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ABSTRACT

In Which Industries Is Collusion More Likely? Evidence from the UK*

This Paper provides an analysis of factors facilitating or hindering collusion using data on the occurrence of price-fixing across UK manufacturing industries in the 1950s. The econometric results suggest that collusion is more likely the higher the degree of capital intensity and less likely in advertising-intensive than in low-advertising industries, while the relationship between market growth and the likelihood of collusion is non-monotonic. Less clear results are obtained with respect to R&D intensity and concentration.

JEL Classification: L10
Keywords: cartels, collusion, UK manufacturing

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NON-TECHNICAL SUMMARY

Despite the substantial theoretical literature on the factors facilitating or hindering collusion, empirical studies of the determinants of cartel formation and sustainability using direct evidence rather than relying on profitability indices to infer the possible operation of collusive arrangements are relatively rare. Moreover, these studies have produced somewhat mixed results and have been subject to data limitations, such as the use of data originating from antitrust cases, which may be subject to selection bias, or relating to export cartels, which cover only a very small fraction of total economic activity.

The theoretical literature on the factors facilitating or hindering collusion distinguishes between the issue of coordination of firms on a collusive price or set of prices and the issue of enforcement of collusive agreements. A number of factors have been suggested, some of which are difficult to observe or to test in empirical work using cross-section data. Of those that are in principle testable, concentration is thought to facilitate collusion; demand uncertainty is expected to hinder it; the effect of demand growth is not clear, although there are reasons to expect a non-monotonic link between market growth and the likelihood of collusion; and product differentiation through advertising or R&D is thought to hinder coordination but to have an ambiguous effect on enforcement. Some factors, such as capital intensity, have not been much discussed in theoretical work.

This Paper examines the impact of several structural industry characteristics on pricing conduct using data on the occurrence of collusive pricing across British manufacturing industries in the 1950s. The construction of such an unusually comprehensive data set has become possible as a result of the 1956 Restrictive Trade Practices Act, which required the registration of restrictive agreements between firms. These agreements were not illegal at the time, but they were also not enforceable by law. By examining the agreements registered under the Act, as well as other sources on competition in British industry in the 1950s, it is possible to identify those industries that were subject to restrictive agreements at the time that the Act was introduced. The final sample used for the econometric analysis of collusion in this Paper contains 151 4-digit industries, nearly half of which had been subject to collusive agreements in the mid- and late 1950s.

The econometric results, based on a comparison of cartelised and non-cartelised industries, suggest the following. Collusion is more likely the higher the degree of capital intensity. It is more likely under conditions of moderate market growth than in a market with declining or stagnant demand, but less likely under fast growth than under moderate growth. Collusion is less likely in advertising-intensive industries than in low-advertising industries. There is no

clear evidence of any link between concentration and the likelihood of collusion once one controls for capital intensity. And finally, there is weak evidence that collusion may be less likely in R&D-intensive industries than in low-R&D industries.

These results may also have implications for the various theoretical approaches to collusion. The apparent absence of any clear link between concentration and the likelihood of collusive pricing may not be surprising in the context of the present study, because coordination and monitoring were presumably facilitated by the fact that the agreements were not illegal. Still, it does not seem to be consistent with models focusing on the enforcement of collusion, since these models predict that high concentration facilitates cartel stability by reducing the incentive to defect. Similarly, the observed negative link between the scope for advertising and collusive pricing is consistent with the notion that product differentiation hinders coordination of colluding firms, but not with the results from most models that emphasize enforcement of collusion. Thus the present Paper suggests that it may be necessary to focus more on coordination rather than on enforcement of collusion in future theoretical work.

Moreover, capital intensity seems to be an important determinant of the likelihood of collusive pricing, although it has been little emphasized in the theoretical literature. More specifically, the result on capital intensity may suggest that more attention should be paid to the conditions of entry as a key factor in the formation and stability of cartels.

1. Introduction.

Despite the substantial theoretical literature on the factors facilitating or hindering collusion, empirical studies of the determinants of cartel formation and sustainability using direct evidence rather than relying on profitability indices to infer the possible operation of collusive arrangements are relatively rare. Moreover, these studies have produced somewhat mixed results. Hence while the findings by Hay and Kelley (1974) suggest that collusion is less likely under product differentiation, this is not confirmed by Dick (1996a). Collusion is more likely in concentrated industries according to Hay and Kelley (1974) or Fraas and Greer (1977), but not according to Dick (1996a) or Asch and Seneca (1976). And while Dick (1996a) finds a clear positive link between capital intensity and the likelihood of collusion, Hay and Kelley (1974) find no link between the ratio of fixed to total costs and collusive conduct. A possible shortcoming of these studies is that the data either originate from antitrust cases and may therefore be subject to selection bias or relate to export cartels which cover only a very small fraction of total economic activity. Also, some of the earlier studies rely on correlations rather than regression analysis for their results, so they may not adequately control for links between the factors examined.[1]

The present study examines the impact of several structural industry

[1] There is also an empirical literature which examines the related but somewhat different issue of cartel *duration* (Jacquemin et al. 1981, Suslow 1991, Marquez 1994, Dick 1996b). These studies have tended to focus on the impact on cartel stability of various organisational factors, demand uncertainty and the business cycle, in addition to structural industry characteristics such as concentration. Probably the most robust prediction from this line of research relates to the negative effect of demand uncertainty on cartel stability.

characteristics on pricing conduct using data on the occurrence of collusion across British manufacturing industries in the 1950s.[2] The construction of such an unusually comprehensive data set has become possible as a result of the 1956 Restrictive Trade Practices Act, which required the registration of restrictive agreements between firms. By examining the agreements registered under the Act, as well as other sources on competition in British industry in the 1950s, it is possible to identify those industries that were subject to restrictive agreements at the time the Act was introduced. The final sample used for the econometric analysis of collusion in this paper contains 151 four-digit industries, nearly half of which had been subject to collusive agreements in the mid- and late 1950s.

The econometric results, based on a comparison of cartelised and non-cartelised industries, suggest the following. Collusion is more likely the higher the degree of capital intensity. There is evidence of an inverted-U relationship between market growth and the likelihood of collusion; in particular, collusion seems to be more likely under conditions of moderate market growth than in a market with declining or stagnant demand, but less likely under fast growth than under moderate growth. Collusion is less likely in advertising-intensive industries than in low-advertising industries. There is no clear evidence of any link between concentration and the likelihood of collusion once one controls for capital intensity. And finally, there is weak evidence that collusive pricing may be less likely in R&D-intensive industries than in low-R&D industries.

The paper is structured as follows. The next section contains a brief survey

[2] An early study of collusive pricing in the UK in the 1950s by Phillips (1972) did not obtain clear results, partly because of data limitations.

of the theoretical literature on the factors promoting or hindering collusion. Sections 3 and 4 describe the state of competition in British manufacturing in the 1950s and the construction of the data set. Section 5 presents the econometric model and results and the final section concludes.

2. Theoretical background.

A common distinction in the literature on the factors facilitating or hindering collusion is between coordination and enforcement of collusive agreements. Product homogeneity, high industry concentration, the absence of significant cost or size differences between firms, and institutional features such as the existence of an industry trade association are often cited as factors facilitating coordination on a collusive price or set of prices (see, for example, Scherer and Ross 1990). For instance, it is sometimes argued that coordination is hindered by product differentiation because of the possible uncertainty about rival product characteristics or because of the need for frequent renegotiation following changes in these characteristics. It is also argued that coordination is easier the smaller the number of firms with significant market shares. In addition, coordination should be easier under a permissive climate of competition policy or when collusive agreements are not illegal. While many of these ideas are intuitively appealing, they have nevertheless proved difficult to model within a formal game-theoretic framework.

On the other hand, the issue of enforcement of collusive agreements has led to a substantial formal literature on cartel stability. These models examine how various structural industry characteristics affect the individual firm's trade-off

between adhering to a collusive agreement and defecting (an action which results in higher current profits, but triggers a breakdown of collusion and therefore lowers the present discounted value of future profits). The models can be used to analyse both tacit and explicit collusion when firms cannot legally enforce agreements. This literature has produced a number of unambiguous predictions as to the factors that promote cartel stability. These include low uncertainty about demand, conditions that facilitate the monitoring of rival firms, and short retaliation lags (see Tirole 1988, Martin 1993). Another common finding is that high concentration facilitates collusion, although Brock and Scheinkman (1985) have argued that the link may be non-monotonic in the presence of capacity constraints. Finally, this literature predicts that collusion is hindered by differences in quality or "perceived quality" between firms in vertically differentiated markets (see Häckner 1994, Symeonidis 1999a), and is therefore less likely to occur in industries with high advertising effectiveness, and possibly also industries with high technological opportunity, than in exogenous sunk cost industries (following the terminology in Sutton 1991).[3]

One problem with the formal literature on cartel stability is that little attention has been paid to possible correlations between the various exogenous factors analysed. Thus a standard result is that collusion is easier the higher the rate of demand growth because the larger is then the importance of future profits from collusion relative to the current gain from defecting (Tirole 1988). This can, however, be misleading for two reasons. First, fast growth may be associated with

[3] In contrast, models of cartel stability under horizontal product differentiation yield ambiguous results.

higher demand uncertainty and therefore destabilise collusion. Second, firms may be subject to capacity constraints which become binding when demand grows fast and this may hinder collusion by limiting the scope for punishing defectors.[4] Thus there may be a non-monotonic relationship between demand growth and the likelihood of collusion: positive for values of growth below a certain level, but negative for high levels of growth.

Another problem in much of the theoretical literature on collusion is that market structure is taken as given and entry is not explicitly modelled. It may be argued, however, that factors which limit the extent of entry (and, more generally, the volatility of market shares) facilitate collusion, because coordination and monitoring are easier when the identity of the principal competitors does not change much over time, and also because the extra payoff from collusion will be less easily or less quickly eliminated by entry. Since capital intensity implies significant sunk costs of entry, this argument can provide a theoretical rationale for a positive effect of capital intensity on the likelihood of collusion. To the extent that significant new entry hinders coordination, it also provides an additional reason why fast demand growth may hinder collusion.

To summarise, the theoretical literature suggests a number of factors that are likely to facilitate or hinder collusion. Some of them are difficult to observe or

[4] A formal analysis of this point is beyond the scope of the present paper. The intuition is, however, easy to see by considering a limit case in an infinitely repeated pricing game between firms with fixed capacities. Demand may grow so fast that there is no scope for punishing a defector tomorrow (since the capacity constraint will tomorrow bind at the collusive level of output), even though there is scope for defecting today (since the constraint does not yet bind). In this limit case, collusion is impossible.

cannot be tested in empirical work using cross-section data. Of those that are in principle testable, capital intensity and possibly also concentration are thought to facilitate collusion, while demand uncertainty and the scope for vertical product differentiation through advertising or R&D are expected to hinder collusion. The effect of demand growth is less clear, but the arguments presented above would predict a non-monotonic link between market growth and the likelihood of collusion.

3. Competition and collusion in UK manufacturing industry in the 1950s.

Collusive agreements between firms were widespread in British industry in the mid-1950s: nearly half of the manufacturing sector was subject to agreements significantly restricting competition. Some dated from the 1880s and 90s, while many others had been stimulated by government policies for the control of industry during the two world wars, and still others were the result of the depression of the inter-war years (Swann et al. 1974). The agreements were not enforceable at law, but they were not illegal.[5] The 1956 Restrictive Trade Practices Act required the registration of restrictive agreements between firms on goods, including both formal, written undertakings and informal, verbal or even implied arrangements. Registered agreements were presumed to be against the public interest and should therefore be abandoned, unless they were successfully defended by the parties in the newly created Restrictive Practices Court as

[5] See Political & Economic Planning (1957) and Kuipers (1950) for details on the legal status of the agreements.

producing positive benefits, of a kind defined in the Act, which outweighed the presumed detriment (or unless they were considered by the Registrar of Restrictive Trading Agreements as not significantly affecting competition). Because the attitude of the Court could not be known until the first cases had been heard, the large majority of the existing restrictive agreements were registered rather than being dropped or secretly continued. The first agreements came before the Court in 1959 and were struck down. Nearly all restrictive agreements were subsequently abandoned.[6]

Many agreements involved important horizontal arrangements. A typical agreement of this kind contained (agreed or recommended) minimum or fixed producer prices and standard conditions of sale; ancillary restrictions, such as collective exclusive dealing or the maintenance of common resale prices, were often used to strengthen the arrangement. In certain cases prices were individually set, but there were common maximum discounts to distributors, resale price maintenance and sometimes specified conditions of sale or exchange of information on individual prices and price changes. Note, however, that in general there were no restrictions on media advertising or R&D expenditure.[7] Also, there

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[6] Hunter (1966) and Wilberforce et al. (1966) describe the structure of the 1956 Act and Symeonidis (1998) discusses the significance of the Act within the broader context of the evolution of UK cartel policy. Symeonidis (1999b, 1999c, 2000) examines in detail the effects of the Act on market structure and conduct.

[7] In fact, media advertising was not regulated in any advertising-intensive industry, even though restrictions relating to sales promotion (e.g. gifts and coupons to consumers, financial inducements to distributors, participation in exhibitions, advertising in trade catalogues etc) were far more common. Expenditure on R&D was non-cooperatively determined in all but one or two

were no significant restrictions on entry in most cartelised industries. On the other hand, some agreements contained restrictions which were probably of little significance in terms of their impact on competition, such as "conditions of sale" (e.g. cash discount terms, delivery charges, formulae for contract price adjustment when costs changed, non-price matters etc), without any regulation of prices or trade discounts, although such regulation would have been feasible under the circumstances. Finally, in some industries the significance of the restrictions is uncertain, as in the case of agreements providing for the central notification by the parties of enquiries received from customers and for some form of uniform action, other than price-fixing, with respect to these enquiries.

Were the agreements effective? Evidence on this issue comes from various sources, including the agreements registered under the 1956 Act, the early Monopolies Commission reports, the Political & Economic Planning study of industrial trade associations, carried out just before the Act was passed, and two studies of the impact of the Act, namely Heath (1961, 1963) and Swann et al. (1973, 1974). Effectiveness depended, first, on the extent to which the parties conformed to the agreement or accepted the recommendations.[8] And, second, on

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industries. There was some degree of technical cooperation, in the form of exchange of technical information between firms, in some industries, and sometimes even some joint R&D; or patent-owning firms had to grant licenses to any other firm participating in the arrangement. In all but one or two cases, however, these schemes do not seem to have amounted to anything close to co-operative determination of R&D expenditure.

[8] While some of the agreements provided for sanctions such as a fine or expulsion from the association in case of non-conformity, most agreements had no such provision. In any case, the provisions on sanctions, like the agreements

the extent of competition from outside firms, domestic or foreign. On the whole, most agreements seem to have been operated honourably prior to cancelation and in most cases the parties accounted for a large fraction of the relevant market. Also, there were a number of factors that limited the effectiveness of outside competition in many industries: the cartels tended to contain most or all of the largest and best-known domestic firms, practices intended to limit outside competition, such as aggregated rebates and collective exclusive dealing, were common, and, finally, competition from imports was often limited.

In conclusion, even though the "degree of collusion" must have varied across cartelised industries, depending on the type of restrictions, the extent of outside competition, the balance of interests within the cartel etc, and there is even some uncertainty about the effectiveness of particular agreements, it seems justifiable to split the UK manufacturing sector in the 1950s into a group of cartelised industries and a group of industries without restrictive agreements. Going beyond this, for instance by classifying industries with respect to the "degree of collusion", seems very difficult given the information available. Still, the binary classification adopted here is sufficient for analysing the structural industry characteristics which have facilitated or hindered collusion in the UK during the 1950s.

4. Construction of the data set.

This section briefly describes the construction of the data set for this study. Further details and information on data sources are contained in the Appendix.

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themselves, were not enforceable at law.

Collusion. The main source of data on the occurrence of collusion in UK manufacturing in the mid- and late 1950s were the restrictive agreements registered under the 1956 Act. In addition, a number of other sources were used to identify non-registered agreements or agreements modified before registration: the various industry reports of the Monopolies Commission; the 1955 Monopolies Commission report on collective discrimination; the 1949 report of the Lloyds' Committee on resale price maintenance; industry studies contained in Burn (1958) and Hart et al. (1973); the Board of Trade annual reports from 1950 to 1956; and the Political & Economic Planning (1957) survey of trade associations, as well as unpublished background material for this survey.

The sample should not be subject to any significant selection bias caused by unknown cases of collusion. Because of the initial uncertainty on how the law would be applied, the large majority of the existing restrictive agreements were registered rather than being dropped or secretly continued. As the Act required the registration of both explicit and tacit collusive arrangements and gave to the Registrar powers of investigation, it is unlikely that there were many industries with unregistered agreements where tacit or explicit collusion continued (cf. Swann et al. 1974); some of these have been, in any case, subsequently investigated by the Monopolies and Mergers Commission, so information on their restrictive practices is available. There were also a few industries that decided to drop effective agreements rather than register them, but there is no reason why this should have occurred in certain types of industries more than others.

Moreover, it is actually possible to check for selection bias, given the

information available. The Board of Trade annual reports and the background material to the P.E.P. survey of trade associations provide information on industries alleged to be collusive, and some of these did not register agreements. This information must be treated with caution due to the fact that it was mainly based on complaints or reports given by buyers, and buyers may wrongly deduce the existence of a price-fixing agreement from price uniformity or parallel pricing. Hence industries which did not register agreements but may have been subject to explicit or tacit collusion according to these sources were classified as "ambiguous" and therefore excluded from the sample. However, this information can also be used to check for selection bias: these industries can be classified as collusive and the new set of results can be compared with the results obtained when they are excluded. Details on this and other robustness checks are given in section 5 below.[9]

All industries were classified as "collusive", "competitive" or "ambiguous" on the basis of three criteria: the reliability of the data source; the types of restrictions; and the proportion of an industry's total sales covered by products subject to agreements and, for each product, the fraction of the UK market covered by cartel firms.

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[9] Evidence from a questionnaire survey of competition in UK manufacturing in the 1950s (Lydall 1958) also suggests that there should not be any significant sample selection bias either from ineffective or from unregistered agreements. The study by Lydall did not specifically discuss collusive agreements, but some of the information given suggests that firms that perceived their condition as being characterised by "no strong competition" were primarily in industries which had agreements, while firms which thought that they were facing "strong competition" were chiefly in industries without agreements.

In particular, the various types of restrictions were classified as significant, non-significant or uncertain, according to their likely impact on competition. Next, the products which were subject to agreements were assigned to the various headings of the classification used in the 1958 concentration statistics. It was sometimes the case that certain products within a particular four-digit industry were subject to significant restrictions, while others were not. An industry was classified as collusive if the products subject to *significant* restrictions accounted for more than 50% of total industry sales. It was classified as competitive if the products subject to *significant or uncertain* restrictions accounted for less than 10% of industry sales. And it was classified as ambiguous in all remaining cases. In fact, most industries classified as competitive were free from any restrictive agreements. I have used the 10% cut-off point because in some cases secondary industry products were subject to restrictive agreements, although core industry products were not. Similarly, most industries classified as collusive had agreements covering all industry products. I have used the 50% cut-off point because in some cases most core industry products were subject to price-fixing, though some were not. However, I have also tried alternative cut-off points to check the robustness of the results.

It was assumed, in the case of agreements of nationwide application, that the parties accounted for a substantial fraction of the market. There were also a few cases of important regional agreements, and a rough estimate of the fraction of industry sales subject to restrictions was then made.

All industries classified as ambiguous were excluded from the sample.[10] Collusion could then be modelled by means of a dummy variable taking the value 1 for "collusive" and the value 0 for "competitive" industries (*COLL*). The final sample, after also excluding industries for which concentration ratios were not available or not relevant (see below), contained 151 four-digit industries, of which 71 were "collusive" and 80 were "competitive".

Concentration, market growth, capital intensity and the extent of foreign competition. The concentration measure used is the share of the five largest UK producers in the total sales revenue of UK firms (*CONC5*). I used Census-based data at the four-digit (or "product group") level of aggregation for 1958, a year when the agreements were still in place. This level of aggregation seems appropriate for the analysis of the determinants of collusive pricing.[11] However, when competition tends to operate at a regional rather than the national level, these concentration ratios may be a poor measure of market structure. An effort was therefore made to identify such cases; five cases were identified and were excluded from the sample.

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[10] Since there were various possible reasons for classifying an industry as ambiguous, it did not seem appropriate to regard these industries as "intermediate" with respect to the state of competition and include them in the sample.

[11] In some cases, a four-digit industry may comprise two or more markets which are largely independent on the demand side. I have tried to identify such cases in the sample, and I have found eight cases. Three were in the "collusive" group and five in the "competitive" group, so it is unlikely that any bias is caused (in particular, regarding the effect of concentration on the likelihood of collusion) from this factor.

A measure of market growth at the four-digit industry level between 1954 and 1958 is the ratio of 1958 industry sales revenue at net producer prices to 1954 industry sales revenue, deflated using 16 sector-specific producer price indices (*GROWTH*). This takes only positive values and is less than 1 for declining industries and larger than 1 for growing industries. This measure goes some way into controlling for changes in relative prices, in particular those induced by changes in the relative cost of materials (a significant factor during the 1950s). An alternative measure of market growth, constructed by deflating the sales figures by the general producer price index, was also tried, as were measures of market growth between 1951 and 1958. All these produced results similar to those reported in section 5. In fact, 1951-58 growth is strongly correlated with 1954-58 growth in the present sample, with a correlation coefficient of 0.86. Note that Census data in the 1950s at the level of aggregation used in this paper are only available for 1951, 1954 and 1958. The 1954-1958 period is a relevant period as most agreements were registered in 1957, and it is long enough to ensure that the change in sales reflects the trend in demand during the 1950s and is not driven by short-run fluctuations.

Two measures of capital intensity in 1958 were defined. The first of these (*CAPINT1*) is the total value of capital stock in the industry divided by the number of plants, i.e. the capital stock of the average plant. The second (*CAPINT2*) is the capital-labour ratio. The data on capital stock are estimates rather than primary data and were taken from O'Mahoney and Oulton (1990). They were only available at the three-digit level of aggregation (i.e. for Census "industries"), but it was often possible to derive reasonable approximations of capital stock at the

four-digit level by using Census data on the fraction of three-digit industry investment accounted for by each four-digit industry within any given three-digit industry.

The extent of foreign competition may have also been a factor influencing the likelihood of collusion between UK firms in any particular industy. Constructing an adequate measure of foreign competition is difficult, however. A somewhat crude measure of the extent of (potential or actual) foreign competition was constructed on the basis of the Kitchin (1976) estimates of effective protection rates for 1963 and other available information for the 1950s. This is a dummy variable (*FOREIGN*) taking the value 0 for industries with higher protection in the mid-1950s and the value 1 for industries with lower protection.[12] Note that this variable does not capture other factors that may have influenced the extent of foreign competition across industries such as transport costs or the scope for restrictive practices aimed at reducing outside competition. Because of possible reservations regarding the use of such a proxy, results are reported below for regressions both with and without the foreign competition dummy.

Advertising-sales and R&D-sales ratios. Advertising-sales ratios and R&D-sales ratios, at the four-digit level, were used to classify the industries in the

[12] The former group contained the engineering industries, instruments, vehicles, finished metal goods, some chemicals, paper and paper products, furniture, pottery and glass, most finished textile goods, rubber products, and various other finished manufactures. The latter group contained the food and drink industries, some chemicals, basic metals, clothing and footware, wood products, publishing, leather and most textile semi-manufactures, and building materials.

sample. The industries were split, on the one hand, into low-advertising and advertising-intensive using the 1% advertising-sales ratio as a cut-off point, and, on the other, into low-R&D and R&D-intensive using the 1% R&D-sales ratio as a cut-off point. The 1% cut-off point was chosen since it is commonly used to classify industries according to advertising or R&D intensity. In addition, it resulted in a not too unbalanced split, while a higher cut-off point (2%, say) would leave only a small number of industries in the advertising-intensive and R&D-intensive categories. In any case, using the 2% cut-off point gave results similar to those reported below. Of the 151 industries in the sample, 111 had an advertising-sales ratio lower than 1% and 119 had an R&D-sales ratio lower than 1%.

There are two reasons why the advertising-sales and R&D-sales ratios were used to classify the industries rather than being used themselves as explanatory variables in the regressions. On the one hand, there were data limitations; on the other, these binary classifications reflect exogenous industry characteristics, such as advertising effectiveness or technological opportunity, but are relatively robust to other factors that may affect advertising or R&D intensity. Hence the dummy variables resulting from these classifications can be treated as exogenous variables.

5. Empirical model and results.

We now examine the effect of several structural industry characteristics on pricing conduct across British manufacturing industry in the mid- and late 1950s. The factors whose impact on the likelihood of collusion will be examined include

demand growth, concentration, capital intensity, and the scope for advertising or R&D.[13]

The empirical model used is a probit model with the basic specification

$$COLL^{*} = \alpha_i + \beta_1 GROWTH_i + \beta_2 GROWTH_i^2 + \beta_3 ADV_i + \beta_4 RD_i + \beta_5 \ln CAPINT_i + \beta_6 CONC5_i + u_i$$

where instead of the "propensity to collude" COLL*, an unobserved latent variable, we observe the dichotomous variable *COLL* which takes the value 0 for industries without collusive agreements in the mid- and late 1950s and 1 for cartelised industries. The other variables are as defined in section 4 above. *ADV* is a dummy variable which is equal to 0 for industries with advertising-sales ratio < 1% and 1 otherwise, and *RD* is a dummy which takes the value 0 for industries with R&D-sales ratio < 1% and 1 otherwise. $GROWTH^2$ was included because of the expectation that the effect of demand growth on cartel stability may be non-monotonic (see the discussion in section 2). All variables are defined at the four-digit level of aggregation except *CAPINT*, which is sometimes defined at the three-digit level and sometimes at the four-digit level. Descriptive statistics for the

[13] The impact of some other factors, such as demand uncertainty, is more difficult to evaluate due to data limitations. Also, since the restrictive agreements were in most cases long-standing and systematic cross-industry information on breakdowns of collusion is not available, the impact of business cycle fluctuations on cartel stability cannot be assessed in the present context. Note, however, that some of the factors mentioned in the theoretical literature as hindering cartel stability, such as the presence of large buyers or the lumpiness of orders, are probably not very relevant in the present context because public bodies, which were the largest buyers, did not do much to deter collusion in the 1950s.

whole sample, as well as separately for "collusive" and "competitive" industries are given in table 1.

A possible objection to the use of *GROWTH* in the above specification is that this variable may be endogenous. In particular, a two-way link between growth and collusion cannot, in principle, be ruled out. Unfortunately, there is no appropriate instrument for *GROWTH*: as *COLL* essentially does not vary over the 1950s, lagged values of sales growth cannot be used as instruments. However, there is some indirect evidence supporting the hypothesis that growth during 1954-1958 was largely determined by exogenous shifts in demand rather than by the state of competition. The 1954-58 growth figures can be compared (for industries with available data for both periods) to the corresponding figures for 1963-1968, a period when the majority of the previously cartelised industries had already abandoned their restrictive agreements. The median value of *GROWTH* is 1.057 for 64 industries which were cartelised in the 1950s and had switched to competition by 1968, and 1.069 for 78 non-cartelised industries. If collusion had had a significant (presumably negative) effect on sales growth during 1954-58, the abolition of restrictive agreements should affect (presumably reverse) this initial small difference in growth between previously cartelised and non-cartelised industries. However, the median value of sales growth during 1963-68 was slightly lower for the 64 previously cartelised industries than for the 78 non-cartelised ones (1.148 versus 1.162). Thus it seems unlikely that collusion had a significant effect on growth during 1954-1958 and there is no reason to believe that endogeneity of *GROWTH* is a serious problem in the present context.

Since *ADV* and *RD* essentially reflect exogenous industry characteristics,

namely advertising effectiveness and technological opportunity respectively, they can also be treated as exogenous variables. The idea here is that, while the actual level of the advertising-sales ratio and the R&D-sales ratio is endogenous and may depend, among other things, on the intensity of price competition itself, it is generally exogenous industry characteristics which determine whether this ratio is above or below 1%. Thus for industries below the 1% cut-off point, advertising or R&D are typically not important strategic variables. As pointed out in the Appendix, a comparison of advertising-sales and R&D-sales ratios in various years revealed very few instances where an industry had switched from below 1% to above 1% or vice versa; and in most cases this was due to an exogenous institutional change, namely the introduction of TV advertising in the UK in the mid-1950s.

One variable which is likely to be endogenous is the concentration ratio. Hence two sets of results are reported below. Table 2 contains results from a one-stage probit model, while table 3 presents results from a two-stage probit (see, for example, Maddala 1983) in which the concentration ratios have been replaced by the fitted values from a regression of *CONC5* on *GROWTH*, *GROWTH*^{2}, *ADV*, *RD*, *lnCAPINT* and *lnSALES*, where *SALES* is 1958 four-digit sales revenue; this variable is typically used in studies of the determinants of concentration as a proxy for market size, but it is not endogenous with respect to collusion in a cross section of industries since it is mainly determined by the industrial classification categories used.[14] The two sets of results are similar, except for the coefficients

[14] The R^2's in these first-stage regressions range from 0.56 to 0.71, depending on which measure of capital intensity is used and on whether sector dummies are included. Recent theoretical and empirical studies of the determinants of

and the t-statistics on *CONC*5 and $CONC5^2$, which differ considerably between the two models.[15]

The first four columns of each table present results for the basic specification, while the next eight columns confirm that the results are robust to including controls for foreign competition and sector-specific effects. The inclusion of sector dummies among the regressors serves as a partial check for misspecification due to omitted variables or the presence of industry effects (these results are very little affected if *FOREIGN* is dropped). In particular, ten sectors are distinguished: food and drink; coal products and chemicals; basic metals; mechanical engineering and vehicles; instrument and electrical engineering; metal products; textiles, leather and clothing; building materials, pottery, glass and wood products; paper products; and, finally, other manufacturing. Coefficients and t-statistics for the sector dummies are not reported, but these are always jointly

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concentration suggest that either separate regressions should be run for exogenous sunk cost industries and advertising-intensive or R&D-intensive industries (Sutton 1991, Symeonidis 1999b) or interaction terms included to capture differences between the two types of industries (Lyons and Matraves 1996). The former modelling strategy cannot be applied here since the second-stage regression must be run for the whole sample. The reason for not including interaction terms in the present specification is that they are very strongly correlated with *ADV* and *RD*. However, results obtained when interaction terms were nevertheless included were very similar to those reported in table 3.

[15] The "two-stage conditional maximum likelihood" procedure proposed by Rivers and Vuong (1988) gave results very similar to those presented in table 3. This procedure also allows for a simple Wald test for exogeneity. The test sometimes rejects the null hypothesis of exogeneity, and sometimes it fails to reject.

significant at the 5% level. All the t-statistics reported are based on robust standard errors.[16] [17]

The results provide evidence of an inverted-U relationship between demand growth and the likelihood of collusion: the coefficients on *GROWTH* and $GROWTH^2$ are respectively positive and negative and typically statistically significant at the 5% or the 10% level (a joint test of significance gives similar results). The value of *GROWTH* that corresponds to the maximum probability of collusion typically ranges around 1.15-1.30. About 25% of the industries in the sample have growth rates between 1954 and 1958 higher than this. Thus it seems

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[16] It is well known that heteroskedasticity results in inconsistent coefficient estimates in probit models. I have therefore also estimated a heteroskedastic probit (see Greene 1997), and both Wald and likelihood ratio tests failed to reject the null hypothesis of no heteroskedasticity at the 1% significance level for various specifications of the error variance function, except when $CONC5^2$ was not included among the regressors (in which case the test may pick up a specification problem). Nevertheless, I have computed robust standard errors as a partial precaution against unknown forms of heteroskedasticity or misspecification due to omitted variables.

[17] Note that in the two-stage model these are uncorrected standard errors, i.e. the fitted values from the first stage are essentially treated as observed values of *CONC5* for purposes of inference. This is in line with much applied work using two-stage maximum likelihood models. A formula for correcting the covariance matrix in the present model is given in Maddala (1983, p. 245), but cannot be used in regressions including the square of the fitted value from the first stage (and this is the most appropriate specification in the present case). However, the corrected standard errors that I computed using the Maddala formula in regressions not including the square of the fitted value were very similar to the uncorrected standard errors. This is consistent with Monte Carlo results comparing corrected and uncorrected standard errors in two-stage probit models (Bollen et al. 1995).

that while a moderate growth rate is more conducive to stable collusion than a stagnant or declining demand, fast growth hinders collusion.

There is also strong evidence that collusion is more likely in industries with high capital intensity: the coefficient on *CAPINT* is positive and significant at the 1% level (whether *CAPINT1* or *CAPINT2* is used). On the other hand, there is no clear evidence of any link between concentration and the probability of collusion. There is some evidence of a non-linear relationship, with both very low and very high concentration hindering collusion, but this is not statistically significant in the two-stage results. A possible reason for the absence of any clear link between concentration and the likelihood of collusion in the present context is that coordination and monitoring may have been facilitated by the fact that the agreements were not illegal and were often operated by members of trade associations. On the other hand, a non-linear relationship could result from the presence of capacity constraints or the fact that high levels of concentration are sometimes associated with significant firm asymmetries or the presence of dominant firms, and these factors may hinder collusion.[18]

Could the results for concentration be affected by measurement error? The issue here is that the Census data used to construct *CONC5* are for domestic firms rather than for the domestic market. This is not necessarily a problem in the present context since most restrictive agreements were operated between UK firms

[18] Note that if the capital intensity variable is dropped, then the coefficient on *CONC5* is positive and highly significant. This suggests that capital intensity, rather than concentration per se, could be the key factor in explaining the alleged high incidence of collusion in highly concentrated industries, even when collusion is illegal (and thus coordination and monitoring are more difficult).

rather than between firms selling in the UK market. But to check whether the results are affected by the decision not to correct the concentration ratios for imports, I have run regressions excluding from the sample all industries for which the value of imports as a fraction of sales by domestic firms was higher than 10% (or 15%). The coefficients and t-statistics on *CONC5* and $CONC5^2$ were similar to those reported here.

The results also strongly suggest that the probability of price collusion is lower in advertising-intensive industries: the coefficient on *ADV* is negative and everywhere statistically significant at the 1% or the 5% level. Classification of an industry as advertising-intensive reduces the probability of collusion (at the sample means) by 25-35%. The link between R&D intensity and the probability of collusion is certainly less clear: although typically negative, the coefficient on *RD* is only in some regressions statistically significant at the 5% or the 10% level.

There may be various reasons for this result. One institutional factor may be that public procurement procedures in the UK in the 1950s have done little to deter collusion in some R&D-intensive industries. Another hypothesis, which is related to the theoretical discussion in section 2 above, is that large differences in product quality between firms may not be a feature of some R&D-intensive industries, since a low-quality firm may find it impossible to compete with a high-quality rival. In advertising-intensive industries, on the other hand, equilibria in which heavy advertisers co-exist with firms that do not advertise but employ different sales strategies are perfectly feasible. Thus price collusion will be less likely in advertising-intensive industries than in R&D-intensive industries, everything else being equal, as seems indeed to have been the case in the UK.

There is some case-study evidence on R&D-intensive industries with price-fixing agreements which seems to be consistent with the above interpretation. Many of these were agreements between a small number of firms which were the only UK producers that could supply the products in question. This was the case for various types of heavy electrical machinery (see Swann et al. 1973 and MRPC 1955) and probably also for telecommunications equipment (Hart et al. 1973). While systematic data on R&D expenditure in these industries at the firm level are not available, it seems likely that all these firms had significant R&D budgets, so that price collusion was not hindered by large quality differences.

Finally, several checks of the robustness of the results to alternative ways of constructing the collusion variable *COLL* were performed. First, I used a sample augmented by 10 industries which did not register any agreements but may have been subject to collusion according to Board of Trade reports or the P.E.P. survey. It is interesting that these industries were more concentrated, on average, than the rest: their average *CONC5* was 0.65, while it was 0.61 for the 71 industries classified as collusive and 0.52 for the 80 industries classified as competitive in the definitions used to produce the results in tables 2 and 3. Second, I experimented with different cut-off points for the classification of industries according to the fraction of total sales covered by products subject to agreements. This did not change the sample very much, anyway; for instance, changing the cut-off points from 10% and 50% to 20% and 80% respectively results in 64 industries being assigned to the collusive group and 86 being assigned to the competitive group. For all these alternative definitions of *COLL*, the results were similar to those reported here. A further check was to include in the sample the "ambiguous"

industries by regarding them as "intermediate" and then perform ordered probit. As mentioned in section 4 above, this is not very appropriate, but it may be useful merely as a robustness check. Again the results were similar to those reported in tables 2 and 3.

6. Concluding remarks.

This paper has provided an analysis of structural industry characteristics facilitating or hindering collusive pricing using data on collusion in British manufacturing industry in the 1950s. At that time nearly half of UK manufacturing was subject to agreements significantly restricting competition. These were not illegal but they were not enforceable at law. The econometric results, based on a comparison of cartelised and non-cartelised industries, can be summarised as follows. Collusion is less likely in advertising-intensive industries than in industries with low advertising intensity, and there is also weak evidence that it is less likely in R&D-intensive industries than in low-R&D industries. Collusion is more likely the higher the degree of capital intensity. Also, while moderate market growth may be associated with a higher probability of collusion relative to a declining or stagnant demand, fast growth is not. Finally, no clear link between concentration and the likelihood of collusion could be found.

These results may also have implications for the various theoretical approaches to collusion. First, the observed negative link between the scope for advertising and collusive pricing is not consistent with theoretical results from models of cartel stability that emphasise horizontal product differentiation. To interpret this result it may be necessary to shift to models of cartel stability

emphasising vertical differentiation or to focus more on the issue of coordination rather than enforcement. Second, the apparent absence of any clear link between concentration and the likelihood of collusion may not be surprising in a context where coordination and monitoring are facilitated by the fact that the agreements are not illegal. Even in this case, however, the standard game-theoretic prediction that high concentration facilitates cartel stability by reducing the incentive to defect would be valid; and this does not seem to get much support for the present sample. Third, capital intensity seems to be an important determinant of the likelihood of collusive pricing, although it has been little emphasised in the theoretical literature. More specifically, the result on capital intensity may suggest that more attention should be paid to the conditions of entry as a key factor in the formation and stability of cartels.

Table 1. Descriptive statistics.

		Collusive (N=71)	Non-collusive (N=80)	All (N=151)
GROWTH	Mean	1.08	1.17	1.13
	St. deviation	0.20	0.45	0.36
	Min.	0.71	0.59	0.59
	Max.	1.59	3.24	3.24
lnCAPINT1	Mean	0.01	-1.09	-0.57
	St. deviation	1.15	1.33	1.36
	Min.	-2.98	-3.60	-3.60
	Max.	2.17	3.42	3.42
lnCAPINT2	Mean	1.23	0.64	0.92
	St. deviation	0.73	0.86	0.85
	Min.	-0.99	-1.18	-1.18
	Max.	3.10	2.38	3.10
CONC5	Mean	0.61	0.52	0.56
	St. deviation	0.20	0.28	0.25
	Min.	0.19	0.08	0.08
	Max.	0.98	0.99	0.99
No. of industries with ADV = 0		62	49	111
No. of industries with ADV = 1		9	31	40
No. of industries with RD = 0		59	60	119
No. of industries with RD = 1		12	20	32
No. of industries with FOREIGN = 0		44	32	76
No. of industries with FOREIGN = 1		27	48	75

Table 2. Regression results for the determinants of collusion: Probit estimation.

	Dependent variable: COLL							
GROWTH	5.44 (1.92)	3.58 (1.59)	7.19 (2.43)	5.26 (2.02)	4.68 (1.59)	3.10 (1.32)	6.53 (2.12)	4.89 (1.76)
$GROWTH^2$	-2.29 (-1.99)	-1.58 (-1.89)	-2.98 (-2.43)	-2.21 (-2.14)	-2.05 (-1.70)	-1.45 (-1.63)	-2.76 (-2.17)	-2.11 (-1.89)
ADV	-1.10 (-3.79)	-1.05 (-3.69)	-1.07 (-3.67)	-1.05 (-3.70)	-0.89 (-2.97)	-0.87 (-2.93)	-0.84 (-2.81)	-0.84 (-2.85)
RD	-0.41 (-1.27)	-0.47 (-1.48)	-0.14 (-0.45)	-0.20 (-0.66)	-0.68 (-2.04)	-0.71 (-2.13)	-0.40 (-1.23)	-0.42 (-1.34)
lnCAPINT1	0.51 (4.14)	0.54 (4.25)	-	-	0.53 (4.27)	0.56 (4.33)	-	-
lnCAPINT2	-	-	0.46 (3.06)	0.44 (2.80)	-	-	0.59 (3.66)	0.57 (3.28)
CONC5	-0.05 (-0.08)	8.95 (3.35)	0.70 (1.19)	9.13 (3.51)	-0.22 (-0.34)	8.30 (2.99)	0.38 (0.62)	8.24 (3.02)
$CONC5^2$	-	-8.09 (-3.42)	-	-7.49 (-3.25)	-	-7.63 (-3.10)	-	-6.93 (-2.86)
FOREIGN	-	-	-	-	-0.63 (-2.49)	-0.55 (-2.07)	-0.71 (-2.81)	-0.63 (-2.36)
constant	-2.46 (-1.39)	-3.30 (-2.13)	-4.71 (-2.70)	-5.48 (-3.34)	-1.52 (-0.83)	-2.49 (-1.55)	-3.88 (-2.15)	-4.73 (-2.77)
sector dummies	no	no	no	no	no	no	no	no
% correct predictions	72.2	77.5	72.8	70.9	76.8	78.8	74.8	74.8
$1 - \ln L / \ln L_0$	0.263	0.319	0.212	0.264	0.291	0.338	0.247	0.289
No. observations	151	151	151	151	151	151	151	151

Note: t-statistics based on robust standard errors in parentheses.

Table 2 (continued).

	Dependent variable: COLL			
GROWTH	4.66 (2.07)	4.28 (2.07)	6.33 (2.37)	5.75 (2.70)
$GROWTH^2$	-1.93 (-2.45)	-1.75 (-2.53)	-2.59 (-2.52)	-2.30 (-3.12)
ADV	-0.95 (-2.75)	-0.94 (-2.69)	-0.77 (-2.25)	-0.77 (-2.20)
RD	-0.87 (-1.73)	-0.76 (-1.54)	-0.46 (-0.93)	-0.38 (-0.76)
lnCAPINT1	0.67 (3.84)	0.69 (4.00)	-	-
lnCAPINT2	-	-	0.76 (3.41)	0.74 (3.32)
CONC5	-3.76 (-0.50)	8.65 (2.94)	0.23 (0.33)	8.34 (2.92)
$CONC5^2$	-	-7.96 (-3.20)	-	-7.06 (-2.89)
FOREIGN	-0.52 (-1.16)	-0.55 (-1.12)	-0.57 (-1.39)	-0.58 (-1.28)
constant	-2.22 (-1.27)	-4.07 (-2.24)	-4.87 (-2.69)	-6.46 (-3.78)
sector dummies	yes	yes	yes	yes
% correct predictions	74.2	80.8	74.8	78.1
$1 - \ln L / \ln L_0$	0.396	0.436	0.352	0.386
No. observations	151	151	151	151

Table 3. Regression results for the determinants of collusion: Two-stage probit estimation.

	Dependent variable: COLL							
GROWTH	5.43 (1.96)	4.58 (1.94)	7.22 (2.64)	6.20 (2.88)	4.64 (1.68)	4.03 (1.67)	6.56 (2.37)	6.01 (2.51)
$GROWTH^2$	-2.27 (-2.02)	-1.92 (-2.11)	-2.79 (-2.50)	-2.31 (-2.96)	-1.98 (-1.76)	-1.73 (-1.85)	-2.53 (-2.26)	-2.27 (-2.50)
ADV	-1.09 (-3.73)	-1.07 (-3.76)	-1.01 (-3.45)	-0.93 (-3.21)	-0.85 (-2.76)	-0.85 (-2.81)	-0.68 (-2.17)	-0.67 (-2.14)
RD	-0.40 (-1.24)	-0.41 (-1.32)	0.09 (0.29)	0.05 (0.16)	-0.68 (-2.04)	-0.68 (-2.05)	-0.20 (-0.62)	-0.20 (-0.63)
lnCAPINT1	0.54 (3.41)	0.55 (3.51)	-	-	0.62 (3.39)	0.62 (3.45)	-	-
lnCAPINT2	-	-	0.75 (3.39)	0.74 (3.29)	-	-	0.99 (3.57)	0.96 (3.47)
CONC5	-0.34 (-0.32)	4.26 (1.55)	-1.21 (-1.03)	4.60 (1.58)	-1.00 (-0.84)	2.84 (1.00)	-2.16 (-1.52)	1.04 (0.35)
$CONC5^2$	-	-4.27 (-1.83)	-	-5.35 (-2.12)	-	-3.49 (-1.50)	-	-2.87 (-1.12)
FOREIGN	-	-	-	-	-0.67 (-2.50)	-0.62 (-2.29)	-0.92 (-3.14)	-0.84 (-2.79)
constant	-2.30 (-1.30)	-2.88 (-1.69)	-4.23 (-2.60)	-5.11 (-3.36)	-1.08 (-0.60)	-1.67 (-0.94)	-3.17 (-1.91)	-3.64 (-2.29)
sector dummies	no	no	no	no	no	no	no	no
% correct predictions	72.2	76.8	70.9	72.8	78.8	80.8	76.2	73.5
$1 - \ln L / \ln L_0$	0.264	0.277	0.211	0.228	0.294	0.303	0.260	0.264
No. observations	151	151	151	151	151	151	151	151

Note: t-statistics based on robust standard errors in parentheses.

Table 3 (continued).

	Dependent variable: COLL			
GROWTH	4.90 (2.22)	4.71 (2.21)	6.82 (2.96)	6.62 (3.01)
$GROWTH^2$	-1.97 (-2.61)	-1.88 (-2.65)	-2.57 (-3.26)	-2.46 (-3.43)
ADV	-0.97 (-2.77)	-0.95 (-2.75)	-0.70 (-2.04)	-0.69 (-2.01)
RD	-0.84 (-1.63)	-0.75 (-1.52)	-0.18 (-0.34)	-0.15 (-0.28)
lnCAPINT1	0.80 (3.34)	0.79 (3.32)	-	-
lnCAPINT2	-	-	1.24 (3.34)	1.20 (3.24)
CONC5	-1.64 (-1.14)	2.03 (0.63)	-3.10 (-1.77)	0.38 (0.10)
$CONC5^2$	-	-3.23 (-1.26)	-	-2.96 (-1.04)
FOREIGN	-0.55 (-1.24)	-0.58 (-1.24)	-0.76 (-1.75)	-0.71 (-1.57)
constant	-1.54 (-0.86)	-2.39 (-1.21)	-3.74 (-2.28)	-4.60 (-2.38)
sector dummies	yes	yes	yes	yes
% correct predictions	76.2	78.1	75.5	77.5
$1 - \ln L / \ln L_0$	0.402	0.408	0.369	0.373
No. observations	151	151	151	151

APPENDIX

The concentration data for 1958 were obtained from Summary Table 5 of the 1963 Census of Production. Data on manufacturers' sales revenue at current net producer prices were obtained from the above table and from the individual industry reports of the Census (various years). The figures are sales by all firms employing 25 or more persons. The exclusion of very small firms is probably a minor problem, as these often produce ancillary rather than core industry products. Producer price indices were obtained from the *Annual Abstract of Statistics* and the *Historical Record of the Census of Production 1907 to 1970*. In some cases where information was not available, approximate price indices were computed on the basis of indices of industrial production published in the *Annual Abstract of Statistics.*

Capital stock was defined as plant and machinery, i.e. buildings and vehicles were not included. I used the net capital stock estimates of O'Mahoney and Oulton (1990) for 1958. Although these are at the three-digit level, it was often possible to compute estimates of four-digit capital stock by multiplying the 1958 three-digit capital stock by the ratio of four-digit investment to three-digit investment (averaged over 1954 and 1958). Investment data as well data on the number of plants and employment at the four-digit level of aggregation were taken from the individual reports of the 1958 Census. Some adjustments were made to ensure comparability in light of the fact that the O'Mahoney and Oulton figures are based on the 1968 S.I.C., which is somewhat different from the 1958 S.I.C. Firms employing less than 25 persons were not taken into account.

R&D expenditure data are available for the early 1960s at a level of aggregation between the two-digit and the three-digit (the "sub-sector" level) and also for the mid- and late 1950s (although some of the latter data are not very reliable). They have been

published in *Research and Development Expenditure*, Studies in Official Statistics no. 21 (HMSO, 1973); *Industrial Research in Manufacturing Industry: 1959-60* (Federation of British Industries, 1961); *Estimates of Resources Devoted to Scientific and Engineering Research and Development in British Manufacturing Industry, 1955* (HMSO, 1958); and *Industrial Research and Development Expenditure 1958* (HMSO, 1960). A comparison of the various sources suggests that there have not been many significant changes in R&D intensity at the sector level between the mid-1950s and the mid-1960s, so all the sources were used to classify the industries according to their R&D intensity (measured as the ratio of company-funded R&D to sales). To derive UK R&D-sales ratios at the four-digit level, US data were also used as a guide for *relative* R&D intensities of four-digit industries within any given UK sub-sector. R&D expenditure data for the US, at a level of aggregation between the three-digit and the four-digit, have been published by the Federal Trade Commission in the Annual Line of Business reports from 1973 to 1977. The R&D-sales ratios thus derived are perhaps not very accurate, but they are sufficient for the purpose of classifying the industries.

Data on manufacturers' advertising expenditure in the UK for each year between 1954 and 1958 were taken from the *Statistical Review of Press and TV Advertising*. The data were adjusted to correct for the underreporting of press advertising and the failure to take into account discounts for TV advertising and costs of production of advertisements. The *Statistical Review* contains information mostly for consumer goods industries; however, nearly all the industries for which data are not reported could be easily classified as low-advertising industries. Although the registration and abandonment of collusive agreements under the 1956 legislation partly coincided with a significant increase in advertising intensity in UK manufacturing caused by the introduction of TV

advertising in the mid-1950s, this has only in very few cases shifted an industry from below 1% advertising-sales ratio to above 1% between 1954 and 1958; these industries were classified according to an estimate of their 1956 advertising-sales ratio (this was the last year before registration of agreements started).

It is difficult to construct a satisfactory measure of foreign competition. Import penetration ratios are clearly endogenous. This may be less of a problem for effective protection rates, but these are only available for 1963, do not cover all manufacturing, are at a level of aggregation higher than the four-digit level, and may be subject to measurement error (see Kitchin 1976). *FOREIGN* was constructed by classifying the industries in the sample as high protection or low protection. The Kitchin estimates of effective rates of protection for 1963 were the starting point (using the 10% rate as the cutoff point), but additional information was also used, including information on tariff changes in the UK between the mid-1950s and 1963 taken from Morgan and Martin (1975), and information on nominal tariff rates, quantitative controls and countries of origin of imports in the 1950s taken from Political & Economic Planning (1959), the *Annual Statement of Trade of the United Kingdom* and other sources.

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