock on the refinery gate and on retail price.

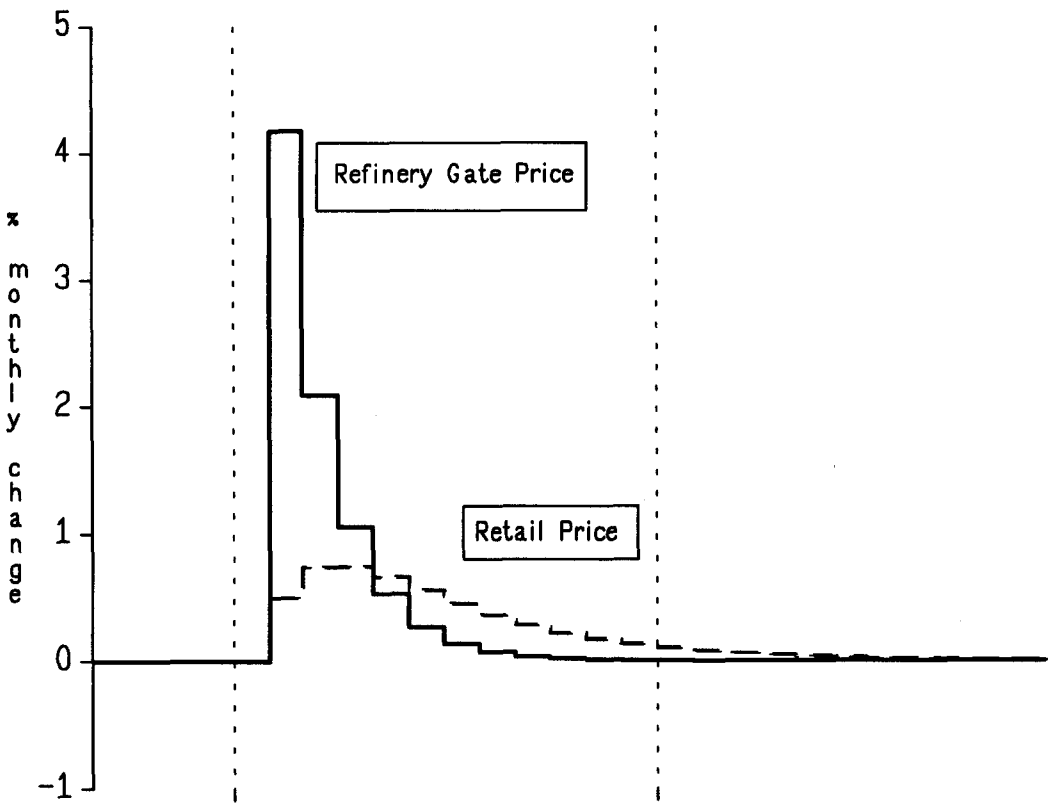
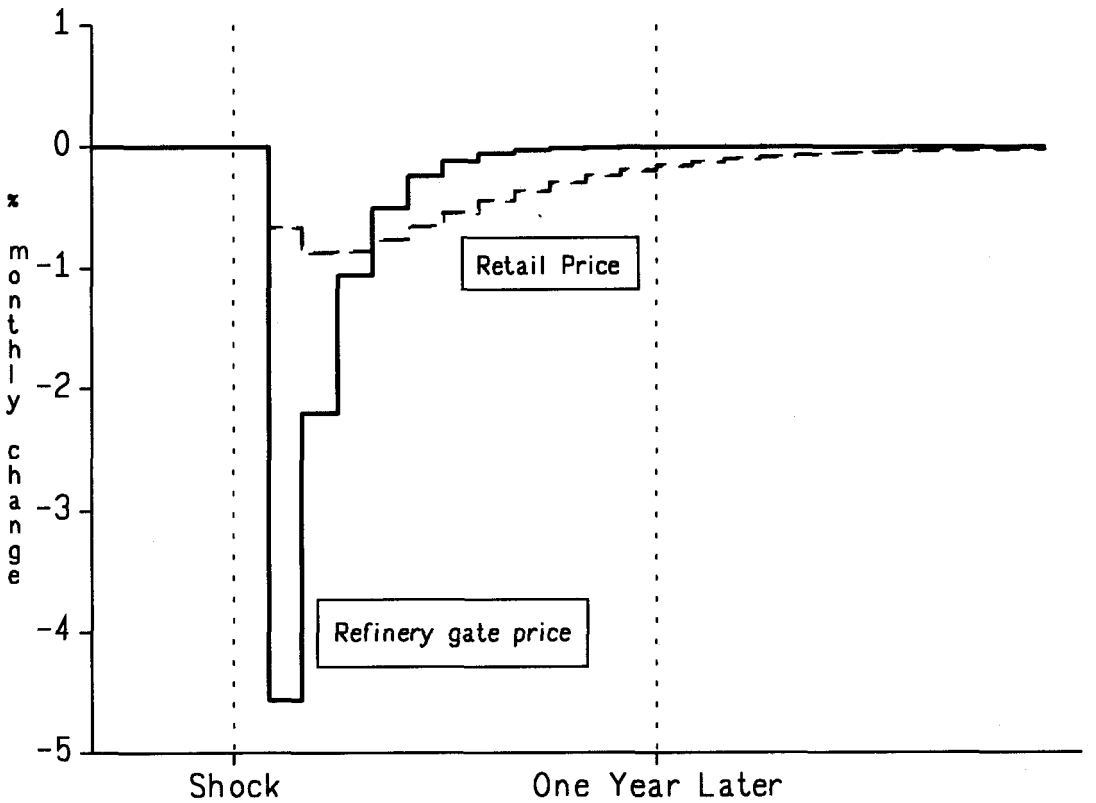


Figure 6

A simulation of the impact of a negative 10 per cent crude oil price shock on the refinery gate and on retail price.



Two characteristics of the price adjustment process have been investigated. First the length of the adjustment lag (the longer the lag, the slower is the adjustment), and second the symmetry or lack of symmetry of price adjustment to cost increase and decrease. To sum up, the results from the gasoline market in the FRG are as follows:

Adjustment of:	Length of Adjustment Lag (months)	Symmetry
Ex-refinery price		No statistical evidence for lack of symmetry.
for positive variation (of crude oil price)	2.94	
for negative variation	2.89	
Consumer price		More rigid downward than upward
for positive variation	5.37	
for negative variation	6.07	

Despite far-reaching structural change and the resulting need for adjustment, a heterogeneous structure of suppliers has been preserved. At the end of the 1980s there were about fourteen refining companies and as many as 100 independent importers. Their share of product as percentage of total imports has increased continuously during the 80s.

The presence of such a fragmentary structure for production and import probably accounts for a fairly competitive market.

Different and somehow ambiguous is the case of distribution. The presence of a not perfect competitive structure clearly stems from the model results. It is difficult to say whether this reflects or not the actual FRG situation due to the lack of specific studies on this particular market.[18]

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18 In a recent study on the gasoline market in the U.K. R. Bacon (1990), used a different econometric technique. His results can only partly be compared to ours. In his study however the mean lag for positive variation was smaller than that for the negative ones but the mean lag was about 2 months while it is 5 in our study.

On the other hand it has been observed that "a characteristic of the gasoline market that facilitates collusion is the small size of individual gasoline stations relative to supplier operations in most areas."[19] This situation can be seen in West Germany during the 1980s; the so-called "white pumps" have taken over big companies which have retained only the function of traders.

As Stigler pointed out "an oligopolist will not consider making secret price cuts to buyers whose purchases fall below a certain size relative to his aggregate sales. It follows that oligopolistic collusion will often be effective against small buyers even when it is ineffective against large buyers". When dealing with small retailers, therefore, the oligopolists "will adhere to the agreed upon price, even though they are cutting price to large chain stores and industrial buyers".

In other words market fragmentation and the onset of small distributors could have fostered a behavioural asymmetry in case of cost increase/decrease. Following this line, pump prices do not appear to reflect the behaviour of the service station owner uniquely but also that of the wholesale gasoline trader.

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19 Schurmann H.J. (1986)

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A.E.R	American Economic Review
E.J	Economic Journal
Econ.	Econometrica
J.I.E	Journal of Industrial Economics
J.P.E	Journal of Political Economy
R.E.S	Review of Economics and Statistics
U.P	University Press (i.e. Cambridge U.P = Cambridge University Press)

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