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Market Domination: Tests Applied to the Danish Cement Industry

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Abstract

We propose an economic interpretation of the definition of a dominant position used by the European Court of Justice (ECJ). Then we apply co-integration techniques to test econometrically whether the sole Danish producer of cement holds a dominant position. Import penetration tests show that its conduct is independent of import price and quantity, so it can act to a considerable extent independently of its competitors. We also test whether it can act independently of its customers and find that its demand is inelastic with respect to its price. It thus holds a dominant position on the relevant Danish market.

Keywords: dominant position, econometric tests, cement

JEL Classification: K21, L41, L61

Aalborg Portland A/S (AP in the following)—Denmark's sole producer of cement with an 85 percent share of Danish demand—was deemed guilty of abuse of its dominant position by the Danish Competition Council at its meeting on June 17, 1998. The alleged abuse consisted of charging excessive prices on the Danish market. However, the Competition Council deferred its decision of an appropriate remedy to a later meeting. At this meeting (on October 28, 1998), the Council then decided that the evidence of AP's abuse was not sufficiently clear and repealed its earlier decision.

In this paper we test econometrically whether AP holds a dominant position in the Danish market in the sense of the European Court of Justice (ECJ). The Court defines "a dominant position" as the ability for a firm "to behave to an appreciable extent independently of its competitors and customers and ultimately of its consumers."[1] We first test whether the firm has acted independently of its competitors who are all importers of cement. We find that AP's pricing and quantity decisions are indeed independent of import price and quantity.

We then test whether AP acts independently of its customers and consumers. The legal terminology used by EU competition lawyers does not translate immediately into economics. Economists might argue that no firm, not even the textbook monopolist, would

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want to act independently of its customers. We interpret the legal language as meaning that the firm faces inelastic demand allowing it to raise prices without loss of revenue. We find that the own-price elasticity of demand is close to zero, indicating that the demand is indeed inelastic.

Our approach follows what has become known as the Scandinavian school of realistic legal theory that was dominating in the Nordic countries during the 20th century. This methodology prescribes that the analysis of legal regimes should aim at predicting how the courts would determine hypothetical cases according to their legal philosophy were the cases to be presented before the courts.[2]

In this paper we do not wish to dispute the wisdom of the Court's definition of domination nor do we want to undertake a full economic analysis of the cement industry. Instead we adopt the more limited scope of interpreting the Court's classic definition of market domination using modern econometric techniques on a particular industry for which data is available. Since AP supplies 85 percent of total Danish demand, it clearly would have a dominant position according to standard European Commission criteria (i.e. a market share of at least 40 percent) *provided* Denmark is automatically accepted as the relevant geographical market. However given that AP exports almost one third of its produced quantity and that importers hold a market share of about 15 percent, it is not immediate that Denmark is the relevant market. We find that AP is indeed dominating the Danish market.

Methods similar to those we employ have previously been employed by others, often to get to results opposite to ours in different markets. In Section 1 we present the methodology and give an overview of this related literature. Section 2 describes the industry and the data. Section 3 analyses whether AP holds a dominant position, arguing that it does. Section 4 concludes the paper and discusses weak evidence as to whether it abused its dominant position.

1. Methodology and related literature

In defining markets, price correlations have often been used to test whether the law of one price holds in different market segments (geographically or with respect to product characteristics). The underlying principle is simple: if substitution or arbitrage may be done easily, we expect to see a high correlation of prices. The idea that price correlation may provide some indication of whether two geographic areas are in the same economic market or the degree of interdependence between sellers dates back at least to Stigler and Sherwin (1985). Prices of the same homogeneous good may differ because of transport or other transaction costs and temporary shocks to costs or demand may cause them to be out of line for a certain period of time.

Today, it is well accepted that a positive and large correlation (taking account of possible lags) could indicate either that the sellers belong to the same market (and thus are highly interdependent) *or* that there is a common third factor (such as an input price) that causes the output prices to move together.[3] However, correlation may be spurious if prices react to a common factor and it is possible that rather than being contemporary, there are lags in the relationship between the prices. This may jeopardize the tests.

By instead testing for stationarity and co-integration, we analyse whether there is a fixed *long-run* relationship between prices, i.e. whether some relation between prices (perhaps

the relative price) tends to revert to a constant mean value after short-term shocks. If markets are integrated or connected then there should be a stationary relationship between prices in different market segments, thus prices should be co-integrated. In that case there would be an error-correction model that would allow for short-run deviations from the long-run relationship but would explain the short-run dynamics to restore equilibrium from a situation characterized by dis-equilibrium. Statistical methods allow us to test for the presence (and number) of such relations. If markets are not integrated, pricing decisions in one market are uncorrelated with prices in the other market and we would not expect prices to be co-integrated.

A number of studies use co-integration methods to test whether markets are integrated or whether, on the contrary, sub-markets may be defined as the relevant market in antitrust terms. Benson et al. (1994) show that regional North American slaughter hog markets are integrated although they are spatially segmented by transportation costs: price shocks in the US or Ontario will thus affect prices in Alberta through its consecutive effects on the prices in Manitoba and Saskatchewan. Gordon and Hannesson (1996) similarly show that within Europe, markets for both fresh and frozen cod products are well integrated. However the U.S. fresh cod market is distinct and separate from European markets since there is no co-integration between prices in these markets. The U.S. frozen cod market might have a long-run link with the corresponding European markets but show no short-run links to European markets.[4]

In this paper we do *not* test whether the Danish market is integrated with other markets, notably contiguous markets. Instead we test whether pricing of the Danish producer on the Danish market is sensitive to changes in import prices, i.e. whether its conduct is independent of that of its rivals. In addition we test its discretion in pricing vis a vis customers. To our knowledge this direct approach of testing for ECJ's definition of market dominance has not been pursued before,[5] but two studies of the market for salmon in France may however in combination be interpreted in the light of the ECJ's definition of market dominance and provide an example that our approach may yield a different result. Gordon, Salvanes, and Atkins (1993) demonstrate that salmon is priced independently of turbot and cod at the Rungis wholesale market for fresh fish near Paris. This means that suppliers of (predominantly Norwegian) farmed salmon may set their prices independently of competitors who supply wild-caught fish that is often taken to be close substitutes to salmon (especially turbot). However, Bjørndal, Salvanes, and Andreassen (1992) have estimated that demand for salmon is elastic: the own price elasticity is -1.30 in the long run and -1.06 in the short run. This means that producers of salmon cannot set prices independently of their customers (and ultimately of consumers). They would thus not (jointly) possess a dominant position in the ECJ's sense.[6]

Co-integrating salmon prices were in fact at the centre of a recent decision by the UK Competition Commission to block a merger between Nutreco Holding NV and Hydro Seafood GSP (see Competition Commission (2000)). Lexecon (2001, p. 2) demonstrated that Scottish and Norwegian prices of salmon co-integrate meaning that "there is a stable differential between the prices of Scottish and Norwegian salmon in the UK over the medium term. This is precisely what would be expected if there is a direct competitive interaction between Scottish and Norwegian salmon in the UK—i.e. if both products are within the

same relevant market." The Competition Commission accepted Lexecon's definition of the relevant market for gutted salmon but turned the merger down because of concerns for the market for fish feed.

Thus we would argue that if (1) the price of the Danish producer of cement does not enter a co-integrating relation with the price of imported cement; (2) the imported quantity is relatively insensitive to the price of the Danish producer on the Danish market; and (3) the demand for Danish cement is inelastic; then the Danish producer holds a dominant position in the sense of the ECJ by acting to a considerable extent independently of competitors, customers, and ultimately of consumers.

2. The industry and the data

There is by now a substantial literature on the relationship between prices and concentration in the U.S. Portland cement industry. A number of studies (McBride, 1983; Koller and Weiss, 1989; Allen, 1993; Rosenbaum, 1994; Jans and Rosenbaum, 1997) report a positive, statistically significant relation between the concentration of cement producers and the price of their product. However, Newmark (1998) shows that if a measure of transportation cost is included in the regression, this positive correlation between price and concentration disappears. Thus, it is not clear from the American studies that a large market share would lead to a high price.

This section describes the industry structure and the sources of supply in Section 2.1, the barriers to entry and the competitors in Section 2.2, the EU case against the European cement cartel in Section 2.3 and the data in Section 2.4.

2.1. Industry structure and supply

The Danish cement industry dates back to 1868 but gained momentum in 1873 when AP started using the abundant limestone of the Aalborg area.[7] In the 1960s industry consolidation had led to the existence of only five plants, four of which were owned and controlled by AP. The fifth plant was owned by a cooperative which already in the early 1960s cooperated with AP since its own capacity was insufficient to satisfy its members' demand. On June 28, 1974 it was decided that AP should take over its smaller rival on January 1, 1975. From then onwards all Danish cement production was controlled by AP.

Up until 1980 almost all import of cement was due to supply shortages: In 1973 there was both general strikes and a problem with one of the kilns; and in 1979 another strike led to imports. However, the 1980s saw independent imports of cement from Poland and East Germany. The Polish cement was imported by BC Industri Cement Aps (BC) and was sold mainly in the eastern island of Sealand. East German cement was imported mainly by Stub Trading (ST) and Mørch Cement (MC).

2.2. Barriers to entry and competitors[8]

Green-field entry into the Danish cement market is unlikely to happen since minimum efficient scale is large compared to the domestic market. The capacity of the newest and largest

kiln is larger than total Danish consumption and other older kilns have remained in operation.[9] In addition, cement production exhibits large economies of scale in capital and labour according to McBride (1983). Due to excess capacity and cost advantages, entry by new producers is thus unlikely. AP most certainly does not have to worry about green-field entry.

A supplier of cement to Danish customers need obviously not itself be located in Denmark as recent history has shown. In the 1980s and 1990s significant amounts of cement have been imported from countries as far away as Greece and Spain. The possibility of imports to (and exports from) Denmark may mean that Denmark is not the "relevant geographic market." In this case, the appropriate geographic market would have to be defined and market shares calculated for this market if one would want to follow the EU Commission's tradition for equating a market share of more than 40 percent with the existence of a dominant position. However, we want to test the more interesting economic question of whether the firm is restricted in its choice of market strategy by the presence of importers. For this we do not have to define Denmark as a relevant geographic market but to test whether, for example, importers react to price changes in Denmark, and whether AP reacts to importers' prices. If they do not, it may be because the firm holds a dominant position due to barriers to entry, be they regulatory or created by the firm itself.

It turns out that AP may have benefited from both regulatory and legal barriers to entry (see below) and from barriers created by a European market sharing agreement (see 3.3).

In 1981 AP succeeded in developing a method of reducing eczema-inducing chromium in cement by adding a compound to the cement. Chromium in cement may cause an allergy that may develop into a chronic decease. By means of the process, this effect is neutralized. The compound was added to all of AP's production. In 1983 a Government order prohibited the sale after April 1, 1984 of cement that was not neutralized in this way. AP held a patent on this process in a number of countries until the end of 2001 and has managed twice to get a ban on sale of East German cement by an injunction granted according to the patent. This led importers to acquire a license so they could add the compound to the imported cement. This license added to their fixed but not to their variable costs.

MC, the largest importer of East German cement, contended that AP had approved the East German cement in its own laboratories in 1986 and that the patent was invalid since the process had been described in a journal as early as 1979. In a counter move, AP sued MC for damages of DKK 100 mn and approached MC's customers telling them that they might be liable too. This was the main reason why MC acquired the licence from AP. AP later withdrew its complaint with the court. MC's contract with the East German cement producer was abruptly discontinued in 1990 when the East German factory was acquired by a large French cement group. Today, MC has formed a joint venture with the Bouri group, a cement trading company and continues to import cement, mostly from Greece.

BC, the importer of Polish cement, initially undercut AP by about 10 percent. Following the initiation of a case before court to establish whether BC violated AP's patent, BC entered a settlement with AP in 1988: AP was to take over the yearly import of 60,000 tonnes of Polish cement; damages for the claimed patent violation would not be claimed; and AP would take over BC's Copenhagen cement silo as of January 1, 1989.

Today, there are two independent importers of cement from southern Europe. They both held licences for the chromium-reducing process in the period, so that imported and

domestically produced cement may safely be perceived as close (if not perfect) substitutes.

2.3. *EU Commission imposes fines on European cement producers' cartel*

In November 1994, the European Commission fined the European Cement Association (Cembureau), eight national cement associations and thirty-three European cement producers, among which AP, for infringement of Article 85 of the Treaty of Rome, see EU Commission (1994). Their offences were a general market-sharing agreement, transnational restrictive practices and restrictive practices relating to exports. The Commission alleged that the infringement had gone on at the latest[10] since January 14, 1983, causing the total fine (ECU 248 mn) to exceed any level previously imposed under EU competition law. AP received a fine of ECU 4 mn.

The Court of First Instance on March 15, 2000 decided to reduce total fines by almost EUR 140 mn out of the EUR 250 mn decided by the Commission. While finding that there was indeed a single agreement between the producers that was designed to ensure non-transhipment to home markets, the Court determined that the Commission had not stated its intention of adopting January 14, 1983 as the starting date for the infringement for all the firms and associations involved and therefore decided to establish the starting date for cartel participation individually for all participants. Some of the associations also claimed that the Commission had never announced its intention of fining them or did not allow them sufficient access to the investigation file. Acknowledging this, the Court decided to annull their fines. (Court of First Instance, 2000)

In the case of AP, the Court reduced the fine from EUR 4,008,000 to EUR 2,349,000 because it restricted the period in which AP was found to have violated Art. 85 to a sub-period of that found by the Commission and because it annulled the verdict on damaging information exchange. AP has decided to appeal the size of the fine. The case of guilt may not be appealed.

Although the market might thus have been rigged and thus protected from competition from the companies that participated in the cement cartel, there was competition from companies not participating in the cartel. In fact, there were independent competitors (non-cartel members) such as MC, BC and ST mentioned in Sections 2.1 and 2.2. In interpreting the market delineation, it should be kept in mind, that competition from other EU countries was curbed by the cartel so that the competitors had to be non-cartel members from non-member countries.

2.4. *The data*

The data set has been constructed mainly from the official statistics of Statistics Denmark, especially the quarterly "Commodity statistics for manufacturing"[11] and "External trade by commodity and countries."[12] From these publications quarterly series for the quantity measured in tonnes and the value measured in DKK may be constructed for production, imports and exports of cement. The total sample runs from the first quarter of 1968 to the fourth quarter of 1998, i.e. 31 years of 4 quarterly observations making for a total of 124

observations. From 1968 through 1980, cement was only reported as one commodity. Since 1981, however, the production statistics have been split into two commodities: white cement and grey cement.[13] Since 1988, the trade statistics have distinguished between those two commodities as well. We have chosen to work with the aggregation of the two commodities in order to increase the number of observations. Statistics Denmark did not publish the value of the export of grey cement between 1994 and 1996. Aalborg Portland kindly provided those data directly.

From the aggregate data (grey and white cement lumped together), unit values may be constructed by dividing the value by the quantity. This is the price information we use in the following. Unit values are vulnerable to spurious variation if e.g. prices of grey and white cement remain constant while the quantities of white and grey cement change. This is one possible source of measurement error in our data. Below we argue that this is not serious for the price series that we employ in the statistical analysis of Section 3.

Since we focus on sales in Denmark, we have constructed AP's supply for the Danish market by subtracting exports from production. This has been done both in values and in quantities, allowing us to construct a unit value that serves as a proxy for AP's price on the Danish market. As will be evident below, there is one extreme outlier in this price series in the fourth quarter of 1992. This outlier is caused by the fact that more white cement was exported in that quarter than was produced, while the price (unit value) of the export was much below the unit value of production. This is possible because cement may be stored, which introduces a second possible source of measurement error in the price data. This may explain why we need to introduce lags in the econometric analysis below.

To test the seriousness of this measurement error we investigated the relationship between the different price series for the period where dis-aggregation was possible, i.e. 1988–1998. Table 1 summarizes the data by showing the average quarterly quantity, revenue and unit value by white and grey cement and by origin and use.

In the 1988–1998 period, AP's production consisted of 21 percent white cement and 79 percent grey cement. Almost all of the white cement was exported, so that AP's domestic delivery consisted of 99 percent grey cement and only 1 percent white cement when quantities are used. If values are used, the grey-cement content of AP's total deliveries

Table 1. Quarterly averages over the 1988–1998 period.

		AP's production	Export	Import	AP's dom delivery
Quantity (thousand tons)	Total	559	255	58	304
	White	117	114	0	3
	Grey	442	141	58	301
Revenue (Mn DKK)	Total	289	91	22	198
	White	72	57	0	15
	Grey	217	34	22	183
Price (DKK/ton)	Total	517	358	375	652
	White	614	503	356	4810
	Grey	491	239	375	610

for the Danish market was 92 percent. This indicates that the unit value of AP's domestic deliveries may be thought of as largely measuring variations in the price of grey cement. In the 1988–1998 sub-sample, the correlation coefficient between the production price of grey cement and the price of domestic deliveries of grey cement is 0.9474, while the correlation between the production price of all cement and that of domestic delivery of all cement only is 0.5733. This is an indication of the level of measurement error in the price variable that we use below. An alternative to the dummies introduced below to eliminate the effects of these measurement errors would thus be to replace single observations of the price variable for total cement delivered by AP to the Danish market with that of grey cement.

Table 1 also shows that for both types of cement, the export price is much below the price obtained on the Danish market. The average unit value of 239 DKK/ton of grey exports is only 39 percent of the price charged to the Danish market and is 36 percent below the import price. It was this difference between the domestic price and the export price that lead the Competition Council to initially decide that AP "abuses its dominant position by charging unreasonably high sales prices on the Danish market. Corrected for the cost of transportation, Aalborg Portland A/S in 1997 sold the most important type of cement (grey cement) at a price that is more than twice as high as on the export markets." (Competition Council, 1998, our translation)

Note that the import prices (unit values) that are employed in the following include cost, insurance and freight (CIF) while the export prices are measured FOB (free on board). This means that the import price includes costs for transportation and insurance to the Danish border and since the value is measured in Danish kroner, it also includes the effect of changing exchange rates. On the other hand, export prices do not include insurance and freight and thus tend to be lower for that reason alone.

For the tests below we also need a variable that may be used to indicate the strength of demand. We constructed two variables: the number of started square metres for all buildings and the total employment in the construction industry. In both cases the source was Statistics Denmark, although we kindly received the employment figures from 1971 through 1998 from the research department of the Danish central bank. The number of started square metres turned out to have undesirable statistical as well as interpretative properties, and in the following building activity will be measured by construction employment.

3. The empirical analysis

We first provide a framework for the empirical analysis of whether AP holds a dominant position in Denmark. We denote by σ the market share of importers when defined in quantities and by Σ importers' share when defined in values:

$$\begin{aligned} \sigma &\equiv \frac{M}{M+D} \\ \Sigma &\equiv \frac{P^M M}{P^M M + P^D D} \end{aligned} \tag{1}$$

where M and D are the imported and domestically produced quantities, respectively, and P^M and P^D are the corresponding prices. Further denote by μ the elasticity of M with respect to P^D and by η the elasticity of D with respect to P^D. Finally denote by ρ the elasticity of P^M with respect to P^D. Then we can show (see Appendix A) that there are simple relations connecting the elasticities of σ and Σ with respect to $P^D$with μ, η and ρ:

$$\begin{aligned} \dot{\sigma} &\equiv \frac{\partial \sigma/\sigma}{\partial P^D/P^D} = (1-\sigma)[\mu - \eta] \\ \dot{\Sigma} &\equiv \frac{\partial \Sigma/\Sigma}{\partial P^D/P^D} = (1-\Sigma)[\rho - 1 + \mu - \eta] \end{aligned} \tag{2}$$

The sensitivity of the import share to domestic price changes is increasing in the market share of the domestic firm, $(1-\sigma)$ or $(1-\Sigma)$, for quantities and values, respectively. It is also increasing in the difference between the elasticities of the import quantity and the domestic quantity. Finally the sensitivity of the value-based import share is increasing in the sensitivity of the import price with respect to the domestic price. Note that it may be that $\dot{\sigma} > 0$ while $\dot{\Sigma} < 0$. This may happen if $1 - \rho > \mu - \eta > 0$.

If $\dot{\sigma}$ and $\dot{\Sigma}$ are close to zero, then the market share of importers is not sensitive to domestic price changes and the dominant firm has the possibility to set prices independently of competitors (as expressed by μ and ρ) and customers (as expressed by η).

To test whether AP holds a dominant position on the Danish market for grey cement, we first estimate ρ in Section 3.1. We investigate the relation between AP's price on the Danish market and its competitors' prices (import prices) and find that $\rho = 0$. In Section 3.2 we provide an estimate of $\mu = 0.6$, i.e. import quantity is relatively inelastic with respect to AP's price. In Section 3.3 we estimate η at -0.27 which shows that AP's demand is also inelastic. In fact we cannot rule out that η could be zero. If $\eta = \rho = 0$, then $\dot{\sigma}$ and $\dot{\Sigma}$ will take on the same (positive) sign only if $\mu > 1$. In Section 3.3 we thus also test whether it is possible that $\mu = 1$ (although estimated at 0.6). We reject that hypothesis. Combining our estimates of μ, η and ρ, we have indirectly estimated $\dot{\sigma} = 0.84 \times 0.60 = 0.5$ and $\dot{\Sigma} = 0.89 \times [0.60 - 1] = -0.356$. These elasticities are small and have opposite signs.

In combination these findings strongly indicate that AP holds a dominant position on the Danish market in the sense of the Court.

3.1. Analysis of price behaviour (ρ)

In this section we investigate whether independent importers' pricing decisions have affected AP's price on the Danish market. Our regression model makes us conclude that there is no evidence that the Danish price of AP has shown signs of following the development in the import price. This suggests that AP's dominant position as a price setter on the Danish cement market has not really been threatened by importers.

Figure 1 graphs AP's domestic price and the price of imported cement. The co-movement of the two series is not too close implying that no strong correlation between the price series will be found in the statistical analysis either.[14] We consider the observation of the Danish price in the 4th quarter of 1992 an outlier.

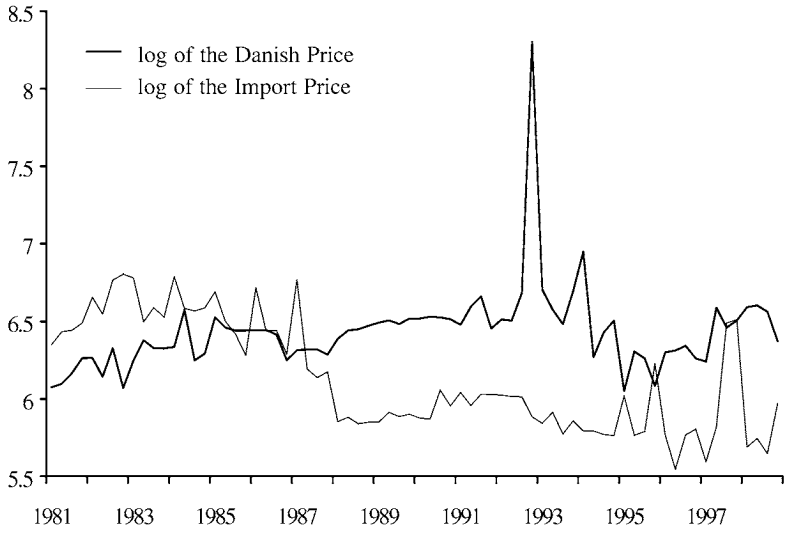

Figure 1. Prices in the Danish cement market.

The graph also indicates slow or no mean-reversion implying that the series must be analysed as non-stationary time series. Univariate Dickey-Fuller tests of the unit root hypothesis (i.e. non-stationarity) support this visual impression, see Appendix C. For non-stationary time series it is possible to analyse both possible long-run (or equilibrium) relations and short-run dynamics among the series. This is most powerfully done within the framework of a multivariate time series model. We apply a vector autoregressive (VAR) model that allows for non-stationary time series and co-integration, see e.g. Johansen (1995). More on this model is found in Appendix D. We use this appropriately specified statistical model to determine the number of long-run relations. Having done so, we can test hypotheses of interest on long-run relations among the levels of the time series. Finally, an analysis of the short run dynamics or special features of the short run adjustment can be performed.

For the two price series we select a VAR(2) model to analyse the data for the sample (estimation) period from first quarter of 1981 to fourth quarter of 1998. To make the model conform to the statistical assumptions, we condition on four event dummies—three for the Danish price series (1992, 4th quarter; 1994, 2nd quarter; and 1997, 2nd quarter) and one for the import price (1995, 1st quarter).[15] As the series contain quarterly observations, we include a set of centred seasonal dummies in the information set. Appendix E provides a more exact definition of the dummy variables and on the results of the mis-specification tests.

The Johansen Trace test is used to determine whether a long run relation among the levels of the two price series exists. Table 2 reports the results from the testing procedure.

The trace statistic for the hypothesis of no long-run relations is not rejected (row one of the table)—even at the 10% level. We find no evidence of a long-run relation among the levels of the two price series and hence no indication that the Danish price behaviour is

Table 2. Results of the Johansen trace-test.

Number of relations	Trace test statistic	90% quantile	95% quantile
0	19.59	22.95	25.47
1	4.42	10.56	12.39

The asymptotic quantiles are from Johansen (1995), Table 15.4.

affected by the behaviour of the import price. On the basis of this conclusion, any further analysis of short-run adjustment behaviour becomes meaningless.

Figure 2 graphs the candidate long-run relation of the VAR-model and clearly supports the impression of non-stationarity and no mean-reversion.

For the sake of completeness, we report the results of a single equation regression for the short run dependence of the Danish price on the import price:

$$\begin{aligned}\Delta lpdk_t = {} & 0.01 + 0.02\,\Delta lpdk_{t-1} - 0.04\,\Delta lpdk_{t-2} - 0.03\,\Delta lpm_t + 0.03\Delta\, dlpm_{t-1} + 0.09\,\Delta dlpm_{t-2} \\ & (0.75) \quad (0.23) \quad (-0.64) \quad (-0.44) \quad (0.43) \quad (1.48) \\ & + 1.61\,\mathrm{D92\text{-}4}_t - 0.43\,\mathrm{D94\text{-}2}_t - 0.34\,\mathrm{D95\text{-}1}_t + 0.23\,\mathrm{D97\text{-}2}_t \\ & (15.59) \quad (-4.51) \quad (-3.65) \quad (2.38)\end{aligned} \tag{3}$$

where Δ is the first difference operator, *lpdk* is the log of the Danish price series and *lpm* the log of the import price series. Daa-b is an event dummy for bth quarter of year aa. Values in parentheses are t-values.

The choice of the number of lagged explanatory variables was inspired by the multivariate analysis. We think of the relation as the first equation of the system conditioned on the contemporaneous changes in the import price. Based on the individual t-values, no

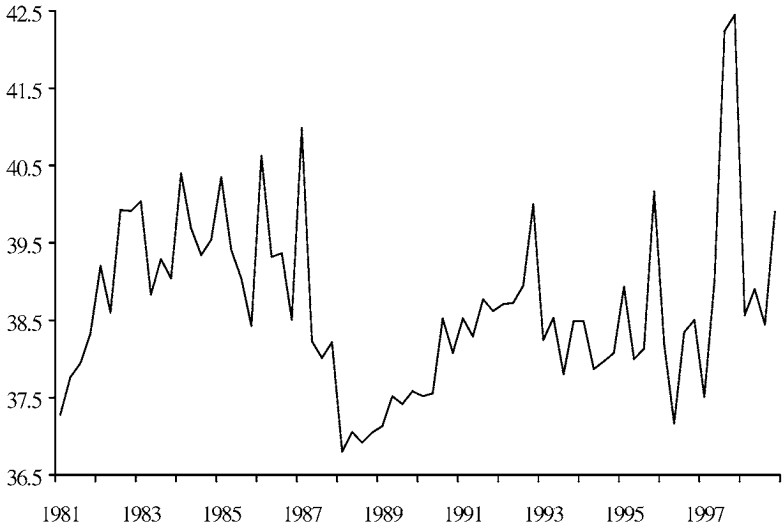

Figure 2. The candidate long-run relation.

significant effects of the import price on the Danish price is found (only the dummy variables are significant). To enforce this conclusion, we performed an F test of the composite hypothesis that the coefficient of the contemporaneous as well as the two lagged values of the change in the import price be zero. The F test statistic is 0.96 with a p-value of 0.41 such that this null cannot be rejected. Furthermore, the results of the long-run and short run analysis taken together exclude any causal (in the Granger sense) effects from import prices to the Danish price. In total, the additional analysis of the short run regression strengthens the conclusions of the long-run analysis: the Danish price does not respond to the import price, supporting the hypothesis that AP's price setting in Denmark has not been affected by competition from imports.

3.2. *The import penetration test (μ)*

We now investigate the sensitivity of imports with respect to prices in general and AP's domestic price in particular. We base the analysis on an import demand relation. The underlying idea is that if the imported quantity is elastic with respect to AP's price then imports are important for AP's market share and profit even in the absence of a price relation. An inelastic cross price effect on the other hand is seen as an indication of no true threat from imports to the price setting of the Danish firm. Again regression methods are applied in the testing procedure and due to the non-stationarity of the price series and possibly also of the imported quantity series the use of a co-integrated VAR-model is called for. As suggested in OFT (1999), an activity variable as well as a time trend is allowed for in the levels or long-run relation. The activity variable is represented by the employment in the construction and housing sector. A trend is included to capture possible technical advances in construction. Hence the data set of Section 3.1 has been extended by the import quantity series and the activity variable. The theoretical relation of interest is:

$$lqm_t = \beta_0 + \beta_1 lpdk_t + \beta_2 lpm_t + \beta_3 lact_t + \beta_4 t \tag{4}$$

where *lqm* is the log of the import quantity, *lpdk* is the log of AP's price on the Danish market, *lpm* is the log of the import price, *lact* is the log of the activity variable and t is the time trend. In order for this relation to be an import demand relation we expect β_1 to be positive (and if elastic to be larger than or equal to 1), β_2 to be negative and β_3 to be positive.

The hypothesis of the test is that the elasticity of imports with respect to AP's price is larger than or equal to 1 i.e. that the import demand is elastic and "the local producer will have limited room to exercise market power" (OFT, 1999, p. 81).On the other hand, if we find that $\mu < 1$, we may conclude that imports are for some reason not responding forcefully to increases in this price and that the firm does not have to worry too much about competitors in its price setting. Note that β_1 is the estimate of μ.

A VAR(4) model turns out to provide an appropriate description of the data for the import quantity series, the two price series and the activity variable. For reports of the misspecification tests and a description of the event dummies used in the analysis, see Appendix F. That the VAR model of this four dimensional data set needs four lags is explained by the strong seasonality of the activity variable. We also include a set of centered seasonal dummies as conditioning variables. Within the VAR(4) model, we determine

Table 3. Results of the Johansen trace test for the import penetration model.

Number of relations	Trace test statistic	90% quantiles	95% quantiles
0	61.98	58.96	62.61
1	26.54	39.08	42.20
2	7.93	22.95	25.47
3	1.34	10.56	12.39

The asymptotic quantiles are from Johansen (1995), Table 15.4.

the number of long-run relations using the Johansen Trace test. The results are found in Table 3:

It is often argued that a significance level of at least 10% is appropriate for such a test since the null hypothesis in each step in a sense is that of non-stationarity which due to standard statistical practices would make it more difficult to find the relations of economic interest that we are looking for. Hence as the test statistic of the null of no long-run relation (first row of the table) is larger than the asymptotic 10% critical value we conclude that the number of long-run relations is at least one. This conclusion would of course have been stronger had the statistic in addition been larger than the 95% quantile. Since the test statistic of the second row in the table is smaller than even the asymptotic 90% quantile, we conclude that the number of long-run relations is one. This conclusion is also supported by the economic interpretation of the relation, see the estimated coefficients in (5) below. The presence of one long-run relation among the variables of the data set could in fact mean that one of the "new" series in the data set—either the import quantity or the activity series—is a stationary series. To exclude this possibility, we test individual stationarity within the multivariate framework conditioning on the chosen number of long-run relations to get a χ^2 test, see Johansen (1995). We find that neither the import quantity nor the activity series is stationary.[16] Normalizing the unrestricted long-run relation on the import quantity, we get:

$$lqm_t = 0.60\ lpdk_t - 1.60\ lpm_t + 0.54\ lact_t + 0.02t \tag{5}$$

Note that the signs of the coefficients in (5) are in accordance with our prior expectations. In this unrestricted version, the elasticity of the import quantity with respect to AP's price, $\mu = 0.60$, is well below 1. This conclusion, however, has to be confirmed by a proper statistical test. The null of the import penetration test is that the elasticity is $1(\beta_1 = 1)$. This hypothesis imposes one restriction on the relation and we use a test statistic with an asymptotic χ^2 distribution with one degree of freedom (Johansen and Juselius, 1994). The test statistic is 6.82 which means that the null is clearly rejected. So the initial impression of an inelastic import demand curve is supported by the statistical test. A final test in the analysis concerns the hypothesis that it is the relative price that matters and at the same time that the import demand is elastic with respect to the relative price. This hypothesis imposes two restrictions on the coefficients of the relation and gives a test statistic of 9.33. As the asymptotic 95% value of the χ^2 distribution with two degrees of freedom is 5.99, this second hypothesis is also clearly rejected. Hence the overall conclusion from the import

penetration testing is that import quantities do not respond sufficiently strongly to changes in the price of the domestic firm to restrain the profitability of a price change.

The import penetration test indicated that the *potential* for abuse of market power seems to have been present for the sample period under study. The analysis of the price behaviour further points towards an independent price setting behaviour of AP in the Danish cement market. In sum, empirical analysis in this case provides us with quite strong evidence that AP has been able "to behave to an appreciable extent independently of its competitors" in the Danish cement market in the 1980s and most of the 1990s.

Our findings are consistent with what we know empirically about entry (Geroski, 1995): Incumbents very often do not use lowering of prices to discourage entry: if they react at all, they often use non-price variables instead. Our findings are also consistent with the analysis Sørgard (1992) carried out for entry into the Norwegian cement industry: the price reaction of the incumbent may be to increase price, to let it stay the same or to decrease the price, depending on the nature of the entrant. If the entrant appears to be weak (high costs and low capacity)—playing the puppy dog ploy—then the incumbent might in fact wish to raise its price in a high quality segment. However, this may depend crucially on the precise calibration of the industry.

3.3. *Determination of the own-price elasticity of demand in the Danish cement market (η)*

We now test whether AP has been able to behave to an appreciable extent independently of its *customers* by analysing whether demand is inelastic. In order to determine the own-price elasticity of demand in the Danish cement market we set op a system that contains the following variables: A quantity variable (*qdk*), the corresponding price variable (*pdk*—AP's price on the Danish market, also used in Sections 3.1 and 3.2), the price of imported cement (*pm*), an activity variable ('act'—the same one as the one used in Section 3.2) and a time trend (to capture changes due to changes in preferences or changes in technology).[17] All of these variables enter the analysis in logs. With only a few lags in the system equations there is no indication of cointegration amongst these variables and hence no long-run demand relation can be discovered. This means that we are unable to report an elastic (with respect to the own-price) demand for Danish cement i.e. that we cannot reject that AP is in a dominant position. It is however possible to set up a quite well specified VAR(8) model[18] for the present set of series and the results of an analysis of that system are reported below just to reinforce the above conclusion. The number of long-run relations amongst the series is determined based on Table 4 below:

Based on the figures in Table 4 we conclude that there is one long-run relation, the content of which is in accordance with an interpretation of a demand relation:

$$lqdk_t = -0.27\ lpdk_t + 0.33\ lpm_t + 2.79\ lact_t + 0.01\ \text{trend} \tag{6}$$

We are unable to provide the Wald-like standard errors in the present case as no restrictions except of a normalizing one are imposed on this relation (Hansen and Juselius, 1995). We are, however, able to add certain significance statements as we have performed additional

Table 4. Results of the Johansen trace test for the demand model.

Number of relations	Trace test statistic	90% quantiles	95% quantiles
0	65.96	58.96	62.61
1	27.00	39.08	42.20
2	14.84	22.95	25.47
3	5.02	10.56	12.39

The asymptotic quantiles are from Johansen (1995), Table 15.4.

Likelihood Ratio (LR) tests for the significance of each of the variables in the relation. These LR tests show that *lpdk*—the own price—is in fact insignificant (p-value = 0.18). The import price is border-line insignificant (p-value = 0.07). The activity variable is clearly significant (p-value = 0.00) and the trend variable is again a border-line case (p-value = 0.05). This means that AP faces an inelastic demand (with respect to own price). We run a final LR test of the hypothesis that the own-price elasticity is 1 to make sure that the above conclusion is correct. This hypothesis is rejected with a p-value of 0.00. Hence there is no support in the data for an elastic demand for Danish cement and the hypothesis cannot be rejected that AP holds a dominant position in the Danish cement market in the sense of the ECJ.

Our finding that the demand for cement has a low elasticity is in line with previous studies. Using a panel of twenty-five cement markets with fifteen yearly observations (1974–1989), Jans and Rosenbaum (1997) predict the average elasticity of demand at 0.81, while Sørgard (1992) uses an elasticity of 0.6. Both of these are higher than ours but still in the inelastic range.

4. Conclusion

We have established that Aalborg Portland holds a dominant position on the Danish market in the sense of the European Court of Justice. We did this through an analysis of AP's pricing behaviour and by an import penetration test thus demonstrating that the company has the power on this market to act independently of its competitors. Furthermore, we established that AP's domestic demand is inelastic allowing it to behave to an appreciable extent independently of its customers and ultimately of its consumers.

Holding a dominant position is not in and of itself prohibited. It is the abuse of this position that is banned. In order to establish abuse by excessive pricing, it is not enough to show that prices are high in a given market. The competition authority must also show that the price-cost margin falls outside the 'normal commercial range' and that the price cannot be considered reasonable in comparison with prices of identical goods. We do not at present possess cost data that would allow us to calculate price-costs margins and must thus refrain from analysing whether AP has abused its dominant position. That is for future research. We have however compared AP's prices with export prices of AP's competitors using unit values calculated on the basis of Eurostat's *Internal and External Trade of the EU*.[19] We find export prices of cement that are both below and above AP's prices. This indicates that

their prices fall within the normal commercial range and we find no indication that AP has abused its dominant position.

Appendix A: The elasticities of Section 3

We denote by σ the market share of importers when defined in quantities and by Σ importers share when defined in values:

$$\begin{aligned} \sigma &\equiv \frac{M}{M+D} \\ \Sigma &\equiv \frac{P^M M}{P^M M + P^D D} \end{aligned} \tag{7}$$

where M and D are the imported and domestically produced quantities, respectively, and P^M and P^D are the corresponding prices. Further denote by μ the elasticity of M with respect to P^D

$$\mu \equiv \frac{\partial M/M}{\partial P^D/P^D} \tag{8}$$

and by η the elasticity of D with respect to P^D:

$$\eta \equiv \frac{\partial D/D}{\partial P^D/P^D} \tag{9}$$

Finally denote by ρ the elasticity of P^M with respect to P^D:

$$\rho \equiv \frac{\partial P^M/P^M}{\partial P^D/P^D} \tag{10}$$

We want to show that there are simple relations connecting the elasticities of σ and Σ with respect to P^D with μ, η and ρ:

$$\begin{aligned} \dot{\sigma} &\equiv \frac{\partial \sigma/\sigma}{\partial P^D/P^D} = (1-\sigma)[\mu - \eta] \\ \dot{\Sigma} &\equiv \frac{\partial \Sigma/\Sigma}{\partial P^D/P^D} = (1-\Sigma)[\rho - 1 + \mu - \eta] \end{aligned} \tag{11}$$

This follows immediately from differentiation of σ and Σ with respect to P^D. Consider σ first:

$$\begin{aligned} \frac{\partial \sigma}{\partial P^D} &= \frac{D\frac{\partial M}{\partial P^D} - M\frac{\partial D}{\partial P^D}}{(M+D)^2} \Rightarrow \frac{\partial \sigma}{\partial P^D}\frac{M+D}{M}P^D = \frac{\partial \sigma/\sigma}{\partial P^D/P^D} = \frac{D\frac{\partial M/M}{\partial P^D/P^D} - \frac{\partial D}{\partial P^D/P^D}}{M+D} \\ &= \frac{D}{M+D} - \left(\frac{\partial M/M}{\partial P^D/P^D} - \frac{\partial D/D}{\partial P^D/P^D}\right) = (1-\sigma)(\mu - \eta) \end{aligned} \tag{12}$$

and the result follows from the definition of $\dot{\sigma}$.

Now consider Σ:

$$
\begin{aligned}
&\frac{\partial \Sigma}{\partial P^D} \\
&= \frac{\left(\frac{\partial P^M}{\partial P^D} D + \frac{\partial M}{\partial P^D} P^M\right)(P^M M + P^D D) - \left(D + \frac{\partial D}{\partial P^D} P^D + \frac{\partial P^M}{\partial P^D} D + \frac{\partial M}{\partial P^D} P^M\right) P^M M}{(P^M M + P^D D)^2} \\
&= \frac{\left(\frac{\partial P^M}{\partial P^D} D + \frac{\partial M}{\partial P^D} P^M\right) P^D D - \left(D + \frac{\partial D}{\partial P^D} P^D\right) P^M M}{(P^M M + P^D D)^2} \\
&= \frac{\left(P^D \frac{\partial P^M}{\partial P^D} - P^M\right) MD + P^M P^D \left(\frac{\partial M}{\partial P^D} D - \frac{\partial D}{\partial P^D} M\right)}{(P^M M + P^D D)^2} \\
&= \frac{\left(\frac{\partial P^M / P^M}{\partial P^D / P^D} - 1\right) P^M MD + \left(\frac{\partial M/M}{\partial P^D / P^D} - \frac{\partial D/D}{\partial P^D / P^D}\right) P^M MD}{(P^M M + P^D D)^2} \\
&= \Sigma \frac{(\rho - 1)D + (\mu - \eta)D}{P^M M + P^D D} = \Sigma(1 - \Sigma)\frac{(\rho - 1) + (\mu - \eta)}{P^D} \\
&\Rightarrow \dot{\Sigma} \equiv \frac{\partial \Sigma / \Sigma}{\partial P^D / P^D} = (1 - \Sigma)[\rho - 1 + \mu - \eta] \qquad (13)
\end{aligned}
$$

This was what we wanted to show.

Appendix B: Graphs of the data

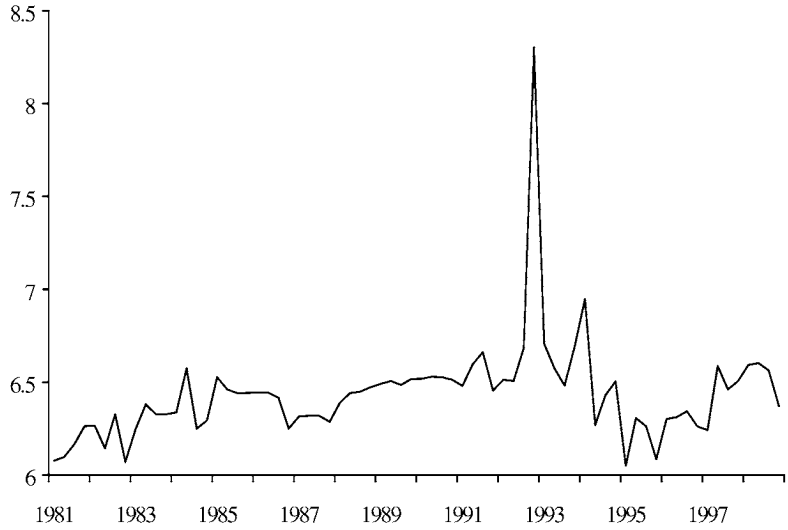

Figure 3. Danish price (log).

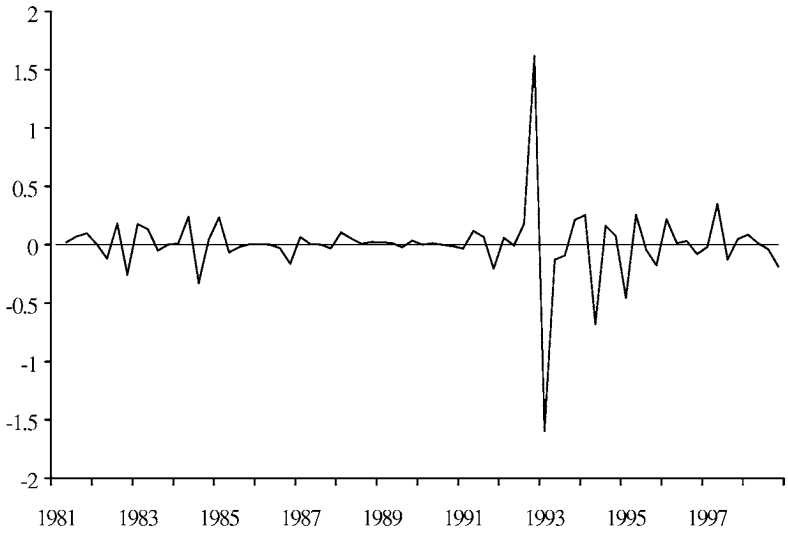

Figure 4. First differences of log of Danish price.

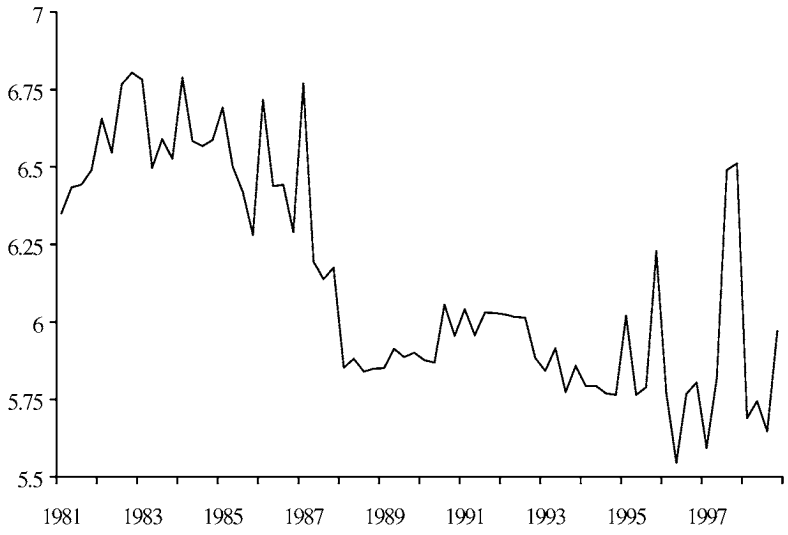

Figure 5. Import price (log).

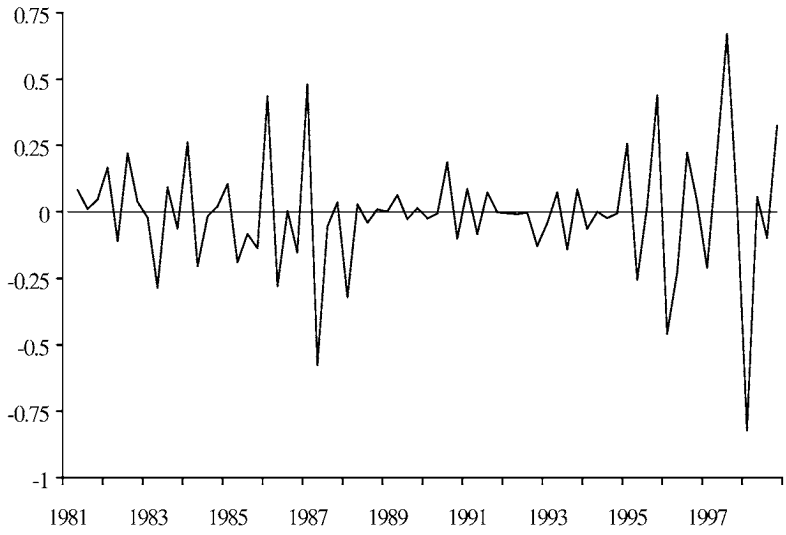

Figure 6. First differences of log of import price.

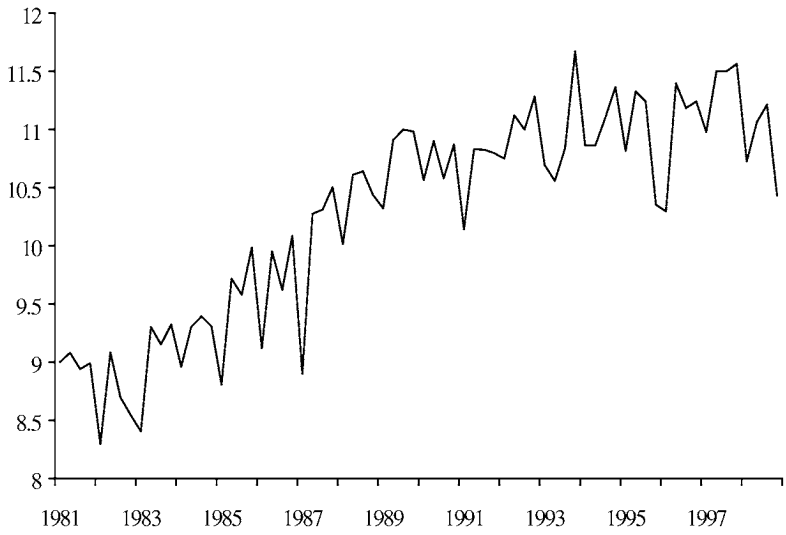

Figure 7. Import quantity (log).

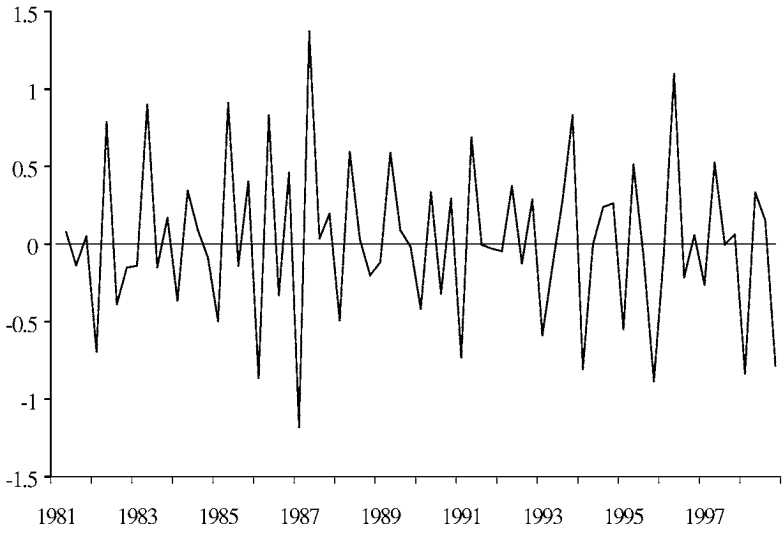

Figure 8. First differences of log of import quantity.

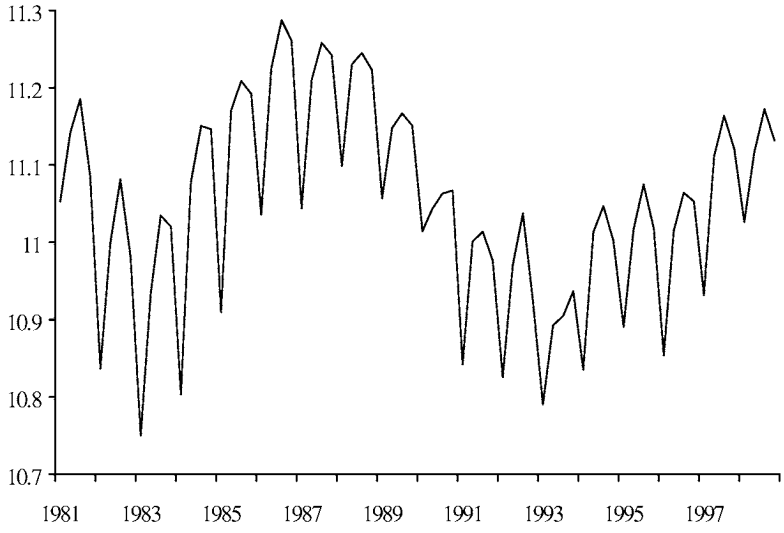

Figure 9. Building activity (log).

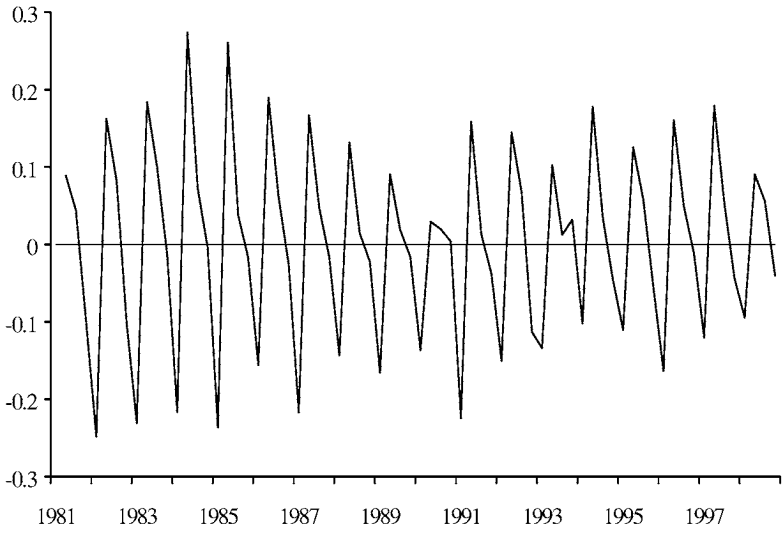

Figure 10. First differences of log of building activity.

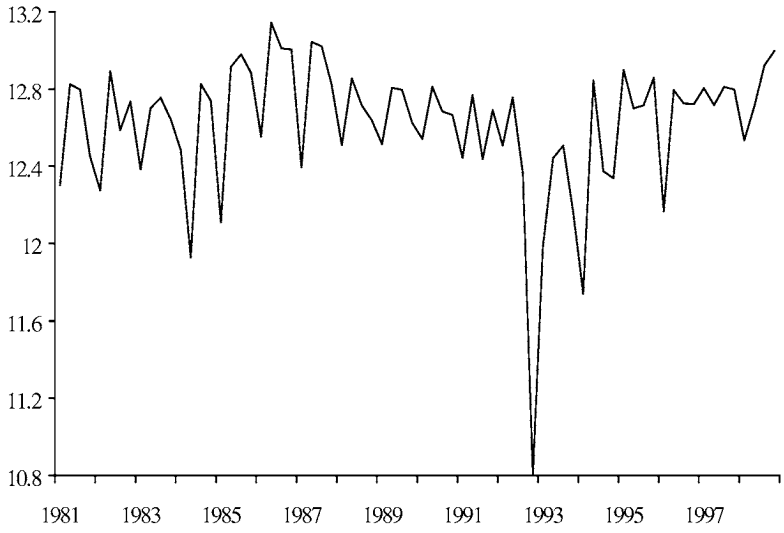

Figure 11. Danish quantity (log).

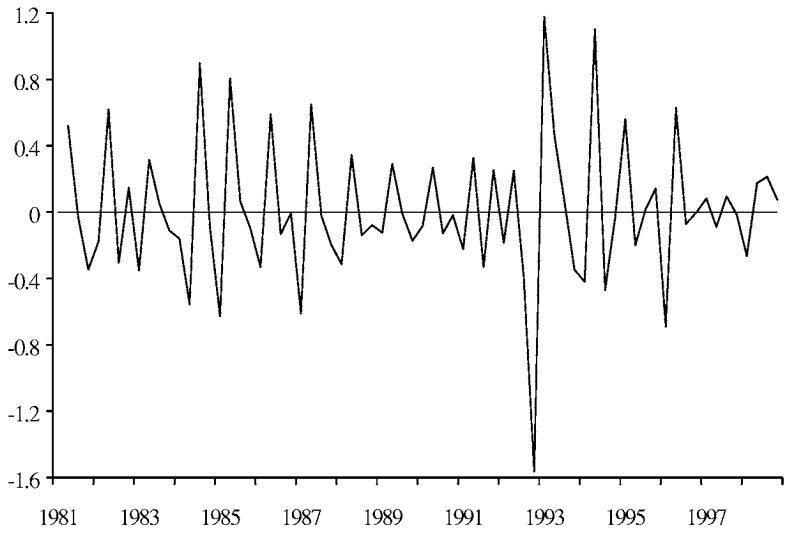

Figure 12. First differences of log of Danish quantity.

Appendix C: Univariate unit root tests

The univariate Dickey-Fuller tests are based on a regression of the change in the series of interest on the lagged level of the series, some lagged differences and maybe also some deterministic components. In the regressions, the results of which are reproduced below, the explanatory variables included are chosen such that each equation look as much like the corresponding one in the multivariate system as possible:

$$\Delta z_t = \alpha_0 + \gamma z_{t-1} + \alpha_1 \Delta z_{t-1} + \text{ Some dummies}; \quad t = 1, \ldots, T \tag{14}$$

where z is either the Danish price series or the import price series. In both cases we include a set of centered seasonal dummies and for the Danish price series also event dummies from the multivariate analysis. We test the null hypothesis: $\gamma = 0$ — i.e. the null of non-stationarity. The test statistic is the usual t-statistic only it does not follow a t-distribution under the null but rather what is known as the Dickey-Fuller distribution with simulated critical values available from various text books on econometrics.

With approximately 100 observations the 5% critical value of the test statistic is: −2.89 (the null of non-stationarity is rejected when the test statistic is smaller than the critical value of the table); while the 10% critical value is: −2.58 (see e.g. Enders (1995), p. 223).

Table 5. Results of the Dickey-Fuller type unit root tests.

Series	DF-statistic	Conclusion
Danish price	−2.16	Non-stationary
Import price	−2.00	Non-stationary

An assumption of the unit root test is that the residuals in the unit root regression are uncorrelated. Based on the Ljung-Box tests the residuals of the import price equation fulfill that assumption while it is rejected for the Danish price equation at standard significance levels. Adding a few more lags to the latter equation does not solve this problem so maybe a model with a MA-structure for the residuals will be better in this case. The absolute value of the tau-statistic does, however, only change marginally when additional lags are added to the equation and as the conclusion that each series are individually non-stationary is consistent with the results obtained in the multivariate analysis we will not pursue this minor problem further.

Appendix D: The multivariate statistical model

A vector autoregressive model (VAR) of order k can be expressed as:

$$\begin{aligned} \text{VAR}(k): Z_t &= \Pi_1 Z_{t-1} + \Pi_2 Z_{t-2} + \cdots + \Pi_k Z_{t-k} + \mu + \varphi D_t + \varepsilon_t, \\ t &= 1, 2, \ldots, T \end{aligned} \tag{15}$$

i.e. in a VAR(k) model the p time series of interest (contained in the vector Z_t) are explained by k lagged values of the time series themselves a constant term and maybe in addition some dummy variables, D_t, in order to make the residuals, ε_t, multivariate normally distributed with mean zero and some covariance matrix Ω_p. The Π- and φ-matrices as well as the μ-vector contain the parameters of the model.

In addition to the multivariate aspect of the analysis we want to use a model that allows us to treat the time series properties of the data in a proper way. Based on graphs of the log-transformed data and various unit root tests, see Appendix B and C, there are indications of non-stationarity in the data. For practical purposes non-stationarity means that the means, the variances and the covariances of the time series are not constant over the sample period. To use OLS on the levels of such non-stationary data is a bad idea as such regressions will be affected by e.g. autocorrelation problems that are known to invalidate the standard statistical inference procedures. Fortunately, the VAR model when respecified properly is able to handle non-stationary time series (see Johansen (1995)). As non-stationary time series often can be made stationary by taking first differences (such series are often referred to as $I(1)$ series) the proper transformation of the VAR is done by subtracting Z_{t-1} from both sides of (15) and rearranging terms:

$$\Delta Z_t = \Pi Z_{t-1} + \Gamma_1 \Delta Z_{t-1} + \cdots + \Gamma_{k-1} \Delta Z_{t-k+1} + \mu + \varphi D_t + \varepsilon_t \tag{16}$$

(16) is also known as a vector error correction model (VECM). The matrices of coefficients in the VECM form of the model are uniquely derived from the parameters of the VAR-form. It can be shown that for $I(1)$ series the matrix Π in (16) will have reduced rank, $\Pi = \alpha\beta^T$; where α and β are $(p \times r)$ matrices and superscript 'T' means the transpose of the preceding matrix. Disregarding the deterministic terms, in long-run equilibrium situations all 'changes-in-variables' will equal zero and therefore $\beta^T Z_t$ must be zero as well. This is why $\beta^T Z_t$ can be interpreted as deviations from long-run equilibria which may allow for interesting

economic interpretations of the regression results. Note that for $r > 1$ there are information on more than one long-run equilibrium relation in the data set. The short-run behaviour of the variables is affected both by lagged differences of the series but also by last periods disequilibrium error. The α-vector indicates how fast the variables will change as a result of a disequilibrium hence is interpretable as a set of speed-of-adjustment coefficients. A thorough description of estimation and inference procedures for this model is beyond the scope of this paper. The interested reader is referred to Johansen (1995). It suffices to say that we have procedures available to test for the number of long-run relations (the cointegration rank), to test restrictions on the coefficients of the long-run relations and in case of more than one long-run relation to tests for a different set of restrictions on each of the long-run relations. Restrictions on the short run parameters of the model can also be tested.

Appendix E: Results of the misspecification tests for the price behaviour analysis

Multivariate tests for autocorrelation in the residuals of the model. The null is that there is no autocorrelation.

Test	Statistic	p-value
Ljung-Box test based on 18 lags	77.65	0.12
Lagrange multiplier test, order 1	4.57	0.33
Lagrange multiplier test, order 4	5.47	0.24

Multivariate test for normality. The null is that of normality.

Test	Statistic	p-value
Hansen-Doornik test	7.77	0.10

Univariate tests for ARCH and normality.

We test for 2th order ARCH. The null is that of no ARCH. The test-statistic is asymptotically Chi-square distributed with 2 degrees of freedom (the critical 5% value is 5.99). Normality is tested based on the Jarque-Bera test. The null is that of normality. The test-statistic is asymptotically Chi-square distributed with 2 degrees of freedom (the critical 5% value is 5.99).

Series	Test-statistic, ARCH	Test-statistic, normality
Danish price	9.59	2.36
Import price	6.83	5.40

Based on the above statistics the VAR model with two lags gives a very acceptable description of the data set. The only point of worry is the significance of the univariate

ARCH(2) tests at the standard 5% level. Using a significance level of 1%, however, will almost make the statistics insignificant and therefore we are quite satisfied with the present form of the unrestricted model.

It is at this stage worth mentioning that the nice results with respect to normality of the residuals are partly due to the inclusion of four event-dummies in the D-matrix. The dating of these dummies are mentioned in the main text and they are primarily present to cope with a few outliers in the data set. Each of these dummies consists of zeros except for the period of the outlier. In the outlier period the dummy is 1 while it is defined to be -1 in the following period. Such a construction ensures that the dummy variables do affect neither the linear trends in the levels of the variables nor the asymptotic distribution of the cointegration rank tests.

Appendix F: Results of the misspecification tests for the import penetration analysis

Multivariate tests for autocorrelation in the residuals of the model. The null is that there is no autocorrelation.

Test	Statistic	p-value
Ljung-Box test based on 18 lags	253.91	0.08
Lagrange multiplier test, order 1	15.33	0.50
Lagrange multiplier test, order 4	18.36	0.30

Multivariate test for normality. The null is that of normality.

Test	Statistic	p-value
Hansen-Doornik test	11.04	0.20

Univariate tests for ARCH and normality.

We test for 4th order ARCH. The null is that of no ARCH. The test-statistic is asymptotically Chi-square distributed with 4 degrees of freedom (the critical 5% value is 9.49). Normality is tested based on the Jarque-Bera test. The null is that of normality. The test-statistic is asymptotically Chi-square distributed with 2 degrees of freedom (the critical 5% value is 5.99).

Series	Test-statistic, ARCH	Test-statistic, normality
Danish price	9.59	2.36
Import price	6.83	5.40
Import quantity	13.44	3.80
Building activity	1.98	2.40

Based on the above statistics the VAR model with four lags give a very acceptable description of the data set. The only point of worry is the significance of the univariate

ARCH(4) test of the residuals from the import quantity equation at the standard 5% level. Using a significance level of 1%, however, will almost make the statistics insignificant and therefore we are quite satisfied with the present form of the unrestricted model.

It is at this stage worth mentioning that the nice results with respect to normality of the residuals are partly due to the inclusion of five event-dummies in the D-matrix. Four of them are the dummies used in the price behaviour analysis while the fifth is an event dummy for the building activity series. The fifth dummy is also an event dummy and is designed to capture the special behaviour of the building activity in the first quarter of 1985.

Appendix G: Results of the misspecification tests for own-price elasticiy of demand analysis

Multivariate tests for autocorrelation in the residuals of the model. The null is that there is no autocorrelation.

Test	Statistic	p-value
Ljung-Box test based on 18 lags	262.19	0.00
Lagrange multiplier test, order 1	8.41	0.94
Lagrange multiplier test, order 4	27.90	0.03

Multivariate test for normality. The null is that of normality.

Test	Statistic	p-value
Hansen-Doornik test	11.37	0.18

Univariate tests for ARCH and normality.

We test for 8th order ARCH. The null is that of no ARCH. The test-statistic is asymptotically Chi-square distributed with eight degrees of freedom (the critical 5% value is 15.51).
Normality is tested based on the Jarque-Bera test. The null is that of normality. The test-statistic is asymptotically Chi-square distributed with 2 degrees of freedom (the critical 5% value is 5.99).

Series	Test-statistic, ARCH	Test-statistic, normality
Danish quantity	9.14	4.61
Danish price	7.82	4.81
Import price	12.35	0.05
Building activity	4.58	1.81

Based on the above statistics the VAR model with eight lags give a quite acceptable description of the data set. There is a small problem with some of the tests for multivariate

autocorrelation but these indications are not too serious and in the light of the fact that this analysis serves as a sensitivity analysis we will not pursue this discussion further.

Acknowledgment

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Notes

1. This mantra is invoked in a great many rulings by the European Court of Justice, see e.g. United Brands Company v. Commission (case 27/76) [1978] ECR 207; 1 CMLR 429; or Hoffmann-La Roche *v.* Commission (case 102/77) [1978] ECR 1139; 3 CMLR 217. See Goyder (1998), ch. 15 for a discussion of the concept of dominance. This definition is indicative of how the Danish Competition Act of 1997 is interpreted, see Fejø (1997) at p. 158.
2. See Nielsen (1999) at pp. 15–16, and Ross (1974). Danish competition law has recently been harmonised with EU rules and it was the law maker's intention to achieve the highest possible degree of conformity with these rules, both in terms of substantive law (see Fejø, 1997, pp. 40–41) and in terms of practice and precedence. Danish competition cases are thus replete with references to EU cases in order to establish precedence.
3. The following scenario is also a possibility: If a dominant firm is more cost efficient than the importers, it might decide to always shadow the import price in order to keep the market to itself. In this case you would find almost perfect correlation between prices but also that the firm would hold a dominant position in some sense of the term (but not in the sense of the European Court of Justice). Since this scenario rules out the observation of imports taking place, and we in fact observe substantial imports, we may rule this scenario out. (In addition, we do not find any correlation!)
4. Further studies in the same vein are Ardeni (1989) on the law of one price for commodities and Goodwin and Schroeder (1991) for spatial price linkages in regional cattle markets.
5. According to legal observers (e.g. Goyder, 1998, p. 324), the European Commission has a tendency to put more emphasis on market shares in establishing dominance than does the European Court of Justice. The problem with using market shares is that the definition of the relevant market becomes of crucial importance.
6. Using co-integration tests, Asche, Salvanes, and Steen (1997) show that fresh salmon, frozen salmon and crustaceans belong to the same market although cross-price elasticities are low (less than unity). They also find elastic demand for each of the three products.
7. See Johansen (1989) for a detailed history of the Danish cement industry.
8. See Albæk, Møllgaard, and Overgaard (1998, p. 87–92).
9. See Johansen (1989) at p. 112.
10. The Commission states that it had evidence that the agreement not to tranship to home markets might have existed well before 1983.
11. To be precise, the Danish title is *Varestatistik for Industri, Serie B: Mineralske og kemiske produkter, træ og papir samt varer deraf.*
12. *Udenrigshandelen fordel på varer og lande, Januar—marts/juni/september/decembe*r, Statistikservice.
13. Commodity codes 2523.21.00 and 2523.29.00 respectively.
14. However a visual inspection may be misleading!
15. The effects of additive outliers on tests for unit roots and co-integration may be to invalidate those tests, see Franses and Haldrup (1994). Our method remedies the invalidating effects on those tests.
16. In the former case the test statistic is 29.21, in the latter 27.05 and with three degrees of freedom (number of series minus number of long-run relations) the asymptotic 95% quantile is 7.81.

17. As with such demand equation in general there is a potential danger of some simultaneity bias in the estimation results.
18. The results of the mis-specification test can be found in Appendix E.
19. Available from Eurostat on CD-Rom.

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