THE ORGANIZATION ENACTS THE ENVIRONMENT AND THE ENVIRONMENT FEEDS BACK: MORTALITY RATES IN THE UK MOTORCYCLE INDUSTRY, 1895-1993♣

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SOM theme G Cross-contextual comparison of institutions and organisations

Abstract

This paper uses the information on 648 manufacturers during the period included between 1895 and 1993 to explore the interaction of different levels of analysis in developing of the United Kingdom motorcycle industry. It provides three general results. First, it demonstrates how long term changes of the organizational environment can be related to the micro-evolution of firms' strategies. Second, it sheds light on the fact that organizations and population act in the opposite way in determining the survival of firms. On the one hand, organizations diversify their production in order to obtain economic advantages of scale and superior profits. On the other, the evolution of the population constrains organizational expansion by increasing the level of competition. These two contrasting forces drive the co-evolution of niches of generalist and specialist producers within the population. Third, while the increasing age of a population's members tend to reduce the level of competition, ages' heterogeneity represents a powerful selective force acting within an organizational population. The implications stemming from this work are related to both the literatures of business strategy and of population ecology.

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♣ I gratefully acknowledge suggestions from Cristina Boari, Bernard Forgues, Andrea Lipparini, Alessandro Lomi and Arjen van Witteloostuijn. All errors remain my responsibility.

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Introduction

Organizational ecology offers us a powerful tool to interpret the evolutionary trajectories of industries. The density-dependence theory (Hannan, 1986) maintains that two counterbalancing processes of legitimation and competition influence the evolution of organizational populations. While an impressive array of evidence has been produced in support of this theory (for a comprehensive review see Baum, 1996), several questions were raised on the underlying assumptions of this model. On the one hand, with respect to legitimation – i.e. the process that allows an organizational form to become taken-for-granted – Baum and Powell (1995) remarked the need for considering the multi-facet nature of this concept. Similarly, Singh (1993) suggested that a sensible improvement could be reached though a more precise and realistic measurement of it. More recently, Hedstrom, Sandell and Stern (2000) have proposed a new perspective to the problem, which accounts for networking effects. On the other, different emerging streams of research have challenged the ecological representation of competition. The theory of mass-dependence (Winter, 1990), for instance, recognizes that organizations do not compete equally, but they generate an amount of competition proportional to their size. By the same token, the theory of size-localized competition (Baum and Mezias, 1992) claims that organizations compete most intensely with those of similar size. In a few words, ecologists have been accused (i) to consider the organizational environment as an exogenous force, and (ii) to consider organizations as homogenous competitors. Last (iii), it is not always clear the contribution of this stream of research for managerial issues.

In this work I propose a new way of overcoming these limits, replacing the density variable with a new one related to market/firm development – i.e. products' diversity[2] –, which mediates the cooperative and competitive processes among organizations. I chose this measure because it allows me endogenously investigating the development of an organizational population, to map the interactions between firms and population in heterogeneous ways, as well as to provide practitioners with

[2] The term product diversity is used in this paper in the same way of Lancaster (1990: 189), as the "number of variants within a specific group of product."

normative implications. Moreover, tracing the evolution of products' heterogeneity at multiple levels of analysis enables me to acknowledge organization and population as mutually related levels of analysis. The organizations differentiate their production in order to obtain superior profits. Yet, doing so they directly mold the evolution of the product's heterogeneity at the population level, which in turn, sets the amount of cooperation/competition the organization faces in the environment.

To reach this goal, I summarize the findings of the literature on product differentiation, population development, and mutual forbearance to provide evidence on how long-term changes of the organizational environment can be related to the microevolution of firms' policies. In particular, I use the information collected on the history of 648 British motorcycle manufacturers during the period included between 1895 and 1993 to provide evidence on how product, market diversity and their interaction influence organizational survival. The paper will proceed as follows. In the next section, the theory will be introduced. Later on, the evolution of the motorcycle industry will be presented. Then data, model, and method used for the analysis will be illustrated. In the last two sections, the results and their normative implications will be discussed.

Theory

Organizations continuously face a trade-off between efficiency and efficacy. Porter (1980) analyzed this problem in terms of the relative advantages of pursuing a broad range versus a focused strategy. Typically, a generalist firm is a broad range competitor – e.g. Honda, whereas a focused policy implies a narrow range of products offering – e.g. Harley Davidson. How many products should a firm offer? The problem of assessing the mutual effects of different policy choices within a firm's strategy arose as soon as the idea of strategy as a series of relatively independent decisions, typical of the neoclassical economic literature, was questioned. Within the bounded rationality framework, several authors (Simon, 1947; Cyert and March, 1963; Thompson, 1967; Nelson and Winter, 1982) developed the concept of strategy as a self-constraining process where the payoff is determined by the mutual dependence of policy choices. The classical strategic analysis builds on the idea that firms grow, expand and increase their profitability (Chandler, 1962). Product variety allows the firm to meet the demand of different groups of consumers and, potentially, it increases a firm's sales. Kekre and Srinivasan (1990) found a positive relationship between product line breadth and market share. Indeed, product proliferation can act as a deterrent to entry. Schmalensee (1978), for instance, discussed this issue in the United States ready-to-eat breakfast cereal industry. He argued that if firms 'pack' the market with a variety of products or brands so that insufficient room exists for a new firm's product, they might be able to have high prices and profits without attracting entries. Last, a multiple product strategy allows also organizations to cope with the patterns of products' life cycle (Cox, 1967).

Yet, as the variety of tasks increases, coordination becomes more problematic (Lawrence and Lorsch, 1967). Interdependencies create uncertainty that render rational decision-making difficult or even impossible (March and Simon, 1958). As Pfeffer and Salancik (1978: 40) noted, "interdependency is the reason why nothing comes out quite the way one wants it to." For these reasons a basic principle of organizational design is to structure it in order to control the uncertainty created by interdependencies (Thompson, 1967). The NK model proposed by Kauffman (1993) has widely been used to investigate this issue. Levinthal (1997) found that the level of interconnections between the policy choices of a firm's strategy represent one of the main determinants of its outcome. In general, offering multiple products is supposed to require a complex firm's design, to increase organizational interdependencies, and to increase inventory costs.

On an empirical standpoint, Barnett and Freeman (1997) found that coordination's uncertainty increase with the number of products introduced by an organization. More recently, Dobrev and his colleagues proposed results that implicitly point to a similar direction. Kim, Dobrev and Solari (2001), studying the Italian automobile industry, did not support the negative linear relationship between niche width and organizational mortality. In a similar research on the automobile industry in Great Britain, Germany and France, Dobrev, Kim and Hannan (2001) found support for the negative relationship only for Great Britain in their most complete model formulation (Table 6: 1328).

In the literature on business strategy, Prahalad and Hamel (1990) suggested that a firm should enter those businesses where its competencies can be properly exploited. Managing a broad range of products implies to properly use the marketing tools – i.e. advertising and distribution – as well as to create products that satisfy the very diverse needs of multiple groups of customers. Indeed, the latter represents a powerful force that can act against the expansion of the range of products of the firm. The history of the motorcycle, for instance, demonstrates how difficult this effort can be. At the end of the Sixties, because of the growth of the demand for small motorcycles, Harley Davidson, the world famous big capacity producers, began to commercialize medium capacity motorcycles – 125 and 250 cc. This strategy soon encountered major losses: traditional clients became unidentified with the brand and the market share of the firm declined. Within a few years, Harley Davidson returned to its traditional production (Grant, 1991). Therefore, I hypothesize that:

Hypothesis 1: There is a ∪-shaped relationship between the diversity of products a firm offers and its rate of failure.

Diversity assumes also a systemic level connotation. At industry-level of analysis for instance, diversity plays a central role in several fields. Social diversity and pluralism, for instance, are widely held to foster institutional and technological innovation (Mokyr, 1994). Economists (Nelson and Winter, 1977) and biologists (i.e. Pielou, 1977) have underlined the importance of variation as a chief cause of evolution (Marshall, 1961). On a technological standpoint, Saviotti and Mani (1995: 390) argued that technological diversity is "a necessary requirement for the continuation of long term development." In a similar vein, Kauffman (1993) noted that growth of cities appears to be strongly correlated with industrial diversity and not with concentration within a single industry. Last, the rate of evolution displayed within a particular industry tends to be proportional to the degree of economic variety contained within it (Gibbons and Metcalfe, 1986).

Diversity represents also an important feature of resilient systems. As Hannan and Freeman (1989: 3) stated, "the ability of a society as a whole to respond to changing conditions depends on the responsiveness of its constituent organizations and on the diversity of its organizational populations." Organizational diversity sets the limit on the range of alternative solutions that are available in the environment. Similarly, Grabher and Stark (1997) suggested that diversity plays an important role in promoting the adaptability of a system. Their analysis of the regional determinants of successful entrepreneurship in Northern Italy and Eastern Europe confirmed that diversity is an important factor in promoting adaptability in an economy. Indeed, diversity can help to reduce lock-in consequences. Increasing returns from learning effects yield immediate benefits, but prevent the system to choose the most efficient solution (Carroll and Harrison, 1994). Diversity mitigates these negative effects by rising the competition among solutions. Thus, diversity is seen to promote the ecological competition among firms and to drive, at the system-level of analysis, economic evolution.

Durkheim, (1897) argued that the division of work represents the byproduct of economic evolution. Yet, fragmented systems – i.e. highly diversified ones - usually under-exploit many resources. Diversity in fact is not a free good. In the case of technology for instance, standardization is important to bring scale advantages and network externalities, usually associated with increasing system-level learning. Indeed, "in many contexts, organizational diversity likely influences outcomes that are possibly very important, but peculiar to the context" (Carroll and Hannan, 2000: 440). Thus, excessively diversified systems tend to be overspecialized. Similarly, Kauffman (1993) suggested that evolution manifest itself at the edge of chaos. Optimal diversity of a system falls between a dense homogeneity and a complete fragmentation. By the same token, Grabher and Stark (1997) argued that an excessive diversity allows the development of a biological process known as compartmentalization. In a greatly diversified system, barriers emerge and buffer the various sub-populations from each other. The risk of this phenomenon is to suppress vital selection processes. Thus, while great diversity constrains system-level evolution, it reduces the ecological competition among firms. Therefore, I hypothesize that:

Hypothesis 2: There is an inverted ∪-shaped relationship between market diversity and organizational rate of failure.

Hypotheses 1 and 2 involve two different levels of analysis, the organization and the population. These two levels are analytically separated but obviously interact, with the another. Ecologists defined the diversity of products a firm offers in term of niche width (Hannan and Carroll, 1995a). Every organization in fact occupies an organizational niche characterized by a set of capabilities (Baum and Singh, 1994b). They distinguish generalist from specialist organizations by the breadth of the niche they occupy. The latter, concentrate their fitness on a narrow space, and they do well when the environment falls within that space, out-competing generalists. On the contrary, generalists spread their fitness over a wider environmental space and do better than specialists when the environment is uncertain. Under uncertain environmental conditions generalists will beat specialists organizations because they maintain the capacity to compete in several different environmental states, whereas specialists remain focused on a single state. In particular the theory maintains that generalists are favored when environmental variation is high and the pattern of this condition is coarse (Hannan and Freeman, 1977). Suarez and Utterback (1995) argued that organizations that enter the industry before the definition of a dominant design have the opportunity to experiment different solutions and, therefore, they are more likely to come up with the right solution. Dowell and Swaminathan (2000) found that the technological uncertainty of the early years of the United States bicycle industry favored those organizations having a broad product line. Usually, diversified strategies are used in fields where uncertainty represents a key variable: financial investments, gambling and energy policy (Sterling, 2000). In general, concepts like flexibility, resilience, robustness and modularity emerged as a response to the condition of ignorance. Under these conditions, no matter how great the resources, or how sophisticated the decision making processes, only fools put their eggs into one basket (Simpson, 1992).

Nevertheless, as noted by Sorenson (2000), environmental uncertainty is not only related to technology. Consumers for instance possess a set of heterogeneous preferences, and boundedly rational managers do not know *ex ante* the distribution of these preferences (March, 1978). Under these conditions, generalist firms benefit by locating products in that part of the resource space with unmet preferences. Yet, as product diversity increases at market level, the set of preferences of customers becomes less uncertain. Growing market diversity helps in fact build legitimation and explore the tails of the resource space, opening up new niches that can be later filled by the more efficient specialist organizations. Similarly, economics models of industrial evolution (Stigler, 1951) suggest that vertical disintegration occurs as market expands. Aldrich and Wiedenmayer (1993: 171) argued that "we would expect specialists to emerge in populations after some early period of expansion." Thus, when all the resource space is legitimated and the set of preferences of customers becomes defined, the environment looses part of its instability. While changing environments favor generalist firms because they fit the environment equally well, as volatility decreases, generalists become increasingly disadvantaged relative to specialist organizations.

Hypothesis 3: As market diversity increases, the relationship between organizational diversification and rate of failure increases.

As I mentioned before, the concept of organizational niche represents a powerful tool to define intra-population differences in resource requirements. A large literature in organizational ecology demonstrated how competition, and therefore mortality, acts locally on some dimensions, with organizations more likely to compete with one another the more they overlap on one of these dimensions. McPherson (1983) defined niche overlap in terms of a common distribution of members across several sociodemographic characteristics. He argued that the competition between two voluntary organizations for members is proportional to their similarities on sociodemographic characteristics. In another study, Baum and Singh (1994b), measured the rate of disbanding of day care centers in Toronto between 1970 and 1989, creating a measure of overlap focused on the similarities of these firms in age range of the children served. Their findings showed that overlap density – the aggregate overlap of an organization’s resource requirements with those of all others in the population – significantly raises the rate of disbanding. The same pattern was found when analyzing overlap on different characteristics: technology (Podolny et al., 1996; Dobrev et al., 2001) and geography (Baum and Mezias, 1992; Sorenson and Audia, 2001; Wezel et al., 2001) represent the most investigated dimensions. In general, these pieces of research agree that the intensity of competition is a positive increasing function of the number of overlapping niches (Dobrev et al., 2001).

Nevertheless, at least two reasons exist to suppose the relationship between niche overlap and competition to not be unidirectional. *First*, Simmel (1950) suggested that the potential for cooperation among rivals increases when they interact in multiple domains, since each will gain by allowing the other to win in some domains in exchange for similar treatment in other domains. Edwards (1955) developed a similar idea in economics. In that work he noted that a multi-markets firm has an incentive to refrain from competing aggressively in the sphere of influence of its multipoint rivals, as long as its own sphere is respected. Several studies found support for this hypothesis that firms mutually forbear when they meet in multiple markets (Bernheim and Whinston, 1990; Scott, 1991; Barnett, 1993). Similarly, Korn and Baum (1999: 191), analyzing the antecedents of multipoint contacts, have shown that “multimarket contact results from firms’ strategists’ recognizing that mutual benefits may result from encountering the same opponent in multiple markets.” *Second*, the overlap of strategies and resources among producers is an important feature of the first phases of the development of an industry. As proposed by Kim, Dobrev and Solari (2001: 6-7) “prior to the burgeoning of competition, niche overlap represents cooperative rather than competitive relationship. Sharing positions in the market structure with others certainly turn two firms into head to head rivals, but it can also make them partners”. This insight is clearly implicit in the density-dependence formulation (Hannan, 1986). Within this theoretical framework, a legitimate organizational form means that organizations sharing the same resource space benefit from each other’s presence, because each contributes to the legitimacy of the market space they collectively occupy. The creation of market diversity – fundamental to differentiate firms and to reduce competition among them - is a process of exploration of new niches. It requires investments both on the demand and on the supply side. Customers need to be informed about the products through expositions and advertising. Suppliers need to be taught and guided, employees instructed in relation to the need of new production, the institutional environment needs time to recognize the presence of these new organizations (Carroll and Hannan, 2000). Collective movements – i.e. association of producers – can significantly help the promotion of products. The construction of market diversity represents an exploratory search of new products' and customers' niches. The more organizations share this route, the less costly this search will be.

In synthesis, the initial phases of social construction of the industry are usually uncertain and dominated by generalist producers. They meet each other in multiple segments of the market and, therefore tend to forbear. On the contrary, when the niches of products are fully explored, and the set of preferences of customers becomes clear, specialist organizations are attracted into the industry. At that time, specialist organizations - by definition single point competitors - reverse the benefits of mutual forbearance. Therefore, I hypothesize that:

Hypothesis 4: Increasing market diversity reverses the negative relationship between niche overlap and organizational rate of failure to positive.

The hypotheses proposed so far suppose a cyclical pattern of competition within industries. After an initial confusion, multi-point organizations prevail, building the environment until the customers' set of preferences becomes established. At that time, single-point competitors enter the market, outperforming them. This pattern is consistent with those studies that showed the tendency of stable industries to be disrupted by waves of new foundings (van Duijn, 1983). These renewals represent the essence of the process of selection. How does selection really act? Technological shifts, for instance, are supposed to generate a change in the demographic structure of the population through their tendency to destroy existing capabilities (Tushman and Anderson, 1986). In general, the variety of organizational forms reflects the rise and fall of different organizational groups in response to technological, political or institutional discontinuities (Delacroix and Carroll, 1983; Dobrev, 2001). All these processes rely on the idea that organizations are inert in reacting to environmental changes. In ecological models, however, inertia represents an organizational construct, without a counterpart at the population level. This argument lead Lomi, Larsen and Freeman (2001: 11) to conclude that, while organizations are subject to friction with any change, populations are mostly seen as adaptive. One of the most powerful forces of organizational inertia is age. The last findings in the ecological literature agree that organizational failure represent a built-in phenomenon: mortality rates rise as organizations grow old (Barron, et al. 1994). As organizations age, the accumulation of rules, routines and structures impede their ability to compete. Obviously, when the age of the individual organizations increases, the average age of the whole population rises. Assuming that older organizations generate weaker competition (Barron et al., 1994), I hypothesize that:

Hypothesis 5a: There is a negative relationship between the average age of population's members and organizational failure.

Therefore, old organizations are supposed to be disadvantaged, compared with younger ones, in changing environments (Carroll and Hannan, 2000: 290). This argument is consistent with an argument of organizational senescence: firms become unfit as they age. Following this rationale, the level of competition an organization faces is proportional to the difference between its age and that of the other population's members. Therefore, I hypothesize that:

Hypothesis 5b: There is a positive relationship between the heterogeneity of population's members' ages and organizational failure.

The density-dependence model assumes the population to reach a steady-state equilibrium (Baum, 1995). The main problem of this formulation of the theory is that it does not account for a wide variety of evolutionary trajectories observed in mature populations, particularly during the period of time that elapses after organizational density reaches its historical peak (Lomi et al., 2001). Several studies have in fact illustrated patterns of sustained oscillations of density and resurgence during the evolution of populations of organizations. Following the same theoretical rationale as hypotheses 5a and 5b, I would expect that oscillation in density in mature populations are related to the more than proportional effect of heterogeneity at increasing average ages. Therefore, I hypothesize that:

Hypothesis 5c: The positive relationship between the heterogeneity of population's members' ages and organizational failure increases with the average age of the population.

To summarize, I predicted firms to interact, one with the other, to develop the industry, promoting the survival of few efficient firms (H1-H3). Yet, the environment they built is self-defeating, because it represents the stage where selection can act (H4-H5).

Methods

Data

In choosing the populations for this research, I opted for the European motorcycle industry for four main reasons. First, the nature of this industry, global but at the same time nationally heterogeneous represents an ideal field to test hypotheses of multi-level evolutionary processes. Second, data availability allowed me to collect observations at multiple levels of analysis, national and European. Third, the accurate records of vital events allowed me to avoid problems related to left truncation and to study the effects of density on the organizational founding and exit rates over the complete history of the population. Last, the significant body of research on the ecological dynamics of automobile organizations (Torres, 1995; Hannan et al., 1995; Hannan, 1997; Hannan et al., 1998; Dobrev, Kim and Hannan, 2001) greatly facilitates comparison and accumulation of empirical results.

The data used to build Figures 1 include 648 motorcycle producers in the United Kingdom in the period between 1885 and 1993. The main source of information came from the book “British Motorcycles since 1900” (Collins, 1998) that includes the date of birth and disbanding of each firm in these countries. The year in which the first model appears was considered as the year of birth of a firm and the year in which the last model disappears from the register was coded as death. Information were refined using the register of motorcycle production that contains a description of most of the models patented in the United Kingdom (Hume, 1991), as well as the text “Enciclopedia della Motocicletta” (Wilson, 1996). In order to test the reliability of the data, I checked the magazines of the period: *Motor Age* (from 1899), *Cycle Trade Journal* (from 1897), and *Motor* (from 1903) were consulted for this reason. Finally, I cross-checked all the information crossing them with other references: Erwin Tragatsch “The Complete Illustrate Encyclopedia of the World’s Motorcycles” (1977; 2000) considered the most reliable text for this industry, “A-Z of Motorcycle” (Brown, 1997), “Historic Motorcycles” (Burgess Wise, 1973), “The Ultimate Motorcycle Book” (Wilson, 1993), and “Encyclopedia of Motorcycling” (Bishop and Barrington, 1995) confirmed the accuracy of data.

Insert Figure1 about here

Period Effects

In order to avoid mispecifications[3], I left the entry and the exit rates freely change over historical periods in response to unmeasured environmental conditions. Nine dummy variables were created to define the main evolutionary periods of the motorcycle industry. These variables were set equal to one within the segment of observation and put equal to zero outside. Each effect measures the change in the rate

[3] “Organizational populations … sometimes spans centuries of time. In these cases, environments commonly develop and change in many dramatic ways. [I]t is often difficult to find systematic data that record environmental variables in reliable and consistent fashion across the entire period. [One option is to] periodize the history and seek to estimate period-specific effects. Such periodization uses historical and institutional knowledge to identify periods where environmental conditions (of any kinds) are thought to differ significantly from each other” (Carroll and Hannan, 2000, p. 202).

in comparison to the omitted category. The first periods were defined starting from the years of publication of the "Manuale Hoepli del Motociclista", released in 1903, 1909 and 1915. The objectivity of this choice is guaranteed by the fact that this publication had to be updated in the year in which the old edition was considered obsolete for the technology of the period. These periods mark the years of increasing international trade and economic growth allover Europe (Maddison, 1991). The years included between 1915 and 1918 are those of the First World War. After the WWI the economic climate changed and protectionism became a common trade policy. Exports declined dramatically. Yet, the enthusiasm around motorcycle production reached its apotheosis. The turn of 1926 - peak of density in many countries - signed the beginning of a new era defined as "new look", during which the aesthetic design went side by side with the functionality of the products: motorcycles were designed using less angular shape, the rounded tanks begin to be diffused and the saddles become anatomical (Tragatsch, 2000). Indeed, in the same year, the United Kingdom represented the first market in the world with 580.330 motorcycles on the road, and Europe was the core of the world automobile production (Hannan et al., 1995). 1939, marks the beginning of the Second World War. Last, 1958 indicates the symbolic year of start of the Japanese era and of the period of international free trade.

Variables

I study the coevolution of organizations and environment as a matter of the interactions among three sets of variables: firms' strategies, market diversity and age structure of the population. The dependent variable is represented by organizational failure. The main events associated with the ending of an organizational history were disbanding, exit to another industry, and merger or acquisition. For the first event, there is no ambiguity: the firm failed as a collective actor. Regarding the exit to another industry, this suggests a lack of success. Mergers and acquisitions are more difficult to be interpreted. Both events indicate the end of at least one independent organization. Yet, given the ambiguous meaning of these events, I based my analysis only on disbanding and exit to other industries. The most challenging issue was related to the definition of those events considered as 'unknown exits'. Following

Hannan, Carroll, Dobrev and Han (1998), I believe these events to be governed by processes very similar to those related to exits. Therefore, the outcome event of interest of my analysis is "disbanding/exit to another industry, defined to include events of unknown type" (Dobrev et al., 2001: 1311). Firms known to have ended by a merger or an acquisition were treated as right-censored observation, a standard practice of event history analysis.

Carroll et al. (1996) noted that organizations can enter an industry following different paths. The more common ones are: i) a firm is founded *de novo* and has no prior experience at the time of entry, ii) a new firm results from a merger, or by the division of one manufacturers into two organizations, or iii) a firm enters from another industry. Previous researches on the American automobile industry found that the life chances of lateral entrants were higher than those that began *de novo*. Thus, I used the same distinction, building three dummy variables to code as *DeNovo* inexperienced organizations, as *DeAlio* lateral entrants, and as *DeIpso* those firms entering through merger or resurgence of motorcycle manufacturers. To measure the relatedness of the competencies of DeAlio entrants I split this category in two dummies: *MotoRelated* and *MotoUnrelated* firms. The former includes manufacturers having experience in bicycle, car or engine productions. The latter, comes from technologically unrelated productions, like armaments and sawing industries. The *Age* of an organization was measured as the tenure of the firm in the industry. Unfortunatly, the archival sources I used contain only the year of the event. Thus, according to Petersen (1991), it was coded as occurring in the midpoint of the year. Those firms entering and exiting the same year received a tenure value of 0.5.

Every organization in a population occupies an organizational niche characterized by a set of organizational capabilities and a location in resource space (Baum and Singh, 1994b: 350). Following previous studies (Podolny et al., 1996; Dobrev et al. 2001), I expressed the organization's niche in a technological space. In particular, like Dobrev et al. (2001) did in their study of the automobile industry, I measured the niche width of a motorcycle producer as the spread of engine capacity over all models that a firm produces in each year, calculated in cubic centimeters (cc). Single product organization were set to have a niche equal to 1cc, to avoid speaking of zero niche width. Measuring the capabilities of an organization along a single dimension can be limited. Yet, this measure is typically used as a synthetic indicator of the complexity and sophistication of motorcycles. Thus, it represents a proxy of the organizational complexity a firm faces. Muffatto and Panizzolo (1996), for instance, in one of the few longitudinal study of the motorcycle industry, used the same measure to differentiate producers' strategies. Therefore, to measure the effect of firm's diversification on the failure rate, I created two variables of heterogeneity, called *FirmDiversification* and its squared term *FirmDiversification*^{2}. These variables were built as coefficients of variation of the range of the products, and indicate the yearly variance of the mean of the organization's niche width. For instance, a firm selling two products, one of 350cc and the other of 500cc, is assumed to have a niche mean of 425cc, a standard deviation of 106.07cc and a *FirmDiversification* value of 0.2496 (standard deviation/mean). A rough indicator of the trend of firm's performance was created through two dummies - *Expansion* or *Contraction* - controlling for the expansion or contraction of the niche width of at least one tenth of the range. I computed competitive intensity as relative to niche-overlap. Similarly to Barnett and McKendrick (2001), I defined competition among firms in proportion to their degree of overlapping production. For instance an organization i that produces 125, 250 and 350cc motorcycles receives a value of 1/3 of competition from those firms overlapping on just one product – e.g. 125cc, and 1 from those having the same range of products. The measures were updated yearly.

The coefficient of variation I used to create the measure of firm diversification represents a natural measure of heterogeneity, widely used among demographers to predict the effect of tenure variation on turnover rates - see the seminal work of (Pfeffer, 1983). As with the variable measured at firm level, I created a coefficient of variation of production at the industry level – *MarketDiversity* - to indicate the yearly level of market heterogeneity.[4] This variable was built making the ratio of market mean production on market standard deviation. For instance in a market with two organizations, one offering a range of 125 to 250cc and the other 250

[4] I measured market heterogeneity also using the Blau index. The findings obtained are qualitatively similar to those reported in the result section.

to 350cc, the mean of the market is at 268.75, the standard deviation at 106.8 and the *MarketDiversity* is equal to 39.74. Figure 2 plots the evolution of this measure over time.

Insert Figure 2 about here

To take into account the level of competition within the population, I defined density as the total number of motorcycle producers active in each year of observation – *National Density*. Nevertheless, the level of competition a firm faces is dependent on the age structure of the population. Barron, West and Hannan (1994) argued that firms become unfit as they age. Thus, as the mean age of the members of a population increases, the organizational failure rate is supposed to decrease. On the contrary, the effect of competition will be higher in a population with a high heterogeneity in ages. Therefore, the mean and the standard deviation of ages of population's members were taken into account through the variables *PopulationMeanAge* and *AgeStandardDeviation*.

More control variables were added to the analyses. The English motorcycle industry had its most important area in the triangle between Birmingham, Coventry and Wolverhampton. All of the worldwide Big Six famous producers apart of Matchless - Ariel, BSA, (Royal) Enfield, Norton and Triumph - were located there. Within the range of a few squared kilometers almost one half (278 out of 648) of the whole number of manufacturers was born and operated there. To control for the potential benefits coming from knowledge spillover, I created a dummy variable, called *District*, to indicate those organizations having their headquarters in that area. Rao (1997) suggested that races are important for firms to demonstrate the reliability of their products. Competitions are especially important during the early years, to promote the social construction of a motor industry (Torres, 1995). No race in England was more important than the Tourist Trophy, known as the "Mecca of motorcyclists" (Collins, 1998: 8). A yearly dummy, starting from the first edition of the race in 1907, was created to indicate which producer had won in at least one of the categories in competition.[5] As Henderson (1999) argued, firms using their own technology are subject to different risks than those using standard components. Not many firms produced their own engine. Most of them used the Villiers, Jap and Minerva engines. To control for the potential different hazard for these organizations, I marked them as using *OwnEngine* with a dummy variable. Further, a clock named *NationalIndustryAge* was defined to control for trends in the development of the population. This was calculated as the difference between 1895, the year in which the first producer entered the market, and the observed year. Last, two variables were included to indicate the fluctuation in the economic and political climate in Great Britain. The measure of Gross domestic product adjusted for inflation - *GDP* - was inserted, using data from Maddison (1991). A dummy variable of governmental instability – *UnstableGoverment* – takes the value of one during the years in which, neither the Conservative nor the Labour parties, possessed the majority of the seats in the English Parliament.

Model and method of analysis

For the analyses presented in the result section, I divided the life of each organization in organization-years through the spell-splitting technique (Tuma and Hannan, 1984). Again I used event history analysis. The final dataset includes the life of 648 firms divided into 4.685 year-segments. In general, different functions of time and different covariates can be used to model the hazard rate of each organization. Given the inconsistent findings on parametric formulation of the rate of age-dependence, a less restrictive way to model it has been recently suggested (Barron et al., 1994). For this reason, I chose to use a flexible model, the *piecewise exponential*, which allows the rate to vary in an unrestricted fashion from one interval to the other at pre-selected ages. The basic idea is simple. The age of an organization is divided into intervals and the hazard is constant within each interval but can vary across them. I defined a set of J intervals, dividing the age variable at precise points (a_1, a_2, a_3, a_4…

[5] The data were obtained from the following web page http//:www.iomtt.com/results/TTresults.asp

aj), where $a_0 = 0$ and $a_j = \infty$. The interval J is given by $[a_{j-1}, a_j)$ and the hazard for firm i is defined by:

$$r(t) = \mu_j \exp[\beta' x], \quad \text{per} \quad a_{j-1} \leq a < a_j$$

[1]

or

[2]

$$\log r_1(a) = \alpha_j + \beta' x_i$$

where $\alpha_j = \log \mu_j$. This formulation allows the intercept of the *log-hazard function* to vary at different cut points (Allison, 1995). The choice of the intervals was driven by the principle of equal number of observations for each category.[6]

To estimate the hazard rate (r) for organization i, I modeled it as a function of the firm's age (a), industry age (t), a vector of firm's characteristics (**x**), namely origin (DeIpso, DeNovo or DeAlio), location and two dummy variables controlling for the years of contraction or expansion of the firm's niche, a vector of other covariates (**v**), including industry age, density, GDP, unstable government, and a function $\psi(\cdot)$ of firm diversification (linear and squared term), niche overlap, market variety (linear and squared term), and their interactions. Last, a function of age characteristics of the population, $\zeta(\cdot)$, and their interaction completed the model:

$$r_i(a, t) = \mu_j(a) \cdot \exp(\mathbf{x}_{ia}'\boldsymbol{\alpha} + \mathbf{v}_t'\boldsymbol{\beta}) \cdot \psi(\text{Niche Overlap}_{ia}, \text{FirmDiversification}_{ia}, \text{Market Diversity}_t) \cdot \zeta(\text{MeanPopulationAge}_t, \text{AgeStandardDeviation}_t),$$

[3]

I estimated the models using the maximum likelihood estimation method as implemented in the software package STATA 6.

[6] According to this idea I divided the age of the firm in six segments: age1[0.5-2), age2[2-4), age3[4-6), age4[6-10), age5[10-17) age6[17-30) and age7[30-∞).

Results

Table 1 and 2 present the maximum likelihood estimates of the piecewise exponential model of failure rates for 648 motorcycle producers in United Kingdom during the period included between 1895 and 1993. In particular, Table 1 provides the test for hypotheses 1 to 3 about the interaction of firm strategy and population diversity, whereas Table 2 investigates hypotheses 4, 5a, 5b, and 5c about the effects of market variety, niche overlap and age structure of the population on organizational exits.

Models 1 and 2 contain only control variables. The estimates of population-level and national controls largely confirm the expectations. Those related to the population – *Industry age* and *Density* – positively influence the exits. As the industry ages and the number of organizations within the population rise, failures increase. On the contrary, increasing levels of *GDP* reduced the probability of failure of motorcycle manufacturers. At the firm level, winning the Tourist Trophy race, significantly help the producer to signal the quality of its products. This result is consistent with the findings by Rao (1997) about the United States automobile industry. As supposed, location matters in this industry. Organizations located in the district included between Birmingham Coventry and Wolverhampton enjoyed the well-known beneficial effects of co-location (Saxeninan, 1994). The hazard of failure for these firms is reduced by about 23% [exp(-.257)] in comparison to the other organizations spread all over Great Britain. Furthermore, competition not only assumed an asocial meaning – *Density* – but also a social, direct effect – *Niche Overlap*.

Insert Table 1 and 2 about here

At the mean value of overlapping production, the probability of failure for the focal firm increases by about 26% [exp(44.4*.0051)]. This finding seems to support the idea that the intra-population pattern of competition depends on the extent to which population members require similar resources, a fundamental principle of the size-localized theory. Last, two other control variables merit attention, namely the effect of prior experience, and the consequences of organizational expansion on the failure rates. *First*, consistently with the prediction of literature (Carroll et al., 1996), the effect of prior experience is negative and statistically significant on the exit rate (the omitted category is *DeNovo*). These beneficial effects are one third more pronounced for *DeIpso* than for *DeAlio* firms.[7] Yet, as Model 2 suggests, the mean value of the latter hides the difference existing between related and unrelated diversifications. Expertise in motor or vehicle related productions allow in fact for a greater survival advantage in comparison to those unrelated.[8] Firms having this experience risk the failure almost half the time than *De Novo* organizations [exp(-.602)]. *Second*, the health of a firm can be measured through its propensity to expand or contract the niche production. Strategic analysis actually builds on the assumption that firms grow, expand and increase profitability. On the contrary, a contraction of the range of products can indicate the beginning of a focalization strategy, induced by increasing competition. The direction of the estimates obtained for *Expansion* and *Contraction* variables is consistent with this prediction. Nonetheless, only the former presents a value statistically significant value.

Interestingly enough, adding the measures of market variety and firm diversification in Model 3 reduce almost by half the value of the positive effect of expanding one's range of production (-.2784 versus -.1503) and deprive statistical significance of the estimate of the impact of this variable. Clearly, the benefits coming from enlarging the production are related to the level of diversification of the firm, and to the diversity of the market. Yet, firms and population act in opposite ways. At the firm level, diversifying the production reduces the probability of failure

[7] This result, not according with the theory suggests the importance of trial by error learning within this industry.
[8] The survival advantage of unrelated firms of the reference category – even for the weakest of those analyzed - is not clear. One explanation can be related to their greater resource endowments. In an industry where the product is relatively easy to build (most of the manufacturers were bicycle producers), the allowance of financial

– see *Firm Diversification*. The opposite happens at the population level: increasing market diversity rises the probability of failure – see *Market Diversity*. To understand how these two variables are related, I added an interaction term in Model 4. The positive sign of the coefficient estimated show that diversification strategies are penalized as market variety increases.

To clarify this complex interaction, I graphed it in Figure 3. This figure plots the effect of firm diversification on failure rate and shows the multipliers at three different levels of market diversification: the mean, the mean plus one standard deviation, and the mean minus one standard deviation. The plot demonstrates that firm diversification is a dangerous strategy as market diversity increases. When the impact of market diversity is .463 (μ-σ) the multiplier of the failure rate for a firm with a broad range of products (50-1000cc) is equal to 3.58; when the market diversity is .622 (μ) the multiplier for the same firm is 5.56; and when the market diversity is .781 (μ+σ) the multiplier increases to 8.62. In general, a fully diversified firm risks failure three times more in 1948 (μ+σ) than in 1923 (μ). These findings support hypothesis 3.

Insert Figure 3 and 4 about here

Nonetheless, this effect is not only related to market variety, but also to the intrinsic negative consequences of being greatly diversified. Managing a portfolio of multiple products is linked to increasing organizational complexity. Thus, in hypothesis 1 I supposed that the relationship between firm diversification and organizational failure is not simply linearly negative. Model 5 adds the curvilinear effect of firm diversification – *Firm Diversification*^{2} – to test it. The estimates of the linear term remain negative, while the estimate of the quadratic term is positive. Figure 4 illustrates the curvilinear relationship. The minimum of the function, and

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resources destined for advertising and distribution could have been important in marking the survival difference between newly founded firms and those diversified.

therefore the ideal level of organizational diversification for the organizations of this population, is equal to .69. This value implies for instance, that a firm offering motorcycles ranging from 125cc and 350cc (diversification value .67) risks the failure almost half of the times than a single product organization.

To create the failure patterns shown in Figure 4 we would expect market diversity to act in the opposite way to organizational diversification. With hypothesis 2, I proposed a high level of market heterogeneity to open up new niches, and to spread the resource space. The curvilinear relationship between market heterogeneity and firm failure is tested with the coefficient *Market Diversity*^{2}. Figure 5 plots the multiplier of the failure rate for this variable. The maximum of the function falls at the value of .76 of market diversity. This value was reached during the years around the Second World War – see Figure 2. Since then, the positive effect of this variable on the exits reverses to negative. The addition of the curvilinear effects of firm diversification and market variety significantly improves the fit of the model ($\chi^2[L_4 \mid L_2] = 6.9$ with 2 d. f.).

Insert Figure 5 and 6 about here

Therefore, we now know that the beneficial effects of even a modest firm diversification can be nullified by the uncertainty related to market diversity. On the one hand, organizations want to find new niches of customers, but on the other hand, a strategy of market exploration is risky. To offer the reader an example of these counterbalancing forces, I use the estimates obtained in Model 3. An organization that (at time t+1) adds 350cc motorcycle to its range of 125 and 250cc products risks about 12% less than the year before (time t). In a hypothetical population where (at time t) three firms exist, each producing 125 and 250cc, the change produced by expansion of the production (at time t+1) to 350cc increases the failure rate of the focal firm of about 68%. How can organizations overcome the risks related to the exploration of new markets? With hypothesis 4 I supposed that this is a problem of legitimacy and of collective effort needed to build the market. The intensity of the endeavor is supposed to be greater in a phase of low market diversity, and lower later. Thus, while in general resource overlap generates competition (see main effect of *Niche Overlap*), sharing a common product's strategy assumes particular importance at low levels of market heterogeneity. Model 6 tests this assumption through the interaction terms between *Niche Overlap*, and the linear and squared term of *Market Diversity*. Even in this case, the addition of the two terms significantly increases the fit of the model ($\chi^2[L_6 \mid L_5] = 18.92$ with 2 d. f.). The effect of niche overlap on the failure rate is moderated by market diversity: interactions between market diversity and niche overlap are negative for the linear term and positive for the quadratic term. As before, to illustrate the pattern of the interaction terms I plotted the effect of market diversity on the failure rate, measuring the multiplier at three different levels of niche overlap: the mean, the mean plus one standard deviation, and the mean minus one standard deviation. Figure 6 shows that, as the market becomes more heterogeneous, the relationship between organizational failure and niche overlap reverses to positive. When the value of niche overlap is 17.23 (μ-σ) at the maximum level of market diversity the multiplier is equal to 1.24; when the value of niche overlap is 44.42 (μ) and the multiplier of the failure rate is equal to 1.76; and when the niche overlap is 71.61 (μ+σ) the multiplier rises to 2.49. In general, while a high value of niche overlap strongly reduce the failure rate at a low level of market diversity, the opposite happens at a high level of market heterogeneity: in a highly diversified market, having low values of niche overlap represents the best strategy. This pattern of results support hypothesis 4.

Model 7 and 8 estimate the effects of age mean, standard deviation and their interaction on the exit rate of the firms of this population – H5a, H5b and H5c. The value obtained for the coefficient of *Population Mean Age* and *Age Standard Deviation* support the hypotheses 5a and 5b ($\chi^2[L_7 \mid L_6] = 16.4$ with 2 d. f.). The mean age has a significant negative effect on the mortality rate: as organizations age, they become weaker competitors. Each additional year in the mean age of competitors reduce the organizational hazard of failure by about 7%. Indeed, population heterogeneity increases the probability of exits. A greater level of competition marks a population with organizations having different ages in comparison to a homogenous one. Last, the interaction coefficient of Model 8 ($\chi^2[L_8 | L_7] = 25.8$ with 1 d. f.) tests the influence of the age heterogeneity in relation of different age values. In particular, as proposed by hypothesis 5c, the impact of the standard deviation is supposed to be higher at high levels of mean age than at low levels.

The effect of the interaction between the age's standard deviation and the mean age - *PopulationMeanAge·Age StandardDeviation* - is positive and statistically significant. In other words, the effect of an increase in the standard deviation on the failure rate rises with the mean age of the population's members. Figure 7 shows the relationship between ages' standard deviation and failure rate, as the industry's members grow old. The vertical axis plots the multiplier of the base rate at the given combinations of mean age and standard deviation. The relationship is clearly steep, supporting hypothesis 5c. Finally, note that adding the interaction term in Model 8 changes the effect of density on the failure rate: its estimate looses statistical significance. Age heterogeneity mattered more than density for the disbanding of these producers. Overall, the estimates displayed in Table 1 and 2 provide support for all the hypotheses proposed in the theory section.

Insert Figure 7 about here

Discussion and Conclusions

In 1994, March wrote "[O]ne of the more important post-Aristotelian developments in evolutionary theory is the emphasis on endogenous environments, on the ways in which the convergence between an evolving unit and its environment is complicated by the fact that the environment is not only changing but changing partly as a part of a process of coevolution… History cannot be seen as simply a product of the organism and its own exogenous environment. Species coevolve, as do institutions" (1994: 43). In this work I tried to address this issue using data on the vital rates of 648 motorcycle producers in United Kingdom during the period included between 1895 and 1993.

The main findings of this work shed light on the interaction of three levels of analysis: the organization, the niches, and the population. Organizations diversify their production in order to obtain economic advantages of scale and superior profits. Yet, the population acts in the opposite way, constraining the organizational expansion. The evolution of these two contrasting forces drives the coevolution of niches of generalist and specialist producers within the industry. Last, while the increasing age of a population's members tend to reduce the level of competition, ages' heterogeneity represents a powerful selective force acting within an organizational population.

These results have several theoretical and empirical implications. First, literature on strategy repeatedly questioned whether diversification cause discount. Results from event studies about diversification do not offer a clear picture of the effect of this strategy on the profits and the economic value of the firm (Villalonga, 2000). This study investigated a similar question at the level of diversification of the range of products. The answer I offer, is related to the ability of the firm to cope with multiple tasks. On average, the results of this research suggest that the 'optimal' level of diversification stand in the middle between tight focus and wide products' range. Nevertheless, a complete analysis of the problem needs to take into account the competitive dynamics of the environment where the firm operates. The value of diversification depends on the timing of industry evolution, on fluctuations in resource flows, and on the distribution of the demographic composition of the members. In a market with few rivals, a diversification strategy outweighs the benefit of being focused. As the market gets crowded, the advantage reverses to those firms able to be more efficient. In general, increasing product variety at the population level reduces the positive consequences of a diversified production at the firm level.

Second, strategic management has in the past underlined the benefits related to the so-called positional advantage that organizations isolated from competition enjoy. Rumelt (1984), for instance, underlined the importance of isolating mechanisms in determining the success of a firm. Yet, the value of competitive isolation depends on the level of development of the population. During periods of market exploration, isolation deprives the organization of the engine of development. On the contrary, during these periods, competitive overlap helps build a collective effort that allows for the reduction of related costs. Nevertheless, these findings do not support the 'Red Queen' hypothesis (Barnett and Hansen, 1996). The relationship between competition and organizational failure is not simply negative – the more you compete, the stronger you are. And neither do they support a theory of organizational failure as a niche overlap phenomenon (Baum and Singh, 1994b). On the contrary, the findings of this study support the legitimation-competition model of evolution (Hannan, 1986). In particular, while many debates emerged about the completeness of the concept of legitimacy (Zucker, 1989; Baum and Powell, 1995; Hannan and Carroll, 1995b) this work provides an alternative point of view to this issue. The number of organizations within an industry is a proxy by which to measure the legitimation of an organizational form, but a more fine-grained variable to explain this concept is represented by the strategies pursued by the individual firms. The more they overlap, the faster the legitimation process. A similar proposition can clarify why industries exhibit different timing in reaching their historical peak of density.

Third, the density-dependence model (Hannan, 1986) assumes the population to reach a steady-state equilibrium (Baum, 1995). The main problem of this formulation of the theory is that it does not account for a wide variety of evolutionary trajectories observed in mature populations. A good example of these patterns can be found looking at the evolutionary trajectories of the European motorcycle industries. The theoretical explanations used to account for these phenomena are generally twofold: one that considers legitimation and competition as not proportional with time (Hannan, 1997), the other that justifies the late resurgence as a matter of resource partitioning (Carroll, 1985). The findings of this study about the effect of the mean and the heterogeneity of ages on organizational failure suggest another hypothesis. Mature organizational populations are typically marked by waves of foundings (van Duijn, 1983). Yet, late populations are typically characterized by a high mean age. The entrance of new producers in a similar environment increases the variability of ages of the industry. Following the rationale of the results proposed here, similar conditions correspond to elevated levels of competition – see Figure 7. Thus, this prevision can be used to explain why populations oscillate after reaching the peak in density. This hypothesis is in line with the positive correlation between entries and exits in mature industries found by Agarwal and Gort (1996). Potential implications of this proposition can also be related to the emerging theory of population inertia (Hannan, 1997).

Fourth, organizational and products' diversity sets the limit on the range of alternative solutions that are available in the environment. Scant attention has been devoted to the systematic exploration of the nature and implications of diversity for the level of flexibility of an organizational population. Thus, at a normative level, policy issues are somewhat clearer. Institutions have to be aware that product diversity represents a variable to determine the level of resilience of an industry to external shocks (Pimm, 1984). When Japanese producers entered the UK market in 1960, the level of diversity was clearly in a phase of decline – see Figure 2. The competition of the Fifties helped to exploit the internal resources[9], but at the same time, it makes the diversity to progressively fall. Wezel (2001) demonstrates how this process evolved. This alternative view to the classical managerial analysis of the United Kingdom motorcycle industry (Pascale, 1984) alerts policy-makers to be aware that diversity plays a central role for the development and maintenance of national industries. Further analyses are needed to shed light on this issue.

Last, since the Sixties, important theoretical approaches were developed in the field of organizational studies: contingency theory (Lawrence and Lorsch, 1967), resource dependence (Pfeffer and Salancik, 1978), population ecology (Hannan and Freeman, 1977) and new institutionalism (Meyer and Rowan, 1977). Each of these theories emphasized the relationship between organizations and environments. All these theories assume that firms, through adaptation or selection, tend to assume an isomorphic configuration with the environment. As a consequence, environmental changes are today studied in relation to exogenous shifts. Less frequently, we have investigated how organizations can mold their environments and how the

[9] During those years the historical maximum level of penetration was reached, with almost .035 motorcycles per inhabitant.

environment, composed of other firms, may influence in turn the same organizations. Organizations, in fact, can influence the availability of resources in a system. They can innovate and expand the resource space of a population. Indeed, organizations build and destroy barriers around them. The development of digital cameras for instance determines the effacement of boundaries between classic camera producers – e.g. Nikon, Olympus - and computer firms. Thus, competition in moving landscapes represents today the norm, and not the exception, of organizational evolution. The findings illustrated in this paper confirm the importance of studying the evolution of a population looking at different levels of analysis. Across level and within level evolutionary interactions represent an important and almost unexplored field of study in the organizational literature.

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Table 1. Maximum Likelihood Estimates of the Piecewise Exponential Model for Exits Rates of United Kingdom Motorcycle Producers 1895-1993.[10]

Variables	Model1	Model2	Model3	Model4
Constant	-3.522**	-3.312**	-3.852**	-3.720
	(.614)	(.467)	(1.283)	(1.290)
NationalDensity	.005*	.005*	.006**	.006**
	(.003)	(.003)	(.003)	(.003)
NationalIndustryAge	.056**	.055**	.056**	.054**
	(.017)	(.016)	(.018)	(.018)
Own Engine	.049	.049	.091	.099
	(.082)	(.080)	(.083)	(.084)
TTSuccess	-12.099**	-12.096**	-11.757**	-11.732**
	(.263)	(.262)	(.270)	(.272)
GDP (in thousands)	-.008**	-.008**	-.003	-.003
	(.002)	(.002)	(.002)	(.002)
DeIpso	-.725**	-.724**	-.720**	-.714**
	(.159)	(.162)	(.155)	(.156)
DeAlio	-.557**		-.572**	-.574**
	(.092)		(.091)	(.091)
MotoRelated		-.602**		
		(.1012)		
MotoUnrelated		-.426**		
		(.133)		
District	-.257**	-.259**	-.253**	-.260**
	(.077)	(.078)	(.078)	(.078)
Niche Overlap	.005**	.005**	.004**	.004**
	(.002)	(.002)	(.002)	(.002)
UnstableGovernment	-.123	-.123	-.178	-.199
	(.184)	(.183)	(.193)	(.193)
Expansion	-.278*	-.279*	-.150	-.145
	(.148)	(.147)	(.152)	(.152)
Contraction	.214	.210	.152	.151
	(.253)	(.243)	(.246)	(.246)
FirmNicheMean			-.0002	-.0002
			(.0003)	(.0003)
FirmDiversification			-.647**	-1.905**
			(.183)	(.774)
MarketMean			-.002	-.002
			(.002)	(.002)
MarketDiversity			2.883**	2.485**
			(1.225)	(1.267)
FirmDiversificat·MarketDiversity				2.175*
				(1.318)
Log Likelihood	2874.79	2875.22	2886.98	2887.99

[10] * p<.10; ** p<.05. Standard errors are in parentheses. Each model also includes market tenure and period effects.

Table 1. Maximum Likelihood Estimates of Piecewise Exponential Model for Exits Rates of United Kingdom Motorcycle Producers 1895-1993[11]. Controls.

Variables	Model1	Model2	Model3	Model4
Constant	-3.522**	-3.312**	-3.852**	-3.720
	(.614)	(.467)	(1.283)	(1.290)
Period2 (1903-1908)	.561	.573	.634	.645
	(.618)	(.622)	(.622)	(.622)
Period3 (1909-1914)	-.048	-.046	.051	.070
	(.217)	(.216)	(.231)	(.230)
Period4 (1915-1918)	-.254	-.257	-.530**	-.528**
	(.185)	(.183)	(.198)	(.198)
Period5 (1919-1925)	-.341	-.358	-.614*	-.630*
	(.320)	(.321)	(.331)	(.331)
Period6 (1926-1938)	.125	.121	.112	.109
	(.293)	(.293)	(.306)	(.306)
Period7 (1939-1945)	-.151	-.150	-.624	-.613
	(.382)	(.382)	(.394)	(.391)
Period8 (1946-1957)	-1.126**	-1.126**	-1.731**	-1.660**
	(.310)	(.310)	(.414)	(.415)
Period9 (1958-1993)	-.064	-.064	.439	.435
	(.320)	(.322)	(.294)	(.293)
Age (2-4)	-.153	-.155	-.125	-.117
	(.104)	(.102)	(.102)	(.102)
Age (4-6)	-.507**	-.507**	-.432**	-.419**
	(.135)	(.135)	(.137)	(.137)
Age (6-10)	-.477**	-.472**	-.356**	-.343**
	(.129)	(.132)	(.130)	(.131)
Age (10-17)	-.995**	-.994**	-.900**	-.887**
	(.164)	(.160)	(.171)	(.172)
Age (17-30)	-1.536**	-1.535**	-1.344**	-1.354**
	(.209)	(.219)	(.220)	(.219)
Age (30-∞)	-1.548**	-1.548**	-1.324**	-1.396**
	(.203)	(.203)	(.208)	(.214)
Log Likelihood	2874.79	2875.22	2886.98	2887.99

[11] *p<.10; ** p<.05. Standard Errors in parentheses.

Table 2. Maximum Likelihood Estimates of the Piecewise Exponential Models for Exits Rates of United Kingdom Motorcycle Producers 1895-1993.[12]

Variables	Model5	Model6	Model7	Model8
Constant	-7.329** (1.876)	-11.111** (2.915)	-13.466** (3.028)	-13.437** (2.975)
NationalDensity	.005* (.003)	.009** (.003)	.006** (.003)	.002 (.003)
NationalIndustryAge	.043** (.018)	.033* (.019)	.002 (.029)	.109** (.034)
Own Engine	.105 (.084)	.070 (.083)	.073 (.083)	.080 (.082)
TTSuccess	-11.708** (.269)	-12.948** (.272)	-12.986** (.277)	-11.992** (.278)
GDP (in thousands)	-.001 (.003)	-.001 (.003)	.006 (.006)	-.004 (.008)
DeIpso	-.728** (.155)	-.761** (.155)	-.759** (.153)	-.742** (.153)
DeAlio	-.583** (.090)	-.584** (.091)	-.568** (.091)	-.563** (.091)
District	-.262** (.078)	-.280** (.079)	-.298** (.078)	-.298** (.078)
Niche Overlap	.005** (.002)	.159** (.070)	.181** (.068)	.169** (.066)
UnstableGovernment	-.168 (.200)	-.243 (.202)	-.369* (.214)	-.769** (.186)
Expansion	-.138 (.152)	-.148 (.152)	-.151 (.152)	-.156 (.151)
Contraction	.142 (.241)	.122 (.237)	.107 (.229)	.132 (.229)
FirmNicheMean	-.0002 (.0003)	-.0002 (.0003)	-.0002 (.0003)	-.0003 (.0003)
FirmDiversification	-1.539** (.462)	-1.741** (.466)	-1.733** (.464)	-1.700** (.459)
$\text{FirmDiversification}^2$	1.155** (.552)	1.347** (.560)	1.302** (.561)	1.278** (.552)
MarketMean	-.004 (.003)	-.002 (.003)	-.004 (.002)	.002 (.003)
MarketDiversity	17.401** (6.477)	30.583** (1.028)	40.861** (1.269)	32.217** (9.679)
MarketDiversity^2	-11.412** (4.982)	-24.858** (8.297)	-31.788** (8.340)	-21.513** (7.758)
MarketDiversity·NicheOverlap		-.680** (.263)	-.741** (.255)	-.693** (.248)
MarketDiversity^2·NicheOverlap		.717** (.246)	.755** (.237)	.708** (.232)
PopulationMeanAge			-.069** (.017)	-.381** (.059)
AgeStandardDeviation			.131* (.070)	-.163** (.082)
PopulationMeanAge·AgeStanrdDeviation				.017** (.003)
Log Likelihood	2891.44	2900.91	2909.17	2922.07

[12] * p<.10; ** p<.05. Standard errors are in parentheses. Each model also includes market tenure and period effects.

Table 2. Maximum Likelihood Estimates of Piecewise Exponential Models for Exits Rates of United Kingdom Motorcycle Producers 1895-1993[13]. Controls.

Variables	Model5	Model6	Model7	Model8
Constant	-7.329**	-11.111**	-13.466**	-13.437**
	(1.876)	(2.915)	(3.028)	(2.975)
Period2 (1903-1908)	.813	.707	1.087*	1.386**
	(.629)	(.646)	(.648)	(.648)
Period3 (1909-1914)	.074	.117	.326	.791**
	(.240)	(.236)	(.248)	(.253)
Period4 (1915-1918)	-.810**	-.845**	-.96**	-.829**
	(.224)	(.221)	(.213)	(.214)
Period5 (1919-1925)	-.604*	-.897**	-1.042**	-1.281**
	(.332)	(.350)	(.371)	(.354)
Period6 (1926-1938)	.209	.501*	.679**	.677**
	(.304)	(.299)	(.288)	(.276)
Period7 (1939-1945)	-.438	.096	.619	.138
	(.397)	(.419)	(.429)	(.432)
Period8 (1946-1957)	-1.451**	-1.220**	-2.197**	-4.461**
	(.383)	(.376)	(.498)	(.617)
Period9 (1958-1993)	.287	.496	.386	-1.283**
	(.281)	(.308)	(.340)	(.477)
Age (2-4)	-.091	-.091	-.076	-.068
	(.103)	(.102)	(.101)	(.101)
Age (4-6)	-.381**	-.402**	-.380**	-.340**
	(.138)	(.136)	(.136)	(.136)
Age (6-10)	-.303**	-.287**	-.252*	-.219
	(.132)	(.134)	(.134)	(.134)
Age (10-17)	-.861**	-.849**	-.796**	-.769**
	(.172)	(.170)	(.168)	(.168)
Age (17-30)	-1.323**	-1.303**	-1.238**	-1.178**
	(.222)	(.220)	(.213)	(.211)
Age (30-∞)	-1.343**	-1.282**	-1.079**	-1.031**
	(.211)	(.218)	(.222)	(.229)
Log Likelihood	2891.44	290.91	2909.17	2922.07

[13] *p<.10; ** p<.05. Standard Errors in parentheses.

Figure 1. Density of Motorcycle Producers in the United Kingdom, 1885-1993.

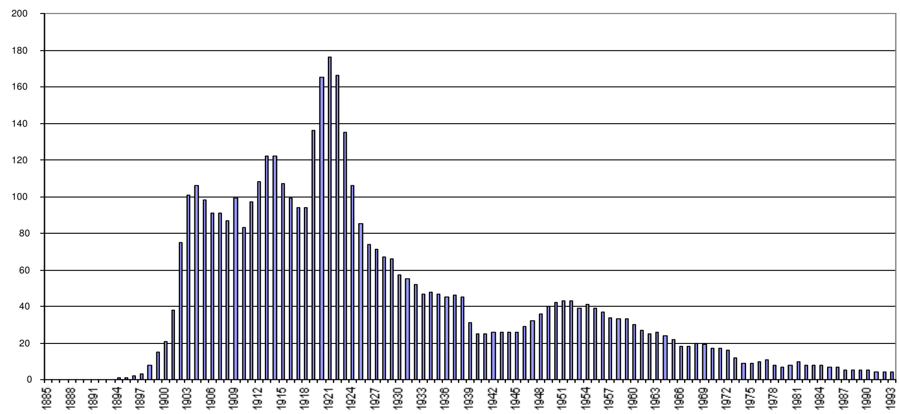

Figure 2. Evolution of market diversity for motorcycle production in United Kingdom, 1895-1993.

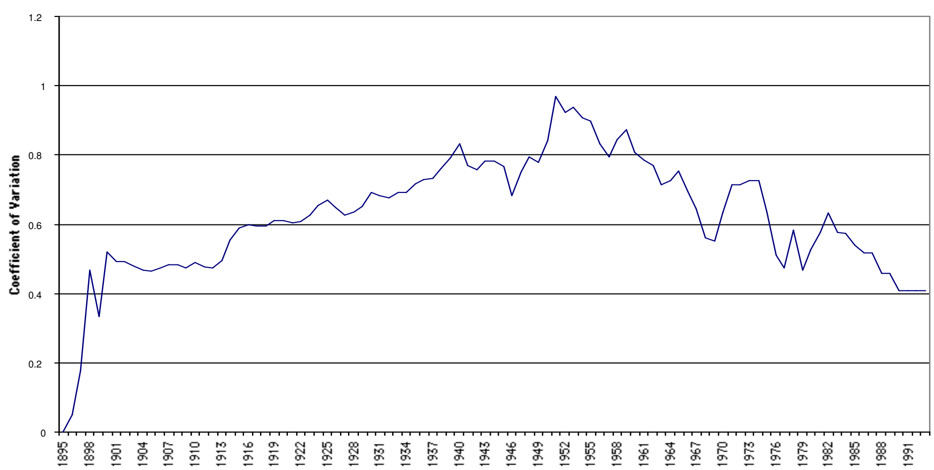

Figure 3. Multiplier of the failure rate for firm diversification, evaluated at three values of market diversity.

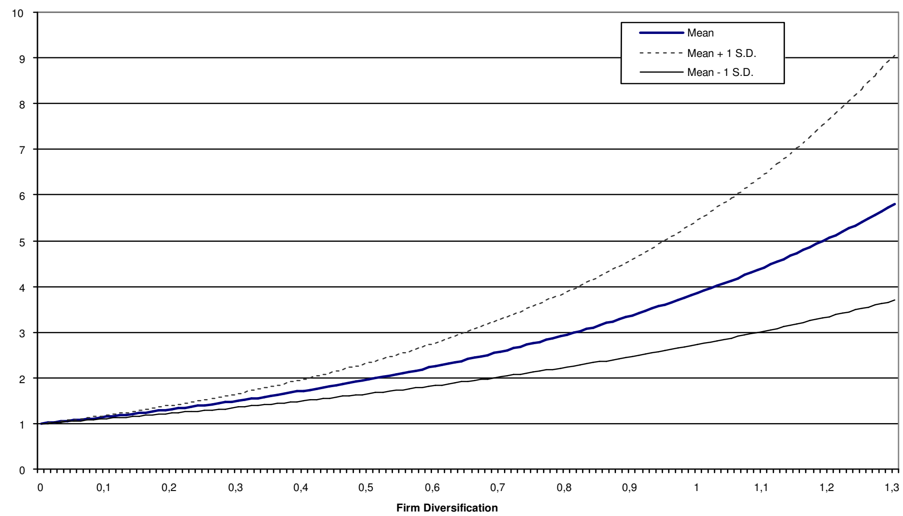

Figure 4. Multiplier of the failure rate for firm diversification.

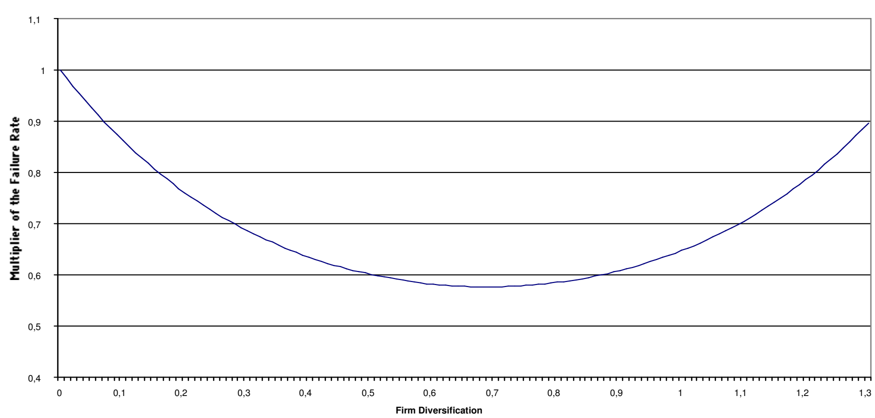

Figure 5. Multiplier of the failure rate for market diversity.

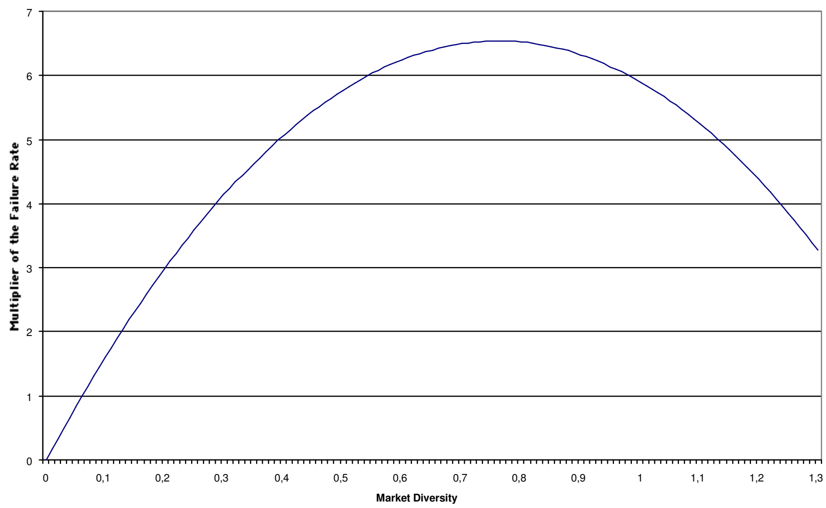

Figure 6. Multiplier of the failure rate for market diversity, evaluated at three values of niche overlap.

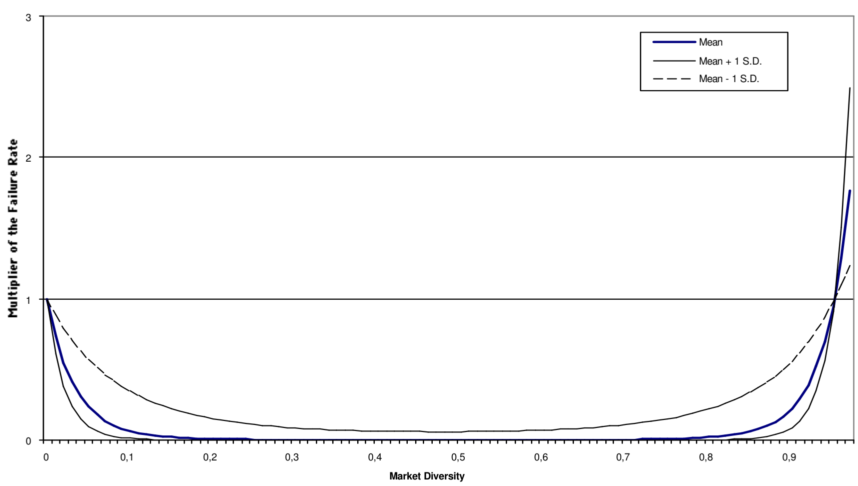

Figure 7. Relationship between mortality rate, mean age and standard deviation of population's members.