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Product Differentiation, Industry Concentration and Market Share Turbulence

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Abstract. Building on the current theory of industrial concentration, we analyze the relation between market size and product differentiation, and show how product differentiation impacts market share turbulence. Our basic results highlight that in markets where vertical product differentiation dominates, firms will have an incentive to escalate investment in advertising and/or R&D as market size increases. Such (firm-specific) investments will make competitive advantage more sustainable as the firm is less imitable. This will not be the case if the market is primarily characterized by homogeneous product or horizontal product differentiation. Our predictions are tested using an original EU dataset for the period 1987-1997. Our results strongly support our predictions – the degree of market share turbulence increases with market size. However, this relation is weakened by competitive investment in advertising and R&D.

Keywords: product differentiation, market size, turbulence

JEL Classification: L11; L13

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INTRODUCTION

Our major objective is to advance the understanding of market share turbulence, drawing from Industrial Organization (IO) and the strategy literature by considering both the industry environment and the role of firm-specific resources and capabilities. Traditionally, the Structure-Conduct-Performance (S-C-P) paradigm hypothesized that there exist observable structural market characteristics (e.g., the number of sellers, the degree of product differentiation) that determine firm conduct (e.g., price, R&D, advertising) that in turn determine performance (e.g., profitability). Thus, product differentiation was considered to be one of the main, largely exogenous, components of industry structure. Moreover, the S-C-P paradigm highlighted the importance of barriers to entry, arguing that if entry barriers are high, then market power is more easily exploited, and firms will earn higher profits. The main sources of entry barriers were identified as the degree of economies of scale, product differentiation, and absolute cost advantages.[1] The S-C-P approach is basically a short-run static one, where conduct is sidelined, and the focus is mainly on the relationship between structure and performance.[2] However, it remains one of the most influential paradigms within the strategy literature (Ferrer, Smith and Grimm, 1999).

In IO, recent game-theoretic advances have displaced the S-C-P approach, showing that industry structure is not merely an exogenous determinant of conduct and performance, but is instead endogenously determined by the competitive process. In other words, history matters. If sunk costs (irreversible commitments) exist, the potential entrant must always consider how the incumbent will respond to entry.[3] Although the development of game theory has allowed large advances to be made, it has also been criticized for yielding extremely sensitive predictions that are hard to test empirically, mainly due to the large number of unobservables (Porter, 1991; Sutton, 1991). As such, although these types of models could potentially be hugely important in the strategic management field, for example, in analyzing inter-firm rivalry, their actual impact to date has been rather limited (Ghemawat, 1998). Thus, given the major weakness of new empirical IO, which is that firm conduct and performance in a particular market can only be explained using some chosen game-theoretic model, so results are neither readily generalizable nor robust, it is perhaps understandable that such models are not currently widely used in strategy, particularly assuming the goal of informing managerial practice and strategic choices. However, Sutton (1991, 1998) is able to generate a few key rigorous, robust and testable predictions from the theory of strategic behaviour, emphasizing the strategic choices of sunk costs in a simple and highly general framework. The general empirical results obtained then usefully complement and extend ultra-micro studies: "the experiences of individual industries can be mapped into special cases of a general theoretical model whose robust results drive the cross-industry regularities" (Sutton, 1991).

In this paper, we complement the Sutton approach with the resource-based view of the firm which essentially argues that firms' resources, rather than the product market they compete in, are more important in terms of competitive advantage (Wernerfelt, 1984; Barney, 1991). Although intuitively appealing, it has been argued that much work remains to be done in formalizing the resource-based view, particularly with respect to how to create competitive advantage, and interactions over time between firms' resources and the external environment (Priem and Butler, 2001). This paper hopes to shed light on the latter issue. Thus, our central question is how firms' heterogeneous ownership of resources and

[1] Note Demsetz (1973) argues that industries could be concentrated because firms have heterogeneous capabilities, with the lowest-cost firms obtaining the highest market shares. Thus, high concentration, and high profits (as a by-product) may reflect superior efficiency, rather than the exploitation of market power.

[2] Indeed, Schmalensee (1989) provides a survey of the hundreds of structure-profitability studies that were undertaken during the 1960s and 1970s.

[3] E.g. the incentives for entry deterrence depend (sensitively) on the correlation between pre-entry actions (e.g. fixed capital investment (Dixit, 1980) or advertising (Schmalensee, 1983)) and competition in the post-entry game.

capabilities lead them to compete over the set of strategic opportunities across industries. A complete characterization of the set is, of course, not possible. However, what is possible, and moreover, of academic interest, is the ability to identify robust regularities that will tend to yield competitive advantage. Thus, we can more easily assess the strategic choices that make firms advantaged or disadvantaged within the same industry, where sunk commitments in a dynamic or uncertain environment influence future outcomes. For example, Ghemawat (1991) argues that irrevocable investments can lead to persistent performance differences among firms. Thomas (1995) shows how sunk investments in advertising affect the order of entry into new product markets in several consumer goods industries.

In Section 2, the impact of endogenizing product differentiation and market structure is discussed. We show that in markets where vertical product differentiation dominates, firms will have an incentive to invest in advertising and/or R&D to enhance consumers' willingness to pay as market size increases. Such investments will tend to make competitive advantage more sustainable as the firm is less imitable. This will *not* be the case if the market is primarily characterized by horizontal product differentiation. In Section 3, our unique dataset on firms' market shares over time in manufacturing industries in Europe is discussed. Descriptive statistics are provided. Section 4 presents the econometric methodology, and empirical application. Finally, Section 5 concludes.

1. THEORETICAL FRAMEWORK

As the new theory of concentration is by now relatively well known, this section (briefly) summarizes Sutton (1991, 1998). Manufacturing industries can be split into two types, which Schmalensee (1992) labeled as Type 1 and Type 2. Type 1 industries are characterized by homogeneous and horizontally differentiated products. Type 2 industries by vertically differentiated products. We focus on the relation between market structure and market size.

1.1 *Market Structure and Market Size: Type 1 Industries*

Homogeneous Product Industries: in such industries, the only source of fixed costs is production economies of scale. The basic intuition of the model is that as market size increases, industry profits increase, and given free entry, new firms will enter until the profits of the last entrant just cover the exogenous overhead costs, paid on entry. The more sensitive is price competition to new entry, the bigger will be the gap between pre-entry and post-entry profits. This implies that if price competition becomes tougher, fewer firms will come into the market. Overall, however, the net effect of an increase in market size must be a rise in firm numbers and thus, reduced concentration. This minimum level of concentration is termed the *lower bound to concentration*.[4] This story highlights that for a given market size, if fixed costs are large relative to market size, only a few firms are sustainable. Thus, the technology of production is an important determinant of industry structure. Moreover, if firms have different costs due to heterogeneous resources and capabilities, the intra-marginal firm who has the lowest marginal costs will have an advantage and earn higher profits. For a given market size, ceteris paribus, the market will be more concentrated than in the symmetric case.[5]

Horizontally Differentiated Industries: the implications of horizontal and vertical differentiation with respect to market structure and sustainability of competitive advantage are

[4] Note the increase in the number of firms is less than proportionate. This is because price-cost (profit) margins fall as the number of firms increases, so each firm has to increase its level of output to cover its fixed costs which means fewer firms can profitably exist.

[5] Röller and Sinclair-Desgagné (1996) attempt to take into account both IO and strategy explanations for why persistent differences in conduct and performance amongst firms in the same industry are observed (Hatten and Schendel, 1977; Mueller, 1986). Using a Cournot model, they show that firms' capabilities would diverge only if there existed some heterogeneity in their initial capabilities, or an appropriate combination of organizational inertia (defined as the cost incurred to update capabilities) and market conditions. Thus, technological, market-based, historical and organizational factors should all be correlated with persistent profitability differences.

very different, so should be carefully examined. If we consider the representative consumer approach, à la Dixit and Stiglitz (1977), the results show that assuming free entry, constant marginal costs with a fixed cost of production, and a CES utility function (which implies that products are treated symmetrically), price and output are independent of market size. Thus, as market size increases, there are now more profitable opportunities and new entry will occur until profits are driven to zero. However, the number of firms will increase proportionately with market size, as the elasticity of substitution is constant.[6]

In locational models, à la Hotelling, on the other hand, competition is localized. Shaked and Sutton (1987) show that as market size increases, and assuming the distribution of consumer tastes is constant, market shares can always be made arbitrarily small by entering between existing products and capturing a positive market share. However, if the number of firms increases in a particular segment, the existing firms now find that there is more competition (the elasticity of substitution has increased). This implies that as market size increases, the increase in firm numbers is less than proportionate. However, in both approaches to understanding horizontal differentiation, the inverse structure-size relationship is a general result.

Thus, in Type 1 industries, we can construct a lower bound to concentration that tells us the lowest level of concentration we would expect to observe for a given market size.[7] Depending on the strategic choices that firms make within specific industries as well as external factors such as government regulation, many industries will lie above the lower bound.[8] Overall, the Sutton approach, although general and robust, cannot tell us much about what we expect to observe above the lower bound to concentration, and this is where the resource-based view of the firm plays a very important role.

1.2 *Market Structure and Market Size: Type 2 Industries*

In an industry characterized by vertical product differentiation, every consumer has the same ranking of quality. Thus, if all products were sold at the same price, all consumers would choose the highest quality product (Mussa and Rosen, 1978; Gabszewicz and Thisse, 1979; Shaked and Sutton, 1982, 1983, 1987). Products can be sold at different prices either because consumers have differing levels of income or relatively less intense preferences for quality (i.e., sensitivity to quality).[9]

In Type 2 industries, firms not only compete in price but also in advertising and/or R&D to increase the (perceived) quality of the product. Intuitively, as market size increases, the incentive to gain market share through the escalation of advertising and/or R&D expenditure also increases. The consequent rise in overhead costs has a countervailing effect on market structure by increasing the degree of economies of scale. The basic notion is that although there appears to be room for more firms in a larger market, '*the escalation mechanism*' raises fixed costs per firm, possibly even to such an extent that the negative structure-size relation breaks down (Sutton, 1991) as shown in Figure 1.

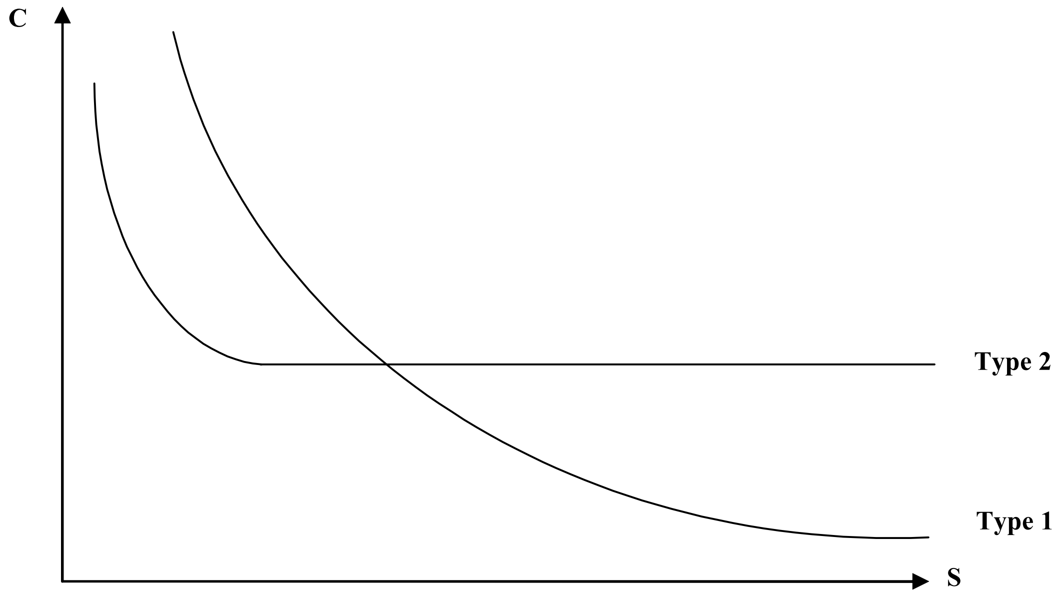
[6] As there are no perceived cross-effects by assumption, strategic interactions such as product positioning cannot be analyzed because all products are generalized substitutes. Intuitively, it is as if firms are assigned a product randomly on entry; there is no notion of 'neighbourhood' relative to the other products in the market.

[7] In an industry characterized by horizontal differentiation, a range of equilibrium outcomes becomes possible. The same group of firms might enter all submarkets leading to high concentration with a few multi-product firms or, on the other hand, small niche firms may enter each submarket, yielding a more fragmented structure.

[8] Also consider whether the market is in disequilibrium. In the short run, it may take quite a long time before firms merge or exit, particularly if economies of scale are large relative to market size, as exit will tend to be slower, the more sunk (industry specific) is the plant.

[9] Such an industry may be labeled a 'natural oligopoly'. This differs crucially from horizontal differentiation where if all products were sold at the same price, every product would have a positive market share, i.e. consumers vary in their rankings of product characteristics.

Figure 1: Comparison of Type 1 and Type 2 Lower Bounds to Concentration



However, horizontal differentiation still has an important role to play, particularly if industries are R&D intensive. This is because, unlike in advertising intensive industries, where we can define the market such that advertising covers all a firm's products in that market, firms in an R&D intensive industry may produce several groups of products that are imperfect substitutes. These products may be imperfect substitutes not only in consumption, but also on the supply side in that they embody different technologies. Thus, each technology may lead to several marketable products, where these products may be close or distant substitutes for products associated with another technology.

A firm can choose whether to focus on a few technologies, undertaking a lot of R&D per technology, "*escalation*" or whether to spread their R&D expenditure across a wide range of technologies, "*proliferation*". It can be shown that the cheaper it is to improve product performance, or the closer the substitutability of rival technologies (and associated product groups), the more likely it is that the *escalation* mechanism dominates, and thus, concentration is expected to be higher (Sutton, 1998; Matraves, 1999).[10]

Thus, at small market sizes, firms have little incentive to spend on advertising/R&D. Given the correlation between horizontal and vertical differentiation, concentration may even be lower in Type 2 industries than in Type 1. However, as market size increases, although (production) economies of scale relative to market size become negligible, escalation in advertising and/or R&D expenditure endogenously increases the returns to scale in an industry. Thus, initial industry conditions and the strategic choices that the firm makes in terms of advertising and/or R&D expenditure will determine relative success, where the focus is on one key variable, market size. This yields Hypothesis 1 (Sutton, 1991; Lyons and Matraves, 1996; Matraves, 1999).

[10] If products are not good substitutes for one another, then a firm that outspends its rivals along a particular technological path can only capture sales for a small product group. This means that the firm cannot capture market share from rival firms on different technological paths. Consequently, it does not pay to escalate R&D spending, and therefore, the incentive to introduce a new product variety, i.e., to *proliferate*, is stronger.

HYPOTHESIS 1: AN INCREASE IN MARKET SIZE IS ASSOCIATED WITH AN INCREASE IN THE LEVEL OF ADVERTISING AND/OR R&D EXPENDITURE THAT, IN TURN, WILL TEND TO MAKE TYPE 2 INDUSTRIES MORE CONCENTRATED THAN TYPE 1 INDUSTRIES.

1.3 *Turbulence and Market Size*

What our theoretical framework has contributed so far is a neat way of thinking about initial industry conditions, and tracing out incentives for firm investment in variables such as advertising and/or R&D. Our theory allows us to draw a lower bound on the number of firms we would expect to observe in an industry, but remains silent on why we might expect to observe industries that lie above the lower bound, or in other words, why firms might vary in size. Thus, the resource-based view of the firm complements our existing theoretical framework, by helping to provide an explanation for why certain firms would be able to succeed, by matching their distinctive competencies to the environmental opportunities (Peteraf, 1993, Amit and Schoemaker, 1993). As Henderson and Mitchell (1997) argue, consensus will probably never be reached about whether organizational capabilities or the firm's environment are more important in terms of sustaining competitive advantage, as both are fundamentally endogenous, and so we must take both explanations into account. This section considers the relation between market share turbulence and our key theoretical variable, market size.

We define competitive advantage as a firm's ability to outperform its industry, and it is sustainable if it persists despite efforts by the firm's current rivals or indeed potential entrants to duplicate or neutralize the advantage. In order to generate sustainable competitive advantage, it has been argued that resources and capabilities should be rare, valuable, difficult to imitate, non-substitutable (Barney, 1991) and non-transferable in that they cannot be easily purchased in resource markets (Dierckx and Cool, 1989). These unique resources create isolating mechanisms that protect the firm from imitation (Lippman and Rumelt, 1982), where such isolating mechanisms might include for example, property rights on scarce resources. In addition, managerial decisions with respect to resource deployment are characterized by uncertainty, complexity and intraorganizational conflicts (Amit and Schoemaker, 1993). Thus, heterogeneity across firms is maintained, where firms with superior resources will earn rents (Peteraf, 1993). Not only are resources heterogeneous in the resource-based view of the firm, but they are also sticky (Teece, Pisano and Shuen, 1997) in that in the short run at least, firms are constrained by their current resources (Dierickу and Cool, 1989).[11]

Arora and Gambardella (1997) show how the size of the market matters with respect to firm competencies, where in larger markets, firms are more efficient. Studying engineering firms that supply licensing and construction services to the oil and petrochemical sector across Europe and the U.S., their results show that in the significantly larger U.S. market, firms dominated in licensing, which required more specific competencies. On the other hand, European firms, operating in much smaller markets, tended to be present in construction services where fundamental skills did not differ much across projects, and therefore required more general competencies.[12]

This evidence emphasizes very nicely the complementarity of our theoretical approaches. Essentially, all these industries are R&D intensive industries, characterized by both horizontal differentiation as well as vertical differentiation. In larger markets, firms have an incentive to produce for market niches, as observed in the U.S. licensing segments. However, these engineering firms will develop rather more specialized competencies, because there is little incentive to escalate R&D spending, if that R&D spending is specific to

[11] If the competitive forces threatening sustainability are pervasive, profits in most industries should quickly converge to zero (Besanko *et al.*, 2000). However, if entry barriers or barriers to imitation are high, then we should expect to observe some persistence in profit rates over time, although it is not at all clear how one should judge "duration of leadership", i.e. what is the short run versus what is the long run? (Mueller, 1986; Sutton, 2002).

[12] Arora and Gambardella (1997) argue that similar patterns can be seen in machine tools, chemicals, computers, and telecommunications, where market size matters more for product-specific competencies than generic competencies.

one product niche, and economies of scope in R&D are not easily obtained. On the other hand, in smaller markets like the various European markets, firms will tend to develop more general competencies, such as was observed in contracting services. This is because if any economies of scale in R&D can be obtained, then contracting services will be the segment. Their results highlight our argument that both organizational capabilities and the firm's environment are crucial in terms of sustaining competitive advantage, and moreover the underlying unifying factor is market size.

Asplund and Nocke (2005) develop a very interesting stochastic dynamic model of a monopolistically competitive industry where firms are heterogeneous (i.e. differ in their initial "efficiency levels") and are subject to idiosyncratic shocks. They analyze the relationship between market size and entry and exit rates, where each firm's efficiency is assumed to follow a Markov process. The results from their theoretical model highlight that entry costs are negatively related to and fixed production costs positively related to entry and exit rates. Their central prediction is that the level of firm turnover is increasing in market size, due primarily to an increase in price competition in larger markets. Intuitively, although firms sell more in larger markets, the increase in the number of firms puts pressure on margins, and so the marginal surviving firm is necessarily more efficient in larger markets, and correspondingly, the probability of failure is higher.[13] This yields Hypothesis 2 (Arora and Gambardella, 1997; Asplund and Nocke, 2005).

HYPOTHESIS 2: THE DEGREE OF MARKET SHARE TURBULENCE WILL INCREASE WITH MARKET SIZE.

However, we do not expect this relationship to hold across all industry types. In Type 2 industries, we have emphasized how a larger market size encourages firms to invest more heavily in such quality increasing overhead costs. If endogenous sunk cost expenditure escalates, this will tend to discourage entry in the first stage of the game as it implies that competition in advertising and/or R&D is tough. However, this entry barrier is the outcome of the competitive mechanism, and as such the concept of the strategic versus the structural entry barrier needs very careful consideration. Moreover, vertical differentiation has a direct influence on barriers to imitation. Although barriers to imitation can also arise from legal restrictions, superior access to inputs or customers or intangible barriers such as causal ambiguity and social complexity, we focus on market size and scale economies. In a Type 2 industry, the firm is creating rather more intangible barriers to imitation than in a Type 1 industry. As market size grows, an incumbent has an incentive to advertise even more, further strengthening the value of its brand name or undertake R&D to enhance actual quality of the product. This endogenous escalation of advertising and/or R&D makes it all the more difficult for less established rivals or potential entrants to build the reputation of their brands. This yields Hypothesis 3.

HYPOTHESIS 3: THE POSITIVE RELATION BETWEEN TURBULENCE AND MARKET SIZE WILL BE LESS PRONOUNCED IN TYPE 2 INDUSTRIES AS COMPARED TO TYPE 1 INDUSTRIES DUE TO HIGHER BARRIERS TO IMITATION.

However, there are some crucial differences between expenditure on advertising versus R&D that we must discuss. First, appropriability is a problem in R&D intensive industries - as soon as one firm innovates, rivals may attempt to copy it, although any non-expertise of the imitators will slow down the diffusion rate. In contrast, in advertising intensive industries, the incentive for firms to imitate actual advertising campaigns is far lower.[14] Second, the patent race

[13] In addition, and although not looking at turbulence per se, Campbell and Hopenhayn (2005) investigate the effects of market size on the size distribution of establishments for thirteen retail trade industries in the U.S., and find that (for the most part), increases in market size are associated with increases in establishment size. See also Bresnahan and Reiss (1991) who look at "the toughness of price competition" and market size.

[14] Interestingly, in those consumer goods industries where firms compete in both advertising and R&D, if a firm introduces a new product, by intensively advertising the new product, consumers can become aware of the increase in product quality more quickly. This will tend to raise the size and speed of the payoff to R&D, and in turn, reduce the appropriability problem.

literature shows that leapfrogging plays an important role in R&D intensive industries, implying a strong positive link between market structure and turbulence. Caves and Porter (1978) look at the stability of market shares for the period 1963-1972, and find that product R&D significantly destabilizes market shares whereas advertising has a stabilizing effect (although insignificant), whatever the level of R&D, as advertising can be more rapidly adjusted to competitive changes. Overall, although R&D expenditure may appear 'more sunk', we might expect greater market share persistence in advertising intensive industries as brand name is harder to imitate (Thomas, 1995). Thus, although we expect the positive relation between turbulence and market size to be less pronounced in Type 2 industries, we might observe the least amount of turbulence in advertising intensive industries as compared to R&D intensive industries.

2. MARKET SHARES IN THE EUROPEAN UNION: DATA AND DESCRIPTIVE STATISTICS

As there is no European census of production, we had to construct our own estimates of market shares. This was a huge task because for each industry, we had to identify the leaders, estimate their disaggregated production, and estimate the size of EU production. Thus, we conduct our empirical analysis with a large hand-collected database comprised of the 223 manufacturing firms that are the industry leaders in the European Union in 1987 and 1997.[15] This market share matrix is designed to track, in a consistent manner, and using firm-level data, the evolution of the industrial and corporate organization of the European Union.[16] The database includes the estimates of the turnovers of the top 5 EU leading producers in each EU manufacturing industry in which they operate for 1987 and 1997. The size of the firm's operations in any given industry is the value of sales of goods produced in that industry - i.e. the firm's output in that industry. A firm qualifies as a *leader* if it is one the five largest EU producers in at least one manufacturing industry. Coupled with published Eurostat data on aggregate industry turnover, we can then calculate the 5-firm concentration ratio (CR5) for each industry in 1987 and in 1997.

We obtain our measure of turbulence from the market shares of the EU firms that persisted in a top five position between 1987 and 1997. Turbulence may occur because new firms enter the top five and/or because leading firms' dominance changes. The market share matrix thus allows us to trace changes in the identity of our leaders over time, as well as the changes in market shares of initially leading firms. In order to quantify turbulence, we start from the top five firms in 1987 that survive as industry leaders in 1997. One measure of the persistence of the leading firms (Veugelers, 2004) is given by the cumulative market share at time t+1 (1997) of the old leaders at time t (1987), written as MS^{L87}_{97}, relative to the new leaders at time t+1 (1997), written as MS^{L97}_{97}. Given that the cumulative market share of the top five leaders in 1997, MS^{L97}_{97}, is simply, the five firm concentration ratio, $C5_{97}$, we can then define turbulence as: $TURB = 1 - (MS^{L87}_{97}/C5_{97})$. This measure of turbulence yields a maximum value of 1 if none of the initial leaders in 1987 manage to survive as one of the top five firms in 1997. Conversely, the measure yields a minimum value of 0 if the same firms are in the top 5, i.e. when there is no new entry in the top5 in that industry. We can therefore think intuitively of TURB as the inverse of persistence in dominance.

To test our hypotheses, we must also distinguish vertically differentiated industries (Type 2 industries) from those producing

[15] As there are 67 industries, if each firm were a leader in one industry only, there would be 335 firms in the dataset. However, as many conglomerates obtain a leading position in more than one industry, our total number of firms reduces to 223 in both years. This implies that each firm is on average a leader in 1.5 industries. This dataset is the result of a collaborative international project financed by the European Commission. The main results are summarized in Davies, Lyons *et al*. (1996), Davies, Rondi and Sembenelli (2001), Dierx, Ilzkovitz, Sekkat (2004). See Appendix 1 for all data measurement issues and sources.

[16] The original 1987 matrix used the NACE classification Rev-0, but due to changes in how industries were classified, the 1997 matrix was constructed using the new NACE Rev-1 classification to ensure comparability with Eurostat industry data. Time comparable firm data became available thanks to a major reclassification of the industry set (from 96 NACE-Rev 0 industries to 67 "sectors", in an effort to match the old and the new classifications). See Appendix 2 for the list of industries.

homogeneous or horizontally differentiated goods (Type 1 industries). This distinction is operationalized using data on typical industry expenditures on advertising and R&D. Moreover, within the subset of Type 2 industries, we further disaggregate according to whether the industries are advertising intensive, R&D intensive or both advertising and R&D intensive (see Davies, Lyons *et al.* (1996) for more details). Appendix 1 identifies industries by type. Before proceeding to the econometric estimates, we contextualize our results by reporting some simple descriptive statistics on concentration and turbulence by industry type.

Table 1A: Concentration and Turbulence by Industry Type (*means and standard dev.)*

	# Industries	$C5_{87}$	$C5_{97}$	Turbulence
Full Sample	67	0.253 *0.1650*	0.263 *0.160*	0.427 *0.258*
Type 1 – Homogenous Products	30	0.169 *0.126*	0.180 *0.127*	0.527 *0.214*
Type 2 – Differentiated Products	37	0.321 *0.163*	0.333 *0.150*	0.346 *0.238*
Type 2a – Advertising intensive	12	0.252 *0.116*	0.303 *0.129*	0.366 *0.198*
Type 2r – R&D intensive	17	0.361 *0.191*	0.347 *0.186*	0.351 *0.282*
Type 2ar – Adv. and R&D intensive	8	0.339 *0.139*	0.356 *0.092*	0.306 *0.211*

Table 1B: Decomposition of Mean Concentration Change

	Number of Firms	Industry sample Means (%)			
		Levels		*Changes*	
		1987	*1997*		
C5[a]	5.00	25.28	26.33	Δ C	+ 1.05
Survivors	2.49	16.25	16.30	SUR	+ 0.05
Exitors	2.51	9.03	-	EXT	- 9.03
Entrants	2.51	-	10.035	ENT	+10.02
Type 1- C5[b]	5.00	16.89	17.69	Δ C	+0.80
Type1 Survivors	2.03	9.40	9.65	SUR	+0.25
Type1Exitors	2.97	7.49	-	EXT	-7.49
Type1Entrants	2.97	-	8.04	ENT	+8.04
Type 2- C5[c]	5.00	32.07	33.33	Δ C	+1.25
Type 2 Survivors	2.86	21.79	21.69	SUR	-0.10
Type 2 Exitors	2.14	10.28	-	EXT	-10.28
Type 2 Entrants	2.14	-	11.63	ENT	+11.63

(a) Across 67 industries; (b) Across 30 industries; (c) Across 37 industries.

A striking pattern is immediately apparent. Although typical concentration remained relatively stable over the decade (one percentage point of increase), inter-industry differences in changes and levels of concentration reveal considerable variation between industry types. Moving down columns 2 and 3 in Table 1A, we find that EU concentration is much higher in Type 2 than in Type 1 industries, a result consistent with the standard results on the determinants of concentration (e.g., Lyons and Matraves, 1996; Lyons, Matraves and Moffatt, 2001). Moreover, R&D (Type 2R) is more strongly associated with high concentration than is advertising (Type 2A). This pattern holds over time, but with a tendency to converge. Concentration has risen quickly where advertising is more important, but has slightly declined where R&D is the primary source of differentiation.

When we turn to our measure of turbulence, we again observe marked differences across our industry types. Type 1 industries exhibit on average much higher turbulence than Type 2 industries, i.e. more of the old leaders have lost position since 1987 relative to the new leading firms in 1997. Within Type 2 industries, there is some evidence that advertising-intensive industries are more turbulent, on average, than R&D intensive industries. On the other hand, persistence of leadership is highest in type 2AR industries, where firms have two endogenous fixed costs, advertising and R&D, with which to compete.

In Table 1B, we examine how survivors, exitors and entrants contribute to the change in mean concentration across all industries and industry types. Our results show that the average market share of surviving industry leaders is stable (around 16% in both 1987 and 1997), where the (small) one percentage point increase in concentration can all be attributed to new entries. When we separate out our industries by type, we notice that the market share of surviving leaders in Type 2 industries is, on average, more than twice that of their Type 1 counterparts. Although this difference obviously depends on Type 2 industries being significantly more concentrated than Type 1 initially, observe that the average market share of Type 2 leaders is about twice the market share of exitors and/or entrants. On the other hand, the market share of exitors and/or entrants within Type 1 industries is only slightly smaller than the market share of survivors. Overall, and consistent with our findings in Table 1A, it appears that Type 1 industries can be characterized by a more turbulent environment, with industry leaders constantly under attack. Conversely, in Type 2 industries, the surviving leaders show a tendency to be much larger than their rivals, and hence possibly more persistently dominant. This pattern is reflected not only in the dynamics of market shares of survivors and exitors/entrants, but also in the average number of firms surviving as leaders: 2.86 in Type 2 industries as opposed to 2.03 within Type 1.

3. ESTIMATION AND RESULTS

To test Hypothesis 1, we use a linear function relating a logistic transform of concentration and the reciprocal of the natural logarithm of industry size relative to economies of scale as the measure of effective market size (see Lyons, Matraves and Moffatt, 2001). Thus, concentration is measured as $C^E_i = \ln(C5_i/[1-C5_i])$ where $C5_i$ is the 5-firm concentration ratio for industry i at the EU level. Market size is measured as $S^E_i = 1/[\ln(MES_i/ESIZE_i]$, where MES_i is an engineering estimate of the output required to achieve minimum efficient scale in industry i, and $ESIZE_i$ is the total output of the EU. We define four dummy variables: $d^1_i = 1$ if industry i is of Type 1, and zero otherwise; $d^{2A}_i = 1$ if industry i is of Type 2A, and zero otherwise; $d^{2R}_i = 1$ if industry i is of Type 2R, and zero otherwise; and $d^{2AR}_i = 1$ if industry i is of Type 2AR, and zero otherwise. Since the fundamental concentration-size relationship is expected to differ according to industry type, we operationalize our model by writing the equation to be estimated as:

$$C^E_i = \beta_1 d^1_i + \beta_2 d^{2A}_i + \beta_3 d^{2R}_i + \beta_4 d^{2AR}_i + \beta_5(d^1_i S^E_i) + \beta_6(d^{2A}_i S^E_i) + \beta_7(d^{2R}_i S^E_i) + \beta_8(d^{2AR}_i S^E_i) + u_{1i} \qquad \text{(H1)}$$

Table 2: Concentration and Market size by Industry Type

Dependent Variable: Concentration (1997)			
	(1)	*(2)*	*(3)*
Constant	-3.358 *(-10.457)*	- -	- -
TYPE 1	- -	-4.163 *(-13.488)*	-4.163 *(-13.488)*
TYPE 2	- -	-2.119 *(-6.023)*	- -
TYPE2A	- -	- -	-1.560 *(-2.210)*
TYPE2R	- -	- -	-2.498 *(-4.211)*
TYPE2AR	- -	- -	-1.526 *(-3.512)*
MARKET SIZE	-11.474 *(-6.762)*	- -	- -
MARKET SIZE (T1)	- -	-14.655 *(-7.943)*	-14.655 *(-7.943)*
MARKET SIZE (T2)	- -	-6.581 *(-4.007)*	- -
MARKET SIZE (T2A)	- -	- -	-3.594 *(-0.887)*
MARKET SIZE (T2R)	- -	- -	-8.391 *(-3.037)*
MARKET SIZE (T2AR)	-	-	-3.988 *(-2.434)*
N. Observ.	67	67	67
Adj. R^2	0.484	0.605	0.588

Notes: T-statistics in round brackets. Standard errors robust to heteroscedasticity.

If we are willing to assume that the ranking of lower bounds will be reflected in averages, then our predictions are as follows: $\beta_1 < \beta_2, \beta_3, \beta_4$ (i.e., Type 1 industries have a lower limit concentration as market size approaches infinity); and $\beta_5 < 0, \beta_6, \beta_7, \beta_8$ (i.e., Type 1 industries have a steeper slope).[17]

The results as presented in Table 2 offer

[17] Note H1 relates to the lower bound to concentration. Sutton (1991) and Robinson and Chiang (1996) fit exact lower bounds to their data, whereas Lyons and Matraves (1996) fit a stochastic lower bound. In practice, this latter technique has almost no effect on the slopes but does substantially shift down the intercept, which is what we would expect given that the slope coefficients are consistent but inefficient, and only the intercept terms are biased. Thus, there is little statistical harm in fitting curves through the middle of the data, particularly if the errors are approximately normal, and as long as only slope coefficients are under scrutiny.

strong support for Hypothesis 1. While the results in column (1) confirm the negative relationship between concentration and size, our findings in column (2) show that the limiting level of concentration increases from Type 1 to Type 2 and, more importantly, that as market size increases, Type 2 industries do not tend to converge to a fragmented structure. Even without making any adjustment to convert our best fit line to a lower bound, the coefficient of -4.16 suggests that EU concentration approaches just 1.5% as market size increases without limit in Type 1 industries. When we break up Type 2 industries according to advertising and/or R&D intensity in column (3), we find that the limiting level of concentration, as market size becomes very large, increases from Type 1 to Type 2A to Type 2R, with Type 2AR industries being significantly different from Type 1 industries.[18] Furthermore, the slope coefficients are smaller in Type 2 industries, even becoming insignificant in Type 2a industries. This evidence confirms that advertising and R&D expenditures are active competitive weapons (firm specific choices) and not exogenous, and is totally consistent with existing empirical work (Sutton (1991), Robinson and Chiang (1996), Lyons and Matraves (1996), Lyons, Matraves and Moffatt (2001)). If advertising and R&D were exogenous sunk costs, than the lower bound would be shifted upwards but the slope effects would not be present.

To test Hypothesis 2, we again employ a simple linear function relating turbulence, TURB = 1 - $MS^{L87}{}_{97}/C5_{97}$ and market size $S^E{}_i = 1/[\ln(MES_i/ESIZE_i]$. Thus, we operationalize our model by estimating the following equation, where we predict that $\beta_2 > 0$:

$$TURB^E{}_i = \beta_1 + \beta_2 S^E{}_i + u_i \qquad \text{(H2)}$$

Since the fundamental relationship between turbulence and market size is expected to differ according to industry type, we specify our equation to test Hypothesis 3 below, where $d^1{}_i = 1$ if industry i is of Type 1 and $d^2{}_i = 1$ if industry i is of Type 2:

$$TURB^E{}_i = \beta_1 d^1{}_i + \beta_2 d^2{}_i + \beta_3(d^1{}_i S^E{}_i) + \beta_4(d^2{}_i S^E{}_i) + u_{1i} \qquad \text{(H3)}$$

We predict that the slope in Type 1 industries will be larger (i.e. a higher degree of turbulence) than the slope in Type 2 industries. Finally, and in line with our discussion (see section 2.3) of the various Type 2 industry subsets, we run an additional regression to see if turbulence is more pronounced in R&D intensive industries (Type 2R) than in advertising intensive (Type 2A) industries. Note although our expectations on the Type 2 industry subsets are not clear cut, our expectation that Type 1 industries are the most turbulent of all is. Thus, our last column in Table 3 reports our results from estimating the following equation, where we include four intercepts and four slope coefficients for all industry types:

$$\begin{aligned} TURB^E{}_i = \; & \beta_1 d^1{}_i + \beta_2 d^{2A}{}_i + \beta_3 d^{2R}{}_i + \beta_4 d^{2AR}{}_i \\ & + \beta_5(d^1{}_i S^E{}_i) + \beta_6(d^{2A}{}_i S^E{}_i) + \beta_7(d^{2R}{}_i S^E{}_i) \\ & + \beta_8(d^{2AR}{}_i S^E{}_i) + u_{1i} \end{aligned}$$

Table 3 presents our results. Hypothesis 2, which predicts that turbulence increases with market size, is supported by the results in column 1. The coefficient on market size is positive and significant. Moreover, the results in column 2 provide strong support for Hypothesis 3. We do find that the positive relationship between turbulence and market size is less pronounced in Type 2 industries as compared to Type 1 industries. The slope coefficient for Type 1 industries is positive and significant whereas the slope coefficient in Type 2 industries is insignificantly negative (i.e. it is not significantly different from zero). This result is consistent with the view that in vertically differentiated industries, the endogenous escalation of advertising and/or R&D expenditures allows the firm to create intangible barriers to imitation.

[18] This further break up implies that few observations are available for Type 2 sub-samples (see Table 1), which suggests some caution in the interpretation of the results.

Table 3: Turbulence and Market Size by Industry Type

Dependent Variable: Turbulence			
	TURB: 1 - $MS^{L87}_{97}/C5_{97}$		
	(1)	*(2)*	*(3)*
Constant	0.591 *(6.276)*	- -	- -
TYPE 1	- -	0.732 *(6.467)*	0.732 *(6.467)*
TYPE 2	- -	0.319 *(2.407)*	- -
TYPE2A	- -	- -	0.457 *(3.307)*
TYPE2R	- -	- -	0.369 *(1.820)*
TYPE2AR	- -	- -	-0.078 *(-0.297)*
MARKET SIZE	0.887 *(1.945)*	- -	- -
MARKET SIZE (T1)	- -	1.271 *(1.998)*	1.271 *(1.998)*
MARKET SIZE (T2)	- -	-0.133 *(-0.227)*	- -
MARKET SIZE (T2A)	- -	- -	0.492 *(0.677)*
MARKET SIZE (T2R)	- -	- -	0.088 *(0.111)*
MARKET SIZE (T2AR)	- -	- -	-1.681 *(-1.602)*
N. Observ.	67	67	67
Adj. R^2	0.029	0.113	0.078

Notes: T-statistics in round brackets. Standard errors robust to heteroscedasticity.

Column 3 presents our results by industry type where we break up Type 2 industries according to whether they are R&D intensive (Type 2R), advertising intensive (Type 2A) or both (Type 2AR). Interestingly, although the turbulence-market size relationship breaks down, as predicted, for advertising intensive industries, the slope coefficients in Type 2A and type 2R are not significantly different. However, we do find that the slope in Type 2AR industries is negative and significant. This indicates the highest degree of persistence and dominance in industries where firms can choose whether to use both advertising and R&D as strategic competitive weapons.[19]

[19] We also re-estimated the results in columns 1 through 3 using a logistic transform of TURB as the dependent variable. We found that the qualitative nature of our results did not change, confirming the ranking of the slopes of the turbulence-market size relationships, although the statistical significance of coefficients improved.

4. CONCLUDING REMARKS

This paper has focused on three key activities – manufacturing, marketing, and R&D – that underlie the competitive process in an industry, and their interaction with market size. We emphasize the importance of sunk costs, and more specifically, whether those sunk costs are exogenous or endogenous. We tested our theoretical implications on a unique dataset containing information on firms' market shares over time. Our basic hypothesis is that in Type 2 industries where vertical product differentiation dominates, firms will have an incentive to escalate investment in advertising and/or R&D to increase consumers' willingness to pay as market size increases. Such (endogenous) investments will tend to make such industries more concentrated for a given market size than in industries primarily characterized by product homogeneity or horizontal product differentiation. The data strongly supported Hypothesis 1, in line with all existing studies.

We then asked whether variations in market shares (or turbulence) increase with market size, a question that is currently attracting much academic attention. Again, the data strongly support Hypothesis 2. Moreover, we argued that endogenous investments will tend to make competitive advantage more sustainable as the firm is less imitable. This will weaken the predicted relation between market share turbulence and market size in Type 2 industries, as compared to Type 1 industries. Once more, our results are consistent with our theoretical predictions.

In conclusion, we can clearly identify an underlying fundamental mechanism, which is that turbulence and market size are positively related. When we introduce competitive escalation in endogenous sunk costs, this weakens the relationship. There remains work to be done on disentangling precisely the relation between market share turbulence and market size in Type 2 industries, where firms have the choice of which competitive weapon to use, and how to use it.

APPENDIX 1: DEFINITIONS AND DATA SOURCES

EU C5: as there is no EU census of manufactures, we first had to identify candidate leaders in order to obtain estimates of the sizes of the largest firms in each industry. We undertook an analysis of the 500 largest European firms, supplemented by firms from industrial directories, and the institutional knowledge of the multinational research team. Company accounts and other secondary sources were used to disaggregate each candidate firm's operations by industry for the years 1987, 1993 and 1997.

EU Industry Size: Eurostat data are available for 'sales of products manufactured by the Kind of Activity Unit and revenue from industrial services rendered to others' [Eurostat code 19(KAU)]. We made extensive use of the footnotes to fill numerous gaps in the data. The data were also grossed up to take account of production by smaller firms (which can be significant in some industries).

Minimum Efficient Scale (MES): the basic source for these engineering estimates is Pratten (1987); as far as is possible, we refer to technological production economies only (excluding R&D, marketing, etc). Although Pratten's is a comprehensive review, there are numerous gaps, some estimates are not representative of the 3-digit industry, and often the information is not provided as a sales value Sometimes, we made use of additional data on unit values from, for example, the UK Annual Abstract of Statistics, or case studies. Industries were placed in 11 size classes reflecting the 'typical' MES which was felt to be as fine a categorisation as the data would allow. While it can be argued that engineering estimates overstate the extent of economies of scale that can reasonably be achieved in the market, our estimates do provide reasonable indicators of relative scale economies, which is all that is required for our purposes.

Industry typology: Note that EU data on advertising and R&D are not available at the required level of disaggregation, so we had to rely on UK and US advertising data, and UK, Italian and US R&D data. This is much less of a problem than might be thought, as the data are required only to classify industries into those which engage in these forms of competition and those which do not (at least, to a significant extent).

a) T2A: Data were obtained for the US (media advertising expense to sales) and the UK (MEAL advertising agency data). The UK data were expressed relative to UK apparent consumption (national industry size minus exports plus imports). To use both sets of available data, we classified the industry as T2A if the advertising to sales ratio was at least 0.7% in both countries.

b) T2R: Data were obtained for the US, the UK and Italy. *Rdsus* (the US R&D/sales ratio) - some observations are at the 4-digit level, and were then aggregated up. *Rdsuk* (the UK R&D/sales ratio) - some observations are at the 2-digit level, these were then disaggregated to the 3-digit level assuming the same R&D intensity among constituent industries. *Rdsit* (the Italian R&D/sales ratio) industries were at a slightly more aggregate level than for the UK, and disaggregated in the same way. To use all sets of available data, and given the more aggregate nature of the UK and Italian data, we classified the industry as Type 2R if *Rdsus*>1% or *Rdsuk*>1% or *Rdsit*>1%, and *Rdsus*>0.25% and *Rdsuk*>0.25% and *Rdsit*>0.25%. Our main results are not sensitive to these cut-off points.

APPENDIX 2: INDUSTRIES BY TYPE

SPES code	*Industry*	*NACE rev. 0*	*NACE rev. 1*	*Type*	
1	first processing of steel	221, 223	271, 273, 287	1	
2	steel tubes	222	2722	1	
3	non-ferrous metals	224	274	1	
4	clay products	241	264	1	
5	cement, lime and plaster	242	265	1	
6	concrete	243	266	1	
7	glass	247	261	1	
8	ceramics	248	262, 263	1	
9	basic chemicals	251, 256, 259	241, 242, 246	2R	
10	paint and ink	255	243	2AR	
11	pharmaceuticals	257	244	2AR	
12	soap, detergents, toiletries	258	245	2AR	
13	man-made fibers	260	247	2R	
14	casting, forging and first treatment of steel	311, 312, 313	272, 275, 284, 285, 287	1	
15	manufacture of metal products	314, 315, 316	281, 283, 286, 287, 296, 361	1	
16	manufacture of tractors and agricultural machinery	321	293	2AR	
17	manufacture of machine tools for working metals	322	294	2R	
18	manufacture of other machinery	323 to 328	291, 292, 295	2R	
19	computer and office equipment	330	300	2R	
20	insulated wires and cables	341	313	2R	
21	manufacture of electrical machinery	342, 348	311, 312	2R	
22	batteries and accumulators	343	314, 316	2R	

23 - 26	23 electronic valves, tubes and other components	345	321	2AR	2R
	24 television and radio transmitters	345, 344	322	2R	
	25 television and radio receivers, sound or video recording apparatus	345	323	2AR	
	26 measuring, checking, testing instruments	345	332, 333	2AR	
27	domestic electrical appliances	346	297	2AR	
28	lighting equipment and lamps	347	315	2R	
29	motor vehicles	351, 352	341, 342	2AR	
30	motor vehicles parts	353	343	2R	
31	Shipbuilding	361	351	1	
32	railway locomotives and stocks	362	352	2R	
33	cycles and motorcycles	363	354	2R	
34	Aerospace	364	353	2R	
35	measuring, checking and precision instruments	371	332, 333	2R	
36	medical instruments	372	331	2R	
37	optical instruments	373	334	2AR	
38	clocks and watches	374	335	2AR	
39	oils and fats	411	154	2A	
40	meat products	412	151	1	
41	dairy products	413	155	2A	
42	fruit and vegetables	414	153	2A	
43	fish products	415	152	1	
44	grain milling and manufacture of starch	416, 418	156	1	
45	Pasta	417	158	1	
46	bread and biscuits	419	158	1	
47	Sugar	420	158	1	
48	confectionary and ice cream	421	158 (except 1586, 1587)	2A	
49	animal feed	422	157	2A	
50	other foods	423	1586, 1587	2A	
51	alcohol, spirits, wine and cider	424, 425, 426	159	2A	
52	beer	427	159	2A	
53	Soft drinks	428	159	2A	
54	tobacco	429	16	2A	
55	textiles	431 to 435 , 437 to 439	171, 172, 173	1	
56	knitwear	436	176, 177	1	
57	leather	441, 442	191, 192	1	
58	footwear	451, 452	193	1	
59-60	clothing + made up textiles	453, 455	181, 182, 174, 175	1	
61	wood sawing	461	201	1	
62	wood boards	462	202	1	
63 - 64	wood manufactures	463, 464	203	1	
65	wooden furniture	467	361	1	
66	paper and pulp	471	211	1	
67	articles of paper	472	212	1	
68	publishing	473, 474	221, 222	1	
69	rubber products and tires	481, 482	251	2R	
70	plastics	483	252	1	
71	musical instruments	492	363	2A	
72	toys and sports goods	494	364, 365	2A	

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