UNIVERSIDAD CARLOS III DE MADRID

TESIS DOCTORAL

THE STATIC AND DYNAMIC DIMENSIONS OF HETEROGENEOUS FIRM PERFORMANCE

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DEPARTAMENTO DE INGENIERÍA MECÁNICA

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A mis padres

"La verdadera ciencia enseña, por encima de todo,
a dudar y a ser ignorante"

(Miguel de Unamuno)

Resumen

Esta tesis aspira a combinar perspectivas complementarias para el estudio de la heterogeneidad en los resultados empresariales. Para ello, distingue entre problemas estáticos y dinámicos asociados a los orígenes causales de las diferencias en los resultados.

Más concretamente, podemos distinguir tres objetivos diferentes dentro de la tesis. Primero, definimos y verificamos un modelo dinámico en el que los resultados se explican en términos de su evolución histórica a lo largo del tiempo. Segundo, analizamos, desde una perspectiva tanto teórica como empírica, las relaciones entre el enfoque basado en los recursos y las aportaciones de la escuela austriaca para el estudio de la rentabilidad empresarial. En tercer lugar, nos ocupamos también de un problema significativamente más específico, como es el estudio de los efectos del tamaño empresarial y el dinamismo del entorno sobre la productividad de los esfuerzos innovadores de la empresa.

Meditante la combinación de una perspectiva netamente estática, mayoritaria en la literatura, con otra dinámica, aspiramos a ofrecer una visión más compleja de la cadena de causalidad que subyace a la heterogeneidad en los resultados. Así, junto con el estudio de *qué* factores explican la rentabilidad empresarial, pretendemos abordar, siquiera parcialmente, cuestiones relativas a *cómo* se desarrollan las citadas diferencias en los resultados.

Para ello, y tras una reflexión teórica y una revisión crítica de la literatura existente, formulamos una serie de hipótesis y planteamos unos modelos de investigación que son sometidos a verificación empírica sobre una muestra de empresas manufactureras españolas. El período de análisis comprende un total de doce años (de 1991 a 2002,

ambos inclusive), lo que nos permite capturar procesos dinámicos. Para ello, y dada la estructura de panel de los datos, utilizamos modelos econométricos de efectos aleatorios. Las técnicas estadísticas concretas se adaptan a los objetivos específicos de la investigación en cada uno de los capítulos.

Entre las aportaciones más relevantes de este trabajo, podemos identificar las siguientes:

Primero, extiende significativamente la literatura previa que ha estudiado las dinámicas de los beneficios empresariales, lo que permite realizar inferencias sobre la naturaleza de los procesos históricos que subyacen a la heterogeneidad empresarial.

Segundo, establece conexiones entre distintas perspectivas, como son el enfoque basado en los recursos y la economía Austriaca, que hasta ahora habían sido tratadas en gran medida de forma independiente en la literatura. Ello nos permite desarrollar una visión más completa de los factores que subyacen a las diferencias en los resultados de las empresas, ofreciendo asimismo, una prueba de la robustez de cada enfoque.

Finalmente, nos ocupamos de un problema largamente estudiado en la literatura sobre innovación tecnológica, como son los factores determinantes de la productividad de la I+D, y muy en particular los efectos del tamaño de la empresa. Para ello, consideramos los efectos moderadores del dinamismo del entorno sectorial; se trata de una variable largamente contemplada en el ámbito de la dirección estratégica, pero que no había sido empleada con anterioridad en este contexto. Nuestros resultados, de hecho, muestran que se trata de una variable relevante, que no sólo puede afectar a la productividad de las inversiones en I+D, sino a la relativa ventaja innovadora de la que parecen gozar las empresas de mayor tamaño.

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En este momento, cuando casi he alcanzado el final del largo camino que culmina en esta tesis doctoral, soy más que nunca consciente de la importancia de aquellas personas e instituciones que me han brindado su apoyo, su colaboración y su ánimo en este proceso. Esta tesis también les pertenece. A todos ellos, mi más sincero agradecimiento.

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CHAPTER 1. INTRODUCTION

‘*Why do some organizations perform better than others? This may be the defining question of the strategy field*’ (Barnett et al., 1994: 11).

The study of heterogeneous firm performance and its causes is central to the field of strategic management; in this dissertation we acknowledge that this problem does indeed involve a static and a dynamic dimensions. The former is concerned with the factors and variables that underlie profit differentials at some given point in time; meanwhile, the dynamic dimension refers to the processes by which such differentials emerge, evolve, and eventually disappear over time. Furthermore, we claim that both dimensions can add to our understanding of the origins of superior performance.

More concretely, we can distinguish three different, if connected, objectives for this dissertation. First, we define and test a model in which firm performance is explained in terms of the dynamic evolution it has experienced over time. Second, we analyze, both theoretically and empirically, the relationships between resource-based and Austrian perspectives on heterogeneous firm performance. Third, we approach a rather more specific problem, and study the effects of firm size and the dynamism of the competitive environment on the economic productivity of firms' innovative efforts.

The objectives we define provide complementary views on the causes of firm profitability. On the one hand, with most previous research, we approach the problem from a static perspective, by studying the incremental effects of certain explanatory variables (such as technological capital or intangible resources) on profitability. On the other hand, we also claim that, whereas this approach yields useful insights for the study of strategy, it only takes us halfway in the search for the ultimate causes of superior firm performance (Porter, 1991; Barnett and Burgelman, 1996; Cockburn et al., 2000; Stinchcombe, 2000; Priem and Butler, 2001). Consequently, we move one step backward in our reasoning in order to engage in a general discussion on how strategy research can move further away along the causality chain behind inter-firm profit differentials, particularly by exploring what we have labelled as the 'dynamic dimension'.

By combining these two perspectives, we aim at contributing to the study of the determinants of firm success. In order to gain a comprehensive perspective on the causality chain of firm performance, we need to understand what factors are associated to profit differentials, but also how such factors develop. This distinction between the 'what' and the 'how' of competitive advantage and firm performance provides the main connecting thread for the different arguments in this dissertation.

Researchers on strategy have developed a number of rationales and theoretical frameworks in order to explain profitability differentials across firms. On the basis of such frameworks, a vast body of research has aimed at identifying which factors and variables are empirically associated with superior performance (the 'what' of competitive advantage). Wherever such associations are verified, empirical findings are normally interpreted in causal terms; from this approach, causes of superior profitability can be traced back to either industry-related (e.g. concentration, entry barriers) or firm-related (e.g. resource endowments) factors (Schmalensee, 1985; Wernerfelt and Montgomery, 1988; Rumelt, 1991).

Such findings, however valuable to strategy formulation, do not exhaust the problem of causal antecedents of firm performance. Even if every potential source of superior profitability was to be known, one last question would remain: how do such factors develop? How can firms acquire favourable competitive positions, yielding higher returns?

Therefore, the question of heterogeneous firm performance is not univocal, and involves at least two distinct problems. Firstly, what are the sources of performance differentials? Secondly, how do such differentials emerge and develop? A proper understanding of causal mechanisms supporting superior profitability requires providing satisfactory answers to both the 'what' and 'how' questions. Moreover, if strategy research fails to address both of them, normative implications following from it would fail the 'operational validity' criterion (Thomas and Tymon, 1982).

A number of different approaches aimed at explaining how superior performance is built. From an industrial organization perspective, researchers working on 'strategic conflict' (Shapiro, 1989 and Ghemawat, 1991 stand out among seminal works in this research stream) have extended the traditional structure-conduct-performance paradigm of industrial-organization (IO) economics. They explore how competitive interaction shapes the conditions of the industry. Market structure (the ‘what’ of performance differentials in IO economics) is not longer treated as an exogenous assumption, but as the result of competitive behaviour by firms (the ‘how’); in doing so, this perspective also introduces a dynamic dimension into the relationship between market conditions, firm behaviour, and performance (Teece et al., 1997).

Meanwhile, scholars working within a resource-based tradition have explored the nature of strategic factor markets in order to unveil the origins of inter-firm resource heterogeneity (e.g. Barney, 1986a, 1989; Diedrickx and Cool, 1989; Amit and Schoemaker, 1993; Chi, 1994); from this perspective, imperfections in factor markets provide the ultimate basis for competitive advantage. Moreover, they have also analyzed how firms can develop superior resource-acquisition (or capability-building) strategies in order to take advantage of such imperfections (Makadok, 2001; Makadok and Barney, 2001).

Whereas these developments have shed light onto the mechanisms underlying performance differentials, they have also been subject to some criticisms (Sutton, 1992; Foss et al. 1995; Teece et al., 1997; Priem and Butler, 2001; Bromiley and Fleming, 2002). Limitations of these approaches can be somehow rooted back to their reliance, either explicit or implicit, on theoretical antecedents from mainstream economics, and particularly on the idea of optimizing behaviour (Powell and Wakeley, 2003).

Neoclassical theory assumes a given and well-defined choice set, and depicts economic selection as mere optimization. Given the conditions of the economic problem, only one alternative is optimal, and consequently rational. In neoclassical economics, agents always find themselves in single-exit situations (Latsis, 1976). Upon facing identical economic problems, optimizing firms will always adopt identical decisions. Therefore, if firms indeed differ in their competitive behaviour and strategies, it is because pre-existent conditions of economic problems were already different; heterogeneity remains an exogenous assumption.

In this sense, theoretical contributions from evolutionary economics provide alternative frameworks that may add to our understanding of the causality chain of firm performance (Jacobson, 1992; Powell and Wakeley, 2003; Roberts and Eisenhardt, 2003; Mathews, 2006; Foss and Ishikawa, 2007). We can define evolutionary economics as the body of economic theory that investigates the transformation of current structures and the emergence and diffusion of novelties (Foss, 1994). Nelson and Winter (1974) establish the following building blocks of an evolutionary theory of economic change:

a) Firms act on the basis of certain decision rules, linking environmental stimuli and organizational responses. Such rules, whereas given and observable at any given point in time, are neither universal nor immutable (such as optimization in neoclassical economics). They can and do vary across firms and along time.

b) Decision rules are relatively stable in the short-term (Winter, 1964), as they are conditioned by the construction of an 'organizational memory' through repetition of routine activities by the firm (Nelson and Winter, 1982).

c) On the other hand, firms permanently engage in search routines and problem-solving activities aiming at attaining their objectives. This leads to change in decision rules and, consequently, in economic conditions.

d) Along with firm adaptation, markets also evolve as the result of economic selection mechanisms, by which successful decision rules expand, whereas unsuccessful ones contract, and eventually disappear.

Witt (1992) identifies three major streams within evolutionary economics. First, the Schumpeterian tradition, which emphasizes the role of innovation and technical progress in economic change. Second, the subjectivist contributions, mainly from the Austrian school, focusing on the ideas of bounded rationality and subjective knowledge, and consequently on market processes led by entrepreneurial discovery. Third, works exploiting analogies with neo-Darwinian theories in biology, centred on the idea of 'natural selection'. These three streams, to a greater or lesser extent, contribute to the theoretical antecedents of this dissertation.

An essential feature of evolutionary approaches is that they adopt a dynamic perspective; their interest lying on economic processes, rather than on economic states (Foss, 1994), they deal with change dynamics. Additionally, they do not assume optimizing behaviour; building on contributions from behaviouralists (Simon, 1955, 1959; Cyert and March, 1963), they acknowledge that firms, which act within the constraints of uncertainty and bounded rationality, differ in their decision rules, and also that such rules do change over time (Nelson and Winter, 1974, 1982). This provides a basis for the emergence and evolution of inter-firm heterogeneity, which ultimately originates from firms engaging in a number of different problem-solving activities and routines, aiming at improving their performance. It is also important noting that, once optimization is sidelined, markets are no longer assumed to be in equilibrium. On the contrary, as Austrian theorists point out (most saliently Kirzner, 1973), there is always room for discovery, innovation and creative thinking giving rise to new economic combinations.

From this perspective, we can clearly distinguish the two dimensions, static and dynamic, we established above. From a static standpoint, results from competition (i.e. firm performance) depend on competitors' decisions rules holding at some given time. Meanwhile, the dynamic dimension informs us about the evolutionary processes that have given rise to such decision rules. A better understanding of these evolutionary processes can contribute to unveiling the origins of heterogeneous firm performance. This may prove a useful approach to the question of 'how profit differentials develop?'..

We can thus claim that empirical strategy research "need to move beyond studies of differential performance to more integrated studies which not only identify those factors that are correlated with superior performance but also attempt to explore the origins and the dynamics of their adoption" (Cockburn et al., 2000: 24). Building such integrated studies sets the grounds for a vast research agenda, which by far exceeds the objectives of this dissertation. Nevertheless, we can contribute to such research agenda by defining and testing a longitudinal model that aims at offering a rather comprehensive depiction of the dynamics of firm performance (which corresponds to the first objective we established above).

More concretely, we explain current profitability as a combination of enduring, time-invariant firm-specific effects (persistent heterogeneity), and emergent differentials stemming from profit trends varying across firms (emergent heterogeneity). In other words, we analyze where firms currently are (in terms of performance) as a result of where they were in the past and how they have moved. Despite the apparent simplicity of our approach, untangling persistent and emergent heterogeneity yields relevant implications for our understanding of how competitive advantages evolve. Whereas strong enduring effects call for explanations based on sustainable advantages and important isolating mechanisms (Rumelt, 1984), greater emergent heterogeneity suggests that such mechanisms are permeable and competitive positions mat change substantially in relatively short periods of time.

The model we define extends existing literature on the dynamics of firm performance. Thus far, research has essentially reduced profit dynamics to the analysis of rates of persistence (seminal works in this research stream being those by Mueller, 1979, 1986); they treat 'abnormal returns' as somehow exceptional departures from competitive equilibrium, and they analyze how long it takes for profit rates to return to equilibrium levels. The assumption of markets approaching equilibrium would be found restrictive, if not plainly unrealistic, by most strategists. By relaxing it, we can capture the fact that firms differ in the relative success of their strategic initiatives and efforts, which have an impact on profitability dynamics that does not respond to a mere "return to equilibrium" logic.

It is worth noting that such departure from previous works reflects profound differences in underlying motivations of research; management scholars studying profit dynamics have been mainly interested in validating alternative equilibrium models: strategy frameworks, which predict sustainable performance differentials, versus neoclassical economic theory (abnormal rents are short-lived phenomena, and markets quickly return to a zero-profit solution). In our case, the interest lies precisely in moving beyond such equilibrium frameworks in order to study how heterogeneous performance emerges and evolves.

Untangling the static and dynamic dimensions of firm performance provides relevant insights on the processes behind performance differentials. Nevertheless, this by no means exhausts the distinction between the 'what' and the 'how' of competitive advantage. In chapter three we approach the same problem by analyzing, both theoretically and empirically, the relationships between resource-based and Austrian perspectives on heterogeneous firm performance (second objective).

Previous research has often considered both schools of thought as independent, when not opposing views. Indeed, they greatly differ in terms of their assumptions, theoretical frameworks, methodological strategies and predictions. Nonetheless, not only they are not mutually exclusive, but may well complement each other. This work aims at contributing to both these literatures by exploring such complementarities, in particular regarding causal explanations of firm profitability. We suggest that Austrian insights on market disequilibrium and entrepreneurial discovery can help elucidating how heterogeneous asset bundles, which in turn result in heterogeneous performance, develop. We have already mentioned that resource-based theorists have investigated factor markets in order to explain asymmetries in resource endowments. Moreover, we have suggested that such efforts may be constrained by the reliance of strategy research on assumptions from neoclassical equilibrium theory (Powell and Wakeley, 2003). Austrian theory of entrepreneurship, on the other hand, suggests that firms act under conditions of 'true uncertainty' (Knight, 1921). There is significant room for managerial discretional action (subjectivism), which creates firm heterogeneity. Austrian insights on entrepreneurial discovery may help explaining asset asymmetries as the result of discretionary managerial decisions on resource development and deployment.

Drawing on this theoretical discourse, we derive an empirical model investigating the effects of intangible assets and competitive moves on profitability. Such a model extends those found in previous literature in that it simultaneously considers the roles of resources and competitive dynamics in determining firm performance.

We must note that there is a significant gap between the theoretical discussion and the empirical model, as far as the literature on competitive dynamics, if based on theoretical antecedents from Austrian economics, does not belong to this school. Therefore, we can distinguish two different sub-objectives, one theoretical (studying complementarities and relationships between RBV and Austrian arguments on business performance) and one empirical (exploring the interaction of intangible resources and competitive moves in order to explain firm profitability), within objective two.

There are substantial difficulties in translating Austrian arguments into empirically testable hypotheses that are comparable to those posed by the RBV; indeed, Austrians place limited value on attempts to explicitly model determinants of firm performance (Jacobson, 1992)[1].

We can contend, however, that the literature on competitive dynamics constitutes the strategy research stream that most precisely incorporates an Austrian view of markets of competition. Assumptions of competitive disequilibrium, interest in market imperfections introduced by innovating firms, competition as a dynamic process and economic rents as short-term phenomena, are all Austrian-based contributions that are present in this literature. Indeed, research streams on technological innovation, competitive dynamics and strategic manoeuvring are central to what Jacobson (1992) refers to as "the Austrian school of strategy".

[1] This comes, to a great extent, from the reluctance of Austrian scholars to assume econometrics and quantitative methods as valid research tools (Mises, 1949; Dolan, 1976; Rothbard, 1997).

The review of Austrian-based strategy literature, and particularly of the implications from the Schumpeterian model of competition, highlighted two relevant circumstances. First, the importance of innovation, most saliently (but not only) technological innovation, for achieving long-term superior performance. Second, the fact that markets are generally not in equilibrium, but subject to constant change; the rate of environmental change (i.e. dynamism) may be a fundamental element in determining the nature and sustainability of competitive advantages (D'Aveni, 1994). We combined these arguments with the Schumpeterian discussion on the relationship between firm size and innovation in order to give rise to our third research objective: exploring the effects of environmental dynamism and firm size on the economic productivity of technological capital.

The relationship between firm size and innovation has received a great deal of attention in the literature (two good reviews can be found in Cohen, 1995 and Subodh, 2002). Neither theoretical arguments nor empirical evidence on this matter are conclusive, however. We contribute to previous literature in a double direction; firstly, by using a Cobb-Douglas production function as our empirical model (Griliches, 1979) we are able to estimate the effect of size on economic productivity to R&D, something that only a few works have done before (normally using quite reduced samples); secondly, we propose a contingent framework in which environmental dynamism has a moderating effect on the size-innovation relationship.

Additionally, we consider that dynamism may not only explain relative size advantages, but also have a direct effect on the productivity of technological capital (more specifically, a positive one). Whereas previous works had already paid some attention to inter-industry differences in R&D productivity, it had mainly been through the lenses of economic theory. We extend existing research by incorporating a concept that, as management literature has already shown, has important strategic consequences, such as environmental dynamism.

In order to conduct our empirical analyses, we rely on data from the Survey on Business Strategies (*Encuesta de Estrategias Empresariales*) an annual rotating panel survey collecting a wide range of data on nearly 2,000 Spanish manufacturing companies per year, classified in twenty different industries. The panel structure of the survey provides us with twelve years (1991 to 2002) of longitudinal data in our analyses. This sample is consistent with what can be found in the literatures on both profitability dynamics; furthermore, it significantly broadens the scope of previous research on competitive dynamics, which yields benefits in terms of external validity or results. On the negative side, having to rely on secondary data sometimes produces measures that could certainly be improved.

The dissertation is structured as follows. In chapter two, we disentangle the static and dynamic dimensions of firm performance and explore the evolution of firm profitability over time. In chapter three, we develop a discourse on the interrelationships between resource-based and Austrian perspectives on firm performance; drawing both on this discourse and on the empirical model we developed in chapter two, we analyze the effects of intangible assets and competitive aggressiveness on firm performance. Chapter four is devoted to the study of firm size and environmental dynamism as contingency factors moderating the contribution of R&D investments to profitability. Finally, in chapter five we discuss the conclusions and limitations of the dissertation, along with a number of suggestions for extending this work in further research.

CHAPTER2. THE DYNAMICS OF HETEROGENEOUS FIRM PERFORMANCE

1. INTRODUCTION

The study of inter-firm profit differentials as a strategic phenomenon can indeed be approached from two different perspectives. Firstly, strategy scholars can aim at understanding what factors underlie superior performance; from an empirical standpoint, this involves identifying those variables that help explaining observed profit differentials. Secondly, and not less importantly, research questions can focus on the historical processes by which such differentials arise and evolve over time. We label these two perspectives as the 'static' and 'dynamic' dimensions of firm performance, respectively (Porter, 1991). We further contend that both dimensions are complementary if we are to build a comprehensive account of how firms develop superior profitability.

Strategy literature offers a number of well-developed theoretical rationales, along with a vast body of empirical evidence, as to factors associated to competitive success. Meanwhile, and despite works studying persistence of profit persistence (drawing on seminal research by Muller, 1977, 1986) there is a lack of models that can properly capture the dynamics of performance (Barnett and Burgelman, 1996); indeed, cross-sectional survey-based studies by far dominate empirical strategy research (Lewin and Volberda, 1999; Volberda and Lewin, 2003). This unbalance has led some scholars to pose doubts on the ability of most strategy research frameworks for untangling the ultimate causes of superior firm performance (Barnett and Burgelman, 1996; Cockburn et al., 2000; Stinchcombe, 2000; Priem and Butler, 2001).

In this study, we aim at addressing this research gap by presenting and testing a dynamic model in which current firm profitability is explained in terms of its historical evolution.

We decompose current variance in returns in terms of two main kinds of effects[1]. First, the initial profitability of firms at some given point in the past[2]. Second, the relative improvement (or weakening) in their competitive positions over time (represented by trends in their profitability rates). We capture the fact that firms reaching different performance levels may differ in terms of both their starting positions and the paths they have followed. In simpler terms, we explain where firms currently are as a combination of where they were in the past and how they have moved. We will refer to these two effects as initial (or persistent) and emergent heterogeneity, respectively. Despite the apparent simplicity of this approach, we claim that disentangling both kinds of

[1] Our approach is to some extent analogous to early variance-decomposition analyses, which, from a static standpoint, distinguish among industry, corporate and business levels effects on performance (Schmalensee, 1985; Wernerfelt and Montgomery, 1988; Rumelt, 1991).

2 It is important noting that, in this context, the term ‘initial conditions’ do not need to refer to the time of founding; consistently with previous research on the dynamics of firm profitability and competitive advantage, it reflects the position in the firm at the beginning of the period of study (Cockburn et al., 2000). Persistence of initial conditions, thus, should be interpreted as that of the starting competitive position of a firm at some given point in the past.

heterogeneity, as they have very different implications for strategy research and practice, can add to the understanding of current differences in performance. A salient role of persisting initial differentials suggest competitive advantages may be highly stable; market positions are consolidated, and the presence of strong isolating mechanisms (Rumelt, 1984) prevents competitors to challenge market status quo. Strong dynamic heterogeneity, on the other hand, indicates firm performance is mainly determined by what firms have made in their recent past, and suggests status quo may be hardly sustainable.

We extend this base model by also analyzing the relationship between starting conditions and subsequent dynamic trends; we can assume with most strategy scholars that firm dynamics are partially path-dependent, so that history of the firm influences the evolutionary paths available to it (Nelson and Winter, 1982; Diedrickx and Cool, 1989; Magnusson and Ottoson, 1997). Consistently with this view, we study systematic relationships between the initial competitive position of firms and their ulterior evolution; more concretely, we argue that firms with weaker starting positions will tend, on average, to 'catch up' with stronger competitors, which should experience some erosion in their competitive advantages.

Our approach significantly extends existing research adopting a dynamic perspective on business performance, which has mainly drawn on autoregressive models such as those proposed by Mueller (1986). Such models distinguish a permanent firm-specific component of performance, which does not vary over time, and an incremental component which is mainly induced by short-term, non-systematic, shocks (McGahan and Porter, 1999, 2003). By doing so, previous literature has essentially reduced profit dynamics to a process of so-called 'abnormal profitability' (Wiggins and Ruefli, 2002) progressively approaching long-run equilibrium levels; this allows analyzing persistence rates of observed profit differentials, but not processes of emergence of such differentials.

This shortcoming comes explained by the fact that this literature has focused on validating alternative equilibrium-based frameworks (see section 4 below), rather than at capturing return dynamics comprehensively. Meanwhile, our theoretical antecedents are mainly based on evolutionary views of firm dynamics.

We acknowledge that firms not only differ on average performance levels, but also on their long-run performance trends. Evolutionary economics establishes that economic change is fuelled by firms systematically engaging in different profit-seeking initiatives (Nelson and Winter, 1974; Barnett and Hansen, 1996) and search routines (Nelson and Winter, 1982) in order to improve their performance. The relative success of such efforts will have an impact on their competitive positioning, and consequently on their long-term profitability. This is captured in our model by inter-firm variability in performance trends, so providing a research setting in which inter-firm heterogeneity is allowed to develop. Consequently, we are in a far better position to analyze how profit differentials emerge, and not only how long they persist.

Additionally, by studying systematic relationship between initial profitability and subsequent performance trends, we sum our efforts to those works that have analyzed processes of converge in firm profitability. Moreover, our model yields a significant advantage in doing so; unlike autoregressive models mentioned above, we capture the dynamics of overall firm profitability, and not only of its incremental components ('excess' profits) (McGahan and Porter, 2003).

A word of caution is needed regarding what the model we develop here can and cannot accomplish. Whereas we provide a framework describing the evolution of business performance, we do not take into consideration any exogenous variables aiming at explaining such evolution. In the terms we defined in the introductory chapter, we do not address the ‘what’ of economic rents. From this perspective, this work is single-sided; we address the dynamic, but not the static problems behind performance differentials. If we consider it can be of particular interest, it is partially because it focuses on the far less-understood side of the question (i.e. the dynamic dimension). This being said, our models and empirical findings do allow us to cast some plausible inferences on the nature of factors that can explain firm success, consistently with the observed dynamic patterns.

We test our model on a Spanish sample of manufacturing firms, spanning from 1991 to 2002. Empirical findings suggest that inter-firm differentials in performance can be meaningfully explained in terms of both heterogeneous initial competitive statuses and variability in firm-specific profitability trends. In other terms, understanding present firm performance requires not only attending to heterogeneous initial conditions that may lead to long-term competitive advantage, but also to the relative success of firms in the profit-seeking initiatives they undertake. Indeed, out results show competitive positions to be rather unstable. Moreover, consistently with most previous research, (e.g. Cuaresma and Gschwandtner, 2006), we also find a significant process of erosion of initial profit differentials, so that firms with weaker initial positions showed, on average, a better dynamic behaviour, and ‘caught up’ with initially stronger competitors.

The chapter is structured as follows. First, we disentangle the ‘static’ and ‘dynamic’ dimensions of heterogeneous firm performance. Next, we discuss potential contributions of dynamic-oriented strategy research to a better understanding on how firms build superior profitability; we argue that comprehending the ultimate causes of performance differentials calls for developing meaningful dynamic models. Drawing on such arguments, we briefly review previous literature approaching profits from a dynamic standpoint; special attention is granted to its contributions, but also to its limitations for the objectives of our research. In order to address some such limitations, a comprehensive model of performance dynamics is defined in section 5 and subsequently subject to empirical verification. Section 6 presents the main methodological and econometric issues, whereas results are reported and commented in section 7. Finally, the main conclusions and implications for both academic research and managerial practice are discussed in section 8, along with the limitations of the study and suggestions for further research.

2. DISENTANGLING THE STATIC AND DYNAMIC DIMENSIONS OF HETEROGENEOUS FIRM PERFORMANCE

Strategy research has long studied inter-firm profit differentials as a central phenomenon. Seminal empirical works decomposed performance variability in firm (either business-level or corporate) and industry (and strategic group) effects (Schmalensee, 1985; Wernerfelt and Montgomery, 1988; Rumelt, 1991). Following evidence found, both theoretical and empirical research has aimed at identifying which factors and variables (either industry or firm-related) are associated to superior performance. Wherever such associations are verified, empirical findings are normally interpreted in causal terms; from this approach, origins of superior profitability can be traced back to causes such as superior resources, favourable market structures, or other analogous variables. However heterogeneous these research streams may be, they all share a static perspective on profit variability; in other terms, they aim at explaining differentials in returns at some point in time by means of cross-sectional analyses.

Meanwhile, we explicitly acknowledge that questions regarding heterogeneous firm performance are not univocal, and involve at least two distinct dimensions, namely static and dynamic[3]. Moreover, we claim both dimensions are indeed complementary, if strategy research is to provide a comprehensive account of causal antecedents of profit differentials. We illustrate our line of reasoning with the example we present in figure 2.1.

Let us consider two firms, so that A outperforms B at some point in time; from the static perspective we mentioned above, we can aim at explaining A's superior performance in terms of a number of independent variables (IVs) that are found to be empirically associated to profit differentials (figure 2.1.a); it can be claimed (provided research is properly designed) that the independent variables 'cause' such differentials. This approach, which is standard within strategy research, aims at identifying factors sustaining superior performance. We can refer to this literature as 'equilibrium-oriented', as it is concerned with the states of competition and their implications at any give point in time, rather than the processes by which those states develop (Powell and Wakeley, 2003).

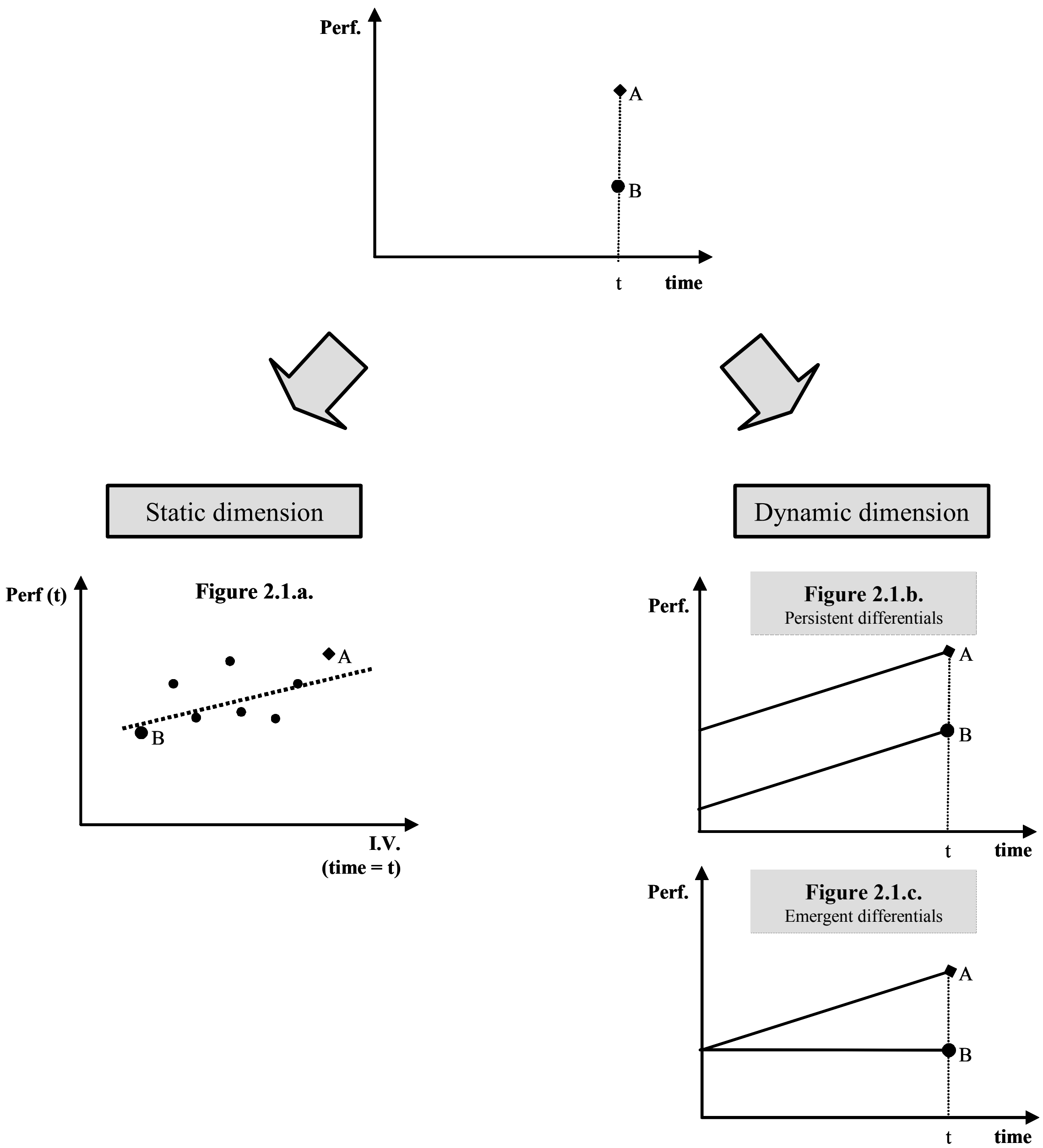
However valuable these findings are for strategy research and practice, they overlook the historical processes by which competitive positions[4] arise and evolve over time.

[3] Somehow analogously, Porter (1991) distinguishes the 'cross-sectional' and 'longitudinal' problems of strategy. We rather use the terms 'static' and 'dynamic' in order to avoid confusion and make clear that the distinction does indeed account for much more than a mere methodological choice when designing empirical research.

[4] Following Schoemaker (1990), we can define competitive advantage as the capacity of the firm to systematically create above-average returns. From this perspective, higher profitability is an indicator of a stronger competitive position, so that the concepts of superior performance and competitive advantage can be treated as synonyms.

These processes conform what we label the ‘dynamic’ dimension of firm performance. As a matter of illustration, we consider two different dynamic scenarios (figures 2.1.b and 2.1.c.).

FIGURE 2.1: The static and dynamic dimensions of performance differentials



First, successful firms may present a long-standing record of superior performance, and *vice versa* (figure 2.1.b). In this case, firms have evolved in similar ways, and current profit differentials mimic those that already existed in the past. The ultimate sources of superior performance, thus, are likely to lie far in the past of the organization. Under this hypothetical scenario, profit differentials are stable and competitive positions highly sustainable; this long-term effect is what we refer to as 'persistent' heterogeneity.

The opposite scenario is presented in figure 2.1.c; in this case, firms depart from equivalent competitive positions, but evolve in significantly different ways. Whereas firm A manages to improve performance, firm B remains stagnant. Profit differentials did not exist far in the past, and have recently aroused over time. We refer to performance differentials arising from heterogeneous profit trends as 'dynamic heterogeneity'.

It must be noted that figures 2.1.b and 2.1.c. represent two stylized, if rather unrealistic, examples. In general, whatever firm span we consider, firms differ in both their initial conditions and evolutionary dynamics; if a number of firms were plotted in figure 2.1, each of them is likely to have its unique intercept and slope. In the terms we have defined above, both persistent and dynamic heterogeneity are likely to play a role in explaining current performance of firms.

The two dynamic scenarios presented above substantially differ in their implications for strategy research, regardless of the substantive variables underlying performance differentials. Figure 1.b. suggests the presence of strong isolating mechanisms (Rumelt, 1984) and limited scope for firms to alter their competitive position; under this scenario, research questions should focus on how and why competitive positions are sustained over time. Figure 1.c, on the other hand, suggests firms can build new competitive advantages in relatively manageable time spans; the main interest, thus, lies in how such advantages are created. We will develop this argument in fuller in section 5 below.

3. WHY STUDYING THE DYNAMICS OF FIRM PROFITABILITY? CONTRIBUTIONS TO THE UNDERSTANDING OF INTER-FIRM PERFORMANCE DIFFERENTIALS

We have thus far identified two dimensions, static and dynamic, of inter-firm profit differentials. Furthermore, we have argued that both of them are relevant if strategy research is to provide a comprehensive account of how such differentials are built and sustained. In this section, we further elaborate on this later argument, and analyze the potential contributions that dynamic approaches can yield to the understanding of superior performance. In doing so, our line of reasoning stresses the need for the development of longitudinal models that can tackle the problem of the dynamics of firm profitability.

We consider two major kinds of arguments. Firstly, from a methodological standpoint, we discuss how dynamic models may provide an advantageous alternative for addressing issues on performance sustainability; moreover, we also claim that longitudinal models may also help in obtaining more robust empirical findings on factors underlying profit differentials. Secondly, we move into more theoretically-driven arguments, and explore how dynamic approaches can help in extending traditional claims on causal antecedents of firm performance; in other words, in moving further along the so-called ‘causality chain’ of competitive success (Porter, 1991).

3.1. Methodological issues

3.1.1. Obtaining empirical evidence on profit sustainability

Strategists have devoted a significant amount of time and to the identification of the conditions for returns to persist over time. The literature has suggested a wide range of ‘isolating mechanisms’ (Rumelt, 1984), either relating to industry conditions (IO economics) or characteristics of firms and resources (mainly drawing from the RBV), that can protect superior performance from the eroding effects of competition.

We argue that sustainability conditions cannot be subject to empirical testing unless dynamic analyses are conducted. In this sense, static-oriented research turns out to be ill-suited for disentangling profitability *levels* from profitability *persistence*, the later corresponding to the idea of sustainability. Whereas a firm showing superior average performance over a period of time is normally taken as evidence of competitive advantage, it really provides no empirical test for how persistent (i.e. sustainable) such advantage is. As a matter of illustration, this research is not able of distinguishing two firms, the first one showing a profit of 10 for two years in a row, and the second with a profit of 20 in year one and 0 in year two.

A number of researchers have highlighted this point and, drawing from seminal works by Mueller (1977, 1986), have made use of dynamic panel models (Hsiao, 2003) in order to study profit persistence. We present some of the most relevant of these works in table 2.1. Overall, this literature has long addressed inter-industry differentials in persistence rates. There is, for example, robust empirical evidence than barriers to new competition do increase performance persistence (e.g. Cubbin and Geroski, 1987; Waring, 1996). Nevertheless, research has reached much less in understanding how firm resources, capabilities, behaviour and strategies may enhance sustainable profitability

TABLE 2.1: Summary of empirical literature on the dynamics of firm profitability

Study	Sample	Main findings
Acquahh (2003)	119 Fortune 500 firms, from 1985 to 1997	Effectiveness of firms' top management enhances sustainability of profits, particularly in highly concentrated industries
Bou and Satorra (2007)	5,000 largest Spanish firms, from 1995 to 2000	There are permanent differences in profitability. Short-run rents converge to average values, but the process is relatively slow
Cuaresma and Gschwandtner (2006)	156 US companies surviving for the period 1950-1999	Profits show relatively low persistence rates. Higher persistence found in other studies can be due to model misspecification
Cubbin and Geroski (1987)	217 medium to large UK firms, allocated along 48 three-digit industries, from 1957 to 1977	Profits show a significant return-to-the-mean effect for about 2/3 of firms, whereas they appear to persist in the long term for the remaining 1/3. Industry structure is a major determinant of convergence rates.
Goddard et al. (2006)	96 large UK firms, with complete annual data for the years 1970 to 2001	Unit root tests confirm certain degree of convergence in both firm sizes and profit rates (results for the later being more consistent). The rate of convergence is not estimated
Jacobsen (1988)	Data from 1963 to 1982 for 241 firms	There a significant and relevant return to the mean in business profits; nonetheless, this process is slow and depends on some factors such as market share, level of vertical integration or intensity in marketing expenditures
McGahan and Porter (1999)	Data between 1981 and 1994 for an average of 4,488 U.S. business units per year, belonging to 638 different industries	Industry effects are more persistent than firm effects, and particularly than those arising at the business unit level
McGahan and Porter (2003)	Data between 1981 and 1994 for an average of 4.488 U.S. business units per year, belonging to 638 different industries	The dynamics of firm profits vary depending on three factors: origin of returns (i.e. industry, corporate, business unit); emergence vs. erosion of differential performance; above-norm vs. below-norm performance
McNamara et al. (2003)	Data between 1978 and 1997 for an average of 5,700 business units in U.S. public corporations per year	Stability (i.e. persistence) of profit differentials decreased in the 80's, but increased again in the 90's
Mueller (1977)	472 U.S. firms for a period of 24 years	Results for some firms, particularly those with very large 'abnormal profitability' (either above or below-average) show high persistence rates
Mueller (1986)	Data for 551 manufacturing firms between 1950 and 1972	There are some persistent differences in performance. Convergence in return rates occurs, but differs depending on certain characteristics of firms and industries
Villalonga (2004)	1,641 public US corporations, between 1981 and 1997.	Greater intangibility of firm assets is associated to higher persistence of profit rates; this result varies significantly across industries
Waring (1996)	Panel with data between 1970 and 1989 for an average of 5.055 firms per year, belonging to 68 different 2-digit industries	Persistence of extraordinary rents is conditioned by a number of characteristics of the firm and its competitive environment: number of competitors, economies of scale, capital intensity, etc.

(for relevant exceptions, see Acquahh, 2003 and Villalonga, 2004).

Consequently, empirical evidence still falls too short for validating theoretical statements on sustainable competitive advantage that can be found in most of management literature. This constitutes a research gap to be filled by appropriate dynamic models.

A gap, moreover, which is of special relevance since a growing number of scholars are challenging the concept of sustainable advantage; they claim that, in today's fast-moving world, competitive advantages are short-lived, even in the presence of isolating mechanisms originating from imperfect product or resource markets (D'Aveni, 1994, 1995; Bettis and Hitt, 1995; Barney, 2001). Success would thus be tied to speed, responsiveness and flexibility. According to this view, firms should not focus on sustainability, but on continuously renewing their sources of advantage (D'Aveni, 1994; Volberda, 1996; Hamel, 2000; Flier et al., 2003). Some recent research has emphasized how environmental change can challenge competitive positions and render resources obsolete (Brush and Artz, 1999; Priem and Butler, 2001). Under such conditions, traditional arguments on sustainability may prove necessary but non-sufficient conditions for long-term profitability (Fiol, 2001). Thus, collecting empirical evidence assessing the processes by which economic rents develop and disappear becomes more than ever a priority[5]. And this can only be accomplished if appropriate dynamic models are employed.

5 We must mention that arguments above are far from uncontroversial. Some authors have indeed found that the nature of competitive conditions is not changing, and traditional arguments on sustainability of competitive advantage may still be fully applicable (Castrogiovanni, 2002; McNamara et al., 2003). Providing satisfactory answers to this debate is mainly a matter of empirical evidence, which does indeed reinforce our case for the development of meaningful longitudinal models.

3.1.2. Robustness to time cross-section

A more serious caveat of static approaches follows from the idea that markets are subject to frequent, if not constant, change and disequilibrium. In this setting, cross-sectional results will be very sensitive to the time data were collected. From a static perspective, competitive outcomes are interpreted as the result of certain equilibrium conditions. However, we can argue that assumptions on markets being in equilibrium are rather unrealistic, departures from equilibrium being the norm, rather than the exception. Should such disequilibria occur not at random, but in a systematic fashion, estimates of cross sectional models may be severely biased (for a formal treatment of this issue in the context of the structure-conduct-performance paradigm, see Geroski, 1990).

From an evolutionary perspective, bias arises from treating as steady-state conditions what really is a rather arbitrary cross-section in a dynamic market process (Kirzner, 1973). In some sense, making inferences on strategy and competition from static analyses would somehow resemble trying to guess the plot of a film from one frame (or a few of them) in isolation.

According to this view, static analyses not only would provide limited information on the persistence of causal relationships, but also may result in misleading inferences on the causal links themselves. It can be convincingly sustained that likelihood of time-specific bias occurring decreases as the period considered increases; however, the fundamental criticism remains, as static-oriented research still interprets outputs from dynamic processes as if they were the result of certain equilibrium conditions. Even when dilated periods of time are considered, empirical evidence from static studies suffer from averaging of effects that may have changed substantially over time.

Consequently, strategy research, particularly as far as robustness of empirical findings is concerned, is likely to gain from revisiting traditional arguments on factors sustaining competitive advantage and firm profitability from a dynamic perspective.

3.2. Theoretical contributions: dynamic perspectives and the causality chain of superior firm performance

Strategy literature offers a number of well-developed theories, along with a vast body of empirical evidence, as to the factors associated with superior performance at any given point in time. Industrial-organization economists suggest, for example, that favourable industry structures, coupled with entry barriers, may consistently yield higher returns (we can mention, among many others, the works by Bain, 1956, 1959; Porter, 1974, 1980; Spence, 1977; Caves and Porter, 1978; Caves, 1980). Strategy research also establishes that some resources, provided they satisfy certain conditions (Barney, 1991; Conner, 1991; Amit and Schoemaker, 1993; Peteraf, 1993), may provide firms with competitive advantage. These arguments, while providing answers to some questions, also give rise to others. How did such factors (underlying advantage) develop in the first place? (Barnett and Burgelman, 1996). How can firms obtain superior resources? Why a certain firm (and not any other) developed such resources and competences? (Cockburn et al., 2000).

We still have limited knowledge, at least from an empirical standpoint, regarding how entry barriers are erected or superior bundles of resources developed (Barnett and Burgelman, 1996); in other terms, regarding dynamic processes of change in competitive conditions, by which superior performance arises and evolves over time. Strategy research has reached way farther in the understanding of the nature of economic rents (the '*what*' of competitive advantage) than in explaining how such rents are built.

We claim that if equilibrium-based approaches do not answer these 'how' questions satisfactorily, it is because they overlook the dynamics through which heterogeneity develops. Indeed, heterogeneity, either in market structures or firm resources, is often treated as an exogenous assumption itself (Peteraf, 1993). As a result, these models only go halfway in providing causal explanations for differential performance. As Powell and Wakeley pose it, 'the concentration upon equilibrium positions of economic systems leads to a paucity of advice to strategists in respect of the means of progression to those equilibria' (2003: 153). This has led some authors to suggest that the question of 'why do firms differ?' still lacks a satisfactory answer (Cockburn et al., 2000; Zott, 2003), due to lack of integration between content and process considerations (Spanos and Lioukas, 2001).

Barney (1986a) approaches the question of asset asymmetries by arguing that managers hold heterogeneous expectations about potential resource values, so that they adopt different decisions on resource acquisition. Thus, firms showing more accurate expectations (or simply being luckier) will end up enjoying superior resource endowments.

From an equilibrium perspective, Barney's arguments have the distinctive advantage of moving one step backward and shifting focus from resource deployment in product markets to resource acquisition in factor markets. This line of reasoning, however, as far it is equilibrium-oriented, still relies on exogenous assumptions on firm heterogeneity; questions regarding why firms develop different expectations strategies in factor markets remain unaddressed. Makadok and Barney (2001) argue that sustained competitive advantage ultimately depends on firms differing in their resource-acquisition capabilities. As a result, it is easy to fall into a circular reasoning: heterogeneous resources and capabilities require assuming heterogeneous managerial expectations, which in turn result from heterogeneous (resource-acquisition) capabilities.

Different, and we believe more fertile, conclusions can be reached if we introduce a dynamic dimension in the analysis, rather than sticking to the neoclassical concept of equilibrium. From a dynamic standpoint, firm resources at any point are result from two different effects, working in opposite directions.

On the one hand, as RBV scholars highlight, resource endowments can prove to be rather stiff; indeed, resource stiffness is a necessary condition for long-term competitive advantage (Barney, 1991; Peteraf, 1993). Contrarily to Barney's (1986a) depiction of factor markets, many strategic resources and capabilities cannot be acquired, but need to be developed by firms; such in-house development is likely to be subject to substantial time compression diseconomies (Diedrickx and Cool, 1989). On the other hand, following Barney's arguments, resource bundles of firms are permanently evolving and changing, on the basis on managerial decisions on asset acquisition and development. From an evolutionary perspective, firms are somehow bounded by their organizational routines, while also engaging in search activities aiming at changing such routines and improving their competitive positioning (Nelson and Winter, 1982). Quite analogously, Rond and Thietart (2007) argue that understanding causal relations in strategy becomes to a great extent a matter of combining the roles of historical determinism, free managerial choice, and chance. Such would be the three main historical components to the dynamics of strategy and firm evolution. These arguments lie beyond the limits of static research designs, leading Stichcombe (2000) to suggest that, by ignoring historical determinants of firm evolution[6], strategy research fails at explaining why some firms perform better than others.

There is an intrinsic difficulty in knowing why firms adopt different decisions or engage in different search routines; we may not be able either to disentangle if successful managerial decisions come from superior insight or mere luck (Barney, 1986a; Stinchcombe, 2000; Rond and Thietart, 2007). The ultimate sources of heterogeneity may thus remain unknown. Still, a dynamic perspective allows us to observe how such heterogeneity develops. We can thus assess the 'tension' between resource stickiness and persistent organizational routines, on the one hand, and managerial decision and profit-seeking search activities (Nelson and Winter, 1982), on the other, as determinants of firm profitability. In the terms we defined above, this is analogous to distinguishing between persistent and emergent heterogeneity. Moreover, we may be able to observe how specific initiatives and decisions act on resource bundles and affect performance. If not unveiling its ultimate determinants, dynamic models may at least help moving backwards in the causality chain of firm performance (Porter, 1991).

4. CONTRIBUTIONS AND LIMITATIONS OF EXISTING LITERATURE ON THE DYNAMICS OF PROFITABILITY

We have made the claim that most strategy literature adopts a static perspective to the study of business profitability. There is, however, a very significant research stream, drawing from seminal works by Mueller (1977, 1986) that is concerned with what we have labelled as the 'dynamic dimension' of the problem.

[6] Stinchcombe (2000) writes within a population ecology tradition. Consequently, his main concerns relate to the implications of population dynamics, focusing on inter-firm (rather than within-firm) evolution as source of competitive change.

Empirical evidence has consistently shown return rates differing across firms. This appears to be at odds with neoclassical depiction of efficient markets. According to mainstream economics, market pressures should quickly erode any 'abnormal' profitability, so that profit rates should rapidly converge across competitors; long-term equilibrium should approach a zero-profit solution (Mueller, 1977). Alternatively, strategic management literature suggested that a number of factors may generate sustainable differentials, thus preventing returns to converge. Consequently, there has long been an interest in studying rates of profit persistence, in order to test strategy theoretical frameworks against the 'efficient-market' hypothesis.

Research questions are often posed in the following or similar terms: '*can we expect high profits to fall to competitive levels, and how long must we wait?*' (Mueller, 1977: 369); or, alternatively, '*does superior economics performance persist in a manner consistent with sustained competitive advantage?*' (Wiggins and Ruefli, 2002: 83).

In order to better understand the contributions and limitations of this literature to the understanding of profit dynamics, we need to briefly consider its standard methodological approach. As mentioned above, the vast majority of research on the dynamics of firm performance is based on seminal works by Mueller (1977, 1986). They approach the problem by estimating a first-order autoregressive process [AR(1)] of the form:

$$y_{it} = \alpha_i + \gamma_i y_{it-1} + \varepsilon_{it} \qquad (1)$$

Where y_{it} represents a measure of performance for firm i at time t, and y_{it-1} the same measure for the previous period. Overall firm profitability is thus decomposed, rather unrealistically, into two components; α_i, on the one hand, represents a constant firm-specific component. We could interpret it as 'average' firm profitability; it represents the stable part of abnormal returns that *does not vary over time* (Bou and Satorra, 2007). Secondly, $\gamma_i y_{it-1}$ refers to the estimated 'incremental component' (that is, above or below α_i) for year t, which is dependent on firm returns in the previous year. The coefficient γ_i is then interpreted as the intertemporal persistence of firm profits. Any $\gamma_i < 1$ provides evidence of a stationary series, in which market pressures erode abnormal rents towards their equilibrium level; higher values of γ_i (i.e., closer to 1) imply a more persistent or sustainable firm abnormal profitability.

We can identify two major limitations within this literature[7]. First, some caution is needed when interpreting the 'persistence' coefficient. Persistence is defined in terms of endurance of incremental components of abnormal profitability, rather than of the total amount of profits themselves. Consequently, a high persistence rate may be associated with a small average incremental component to profitability, being largely irrelevant to the tendency of profits to last between periods (McGahan and Porter, 2003). Equation (1), thus, yields limited information as to the stability of total firm performance.

Second, and perhaps more importantly for our research purpose, it is important noting that this literature does not challenge the notion of market equilibrium from mainstream economics. Indeed, Geroski (1990) justified theoretically equation (1) in a clearly neoclassical fashion, as a reduced form of a system of two equations, in which entry of

[7] We can also add a third problem, of an econometrical nature. The use of a lag of the dependent variable as a covariate yields some estimation problems; in presence of dynamic panel models (Hsiao, 2003), OLS estimates of the fixed-effects model are biased (see Nickell, 1981). A number of different estimation techniques have been used in the literature: correcting OLS estimates by adding back the bias (Waring, 1996; McGahan and Porter, 1999), Anderson and Hsiao's (1982) instrumental-variable estimator, and Arellano and Bond's (1991) Generalized Method of Moments. All these techniques allow the estimation of fixed effects models, which account for firm-specific intercepts; however, previous research has failed to consider heterogeneity in the slope γ_i. This not only may introduce additional bias (Pesaran and Smith, 1995), but it also limits the ability of the model to test inter-firm differences in the persistence of abnormal returns. Some authors have opted for fitting separate regressions for each firm, and then use the individually estimated coefficients in subsequent analysis (Maruyama and Odagiri, 2002); this approach, however, can pose some small sample problems unless long enough time-series are used, yielding unreliable estimates.

new competitors mediates between past and current profits. The underlying idea of equilibrium can be easily shown when considering that, following equation 1, firm profitability approaches α_i / (1-γ_i) in the long term[8]. Studies differing in their theoretical frameworks also differ in their assumptions on the conditions of long-run equilibrium and on how long it takes to reach such equilibrium. They all coincide, however, in assuming that all firms ultimately approach their long-run equilibrium profit levels, which is indeed quite an implausible assumption (Ruefli and Wiggins, 2003) [9].

Overall, this research stream has come up with relevant findings as to how factors such as industry structure and firm resources may prevent profits to converge, yielding sustainable differentials (table 2.1 presents the main results from some of the most significant works on this topic). Not in vain this has been its major goal. It fails, however, to provide a comprehensive account of performance dynamics, in order to contribute at explaining how profit differentials emerge and evolve. On the one hand, the so-called 'constant component' stays unchanged. On the other hand, incremental profits are treated as exogenous phenomena that appear in an unsystematic fashion (it is the process of erosion, not emergence, which is systematically analyzed), so that they remain unexplained. No account is given as to how differential performance appears. It is symptomatic, as an illustration, that McGahan and Porter (2003) need to conduct a series of exploratory analyses in order to study the emergence of abnormal profitability, while they leave formal modelling just for the analysis of sustainability.

It should be clear at this stage that previously tested models on profit dynamics are ill-

[8] This implies that the idea of firms approaching 'equilibrium' is imposed by design, and not the result of empirical findings.
[9] Ruefli and Wiggins (2003) propose a different approach, based on the iterative application of the non-parametric Kolmogorov-Smirnov test (Ruefli and Wiggins, 2000); this alternative methodology, however, shows its how weaknesses and limitations (for a debate on the topic, see McGahan and Porter, 2005 and Ruefli and Wiggins, 2005).

suited in order to yield the potential contributions we stated in section 3.2 above. In what follows, we define our research model, which aims at addressing this research gap.

5. A COMPREHENSIVE MODEL OF THE DYNAMICS OF FIRM PERFORMANCE

We present in what follows the building blocks of our model for analysis. The aim is providing a comprehensive and meaningful account of how firm profitability evolves over time. First, we distinguish between profit differentials arising from heterogeneous initial conditions that already held in the past, and those emerging from heterogeneous dynamic processes experienced by firms over time (i.e. improvement or weakening in profit rates). This is nothing but the distinction between persistent and emergent heterogeneity we have already presented, and which is central to our line or reasoning. Then, we study the nature of emerging differentials. Why do firms evolve in different ways? We pay special attention to the role of managerial discretional choice, but also to systematic relationships between the starting position of firms and their subsequent evolution; as a particular case of such systematic relationships, we explore the process of erosion (i.e. convergence) of initial profit differentials. Finally, we acknowledge that, along with systematic processes of long-term change that can be meaningfully captured by our model, there are short-term shocks that also make up for actual profitability of firms at any time we may consider.

5.1. Firm-specific initial conditions and change processes: persistent vs. emergent heterogeneity

Porter (1991) suggested that any dynamic account of strategy and competitive advantage should take two complementary factors into consideration. First, the initial conditions of the firm and its environment at some point in the past. Second, how managerial action acts upon such conditions and contributes in shaping the current competitive position of the firm. From an evolutionary perspective, Nelson and Winter (1974) established that the behaviour of firms and, consequently, the competitive status may be rather stable in the short and medium terms, although they are also subject to substantial change processes, driven by firm efforts aiming at improving performance. Somehow analogously, we can observe some tension in firm dynamics between structural inertia (Hannan and Freeman, 1977, 1984) and organizational adaptation and evolution (Burgelman, 1991; Aldrich, 1999; Zollo and Winter, 2002). In a sense, competitive dynamics seem to be presided by a combination of persistent effects from the past (i.e. historical dependence) and change processes modifying such effects.

Accordingly, we distinguish two historical components of performance heterogeneity: to the question ‘why do firms differ?’ (Rumelt, 1991) we can provide the following two kinds of answers. First, they differ because they already did in the past and such differences persist nowadays[10]; second, they differ because firms have evolved in different and unique ways, so that heterogeneity could emerge (this is the case, for example, of the simulation study conducted by Zott, 2003). We illustrated these two kinds of effects in figures 2.1.a and 2.1.b above.

An obvious criticism to this approach follows; nothing is said, at least explicitly, as to the factors sustaining superior performance. Stating that a firm performs better because it already did in the past raises the question of why it did in the first place, and the same applies to firms improving profitability. We do not claim we are providing a full

[10] Of course, this opens the question of why did firms differ in the past. This inquiry can be repeated iteratively until we explore the ultimate causes of the founding conditions of the organization. However, unless we take a strict ecological perspective (firm evolution being subject to strong determinism since the time of founding), we can safely assume that firm evolution is not deterministic on founding conditions that held very far in the past. Thus, in order to reasonably understand firms today we only need to move back in the past for a moderate time span.

account of causal antecedents of profitability. This cannot obscure, however, that understanding the dynamic evolution of performance provides some useful insights into the nature of such antecedents.

Persistent differences suggest firm performance is driven by relatively stable equilibrium conditions. As for the nature of such conditions, traditional strategy frameworks highlight either limited competition or greater firm efficiency (Barney, 1986b; Teece et al., 1997). Provided isolating mechanisms are erected (Rumelt, 1984), whereas in the form of entry and mobility barriers, non-replicable resources, or analogous factors, such conditions will remain stable over time. Under strong isolating mechanisms, competitive positions by advantaged players, if still not immune to competition, become firmly established. Firms have limited options available for disrupting existing market equilibrium and improving performance. Accordingly, we would expect to find relatively homogeneous dynamic patterns, leaving heterogeneous initial statuses as the main determinant of current profitability.

This view is coherent with dominant academic interest on sustainable competitive advantage (Hoffman, 2000); both industrial-economics and RBV theorists work on the basis of equilibrium-based frameworks. Their interest being in long-term competitiveness, they have paid a good deal of attention to conditionds driving sustainability. Performance differentials resulting mainly from heterogeneous initial conditions are also consistent with views of firm evolution that stress organizational inertia and the relative inability of firms to adapt, as those posed by population ecologists (e.g. Stinchcombe, 2000).

Arguments above do not imply that under conditions of sustainable competitive advantages, strong isolating mechanisms, and highly inertial organizations, relative firm performance would remain unaltered. On the contrary, even within the extreme (and highly unrealistic) scenario of firms being totally passive (i.e. unchanging), output from competition would still change as a result of both exogenous shocks and economic selection mechanisms (Nelson and Winter, 1974; Singh et al., 1986). Nonetheless, we can expect such conditions to be associated, *ceteris paribus*, to a more salient role of persistent initial conditions.

On the opposite side, most management scholars are also willing to highlight the role of strategic response (Cyert and March, 1963) and strategic choice (Child, 1972, 1997) in determining business performance. Firms are able to change and adapt to external and internal signals seeking for improving results. Not in vain a core implicit assumption of strategy research is that somehow free managerial choice can influence firm competitiveness; there would be no point in 'strategizing' otherwise (Rond and Thietart, 2007). Somewhat analogously, a basic element of evolutionary theories of economic change is that agents engage in goal-seeking search routines that modify their rules of behaviour in a systematic and intentional fashion (Nelson and Winter, 1974). The relative success of such routines for different competitors will determine changes in performance for each of them. In other terms, firms learn, and learning has an impact on results.

Similar conclusions can be drawn from the 'capabilities', and particularly the 'dynamic capabilities' (Teece et al., 1997; Eisenhardt and Martin, 2000) concepts. Seminal works within the RBV focused on the firms' endowment of resources at some point in time[11]

[11] This is true, at least, as far as works explicitly linking firm resources and competitive advantage are concerned. The most salient antecedents of the RBV, however, focused on firm growth; consequently,

(e.g. Barney, 1991; Grant, 1991). They relied on equilibrium-based frameworks to study how imperfections in strategic factor markets could result in differential firm performance (Barney, 1986a). Focus, however, has progressively shifted from what firms *have* to what firms *do* in order to improve their competitive positions (Barney, 2001; Barney et al., 2001). Particularly, dynamic capabilities refer to firms continuously integrating, constructing, and reconfiguring their set of competences (Teece et al., 1997), so that they can attain new configurations of resources (Eisenhardt and Martin, 2000) and improve (if successful) their competitiveness.

These arguments are represented in our model by heterogeneous performance trends (emergent heterogeneity). We acknowledge that, regardless of their starting positions, firm engage in several routines and learning processes, which relative success will impact their future profitability. This is captured by the firm-specific average rate of change in profitability (slopes of lines in figure 2.1), representing if, and to what extent,, firms are able to improve performance.

In summary, a salient role of emergent heterogeneity favours explanations of superior performance based on organizational learning and change, strategic manoeuvring and managerial choice, and vice versa: relatively homogeneous dynamics and a strong effect of initial conditions point to long-living advantages, typically based on superior initial bundles of resources or limited competition and protected by strong isolating mechanisms. This arguments leads to a noticeable conclusion: although no explanatory variables are considered, careful examination of the dynamics of profitability may support some plausible inferences on the nature of substantive factors underlying performance differentials.

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they addressed the effects of resource endowments on the evolution of the firm (Penrose, 1959; Wernerfelt, 1984).

5.2. Explaining changes in profitability rates: the roles of historical dependence and managerial choice

We have distinguished thus far between heterogeneity in initial conditions and heterogeneity in firm dynamics. As for initial conditions, they can take the form of any factors, either environmental or firm-based, potentially influencing performance. By definition, they originate in a period previous to that considered by the researcher. We can observe their effects on performance, but not how they emerge, so that we need to treat them as exogenous conditions. The argument does not hold, however, for what we have labelled as emergent heterogeneity; something can, and certainly should, be said about how it develops.

Let us assume two initially identical-twin firms. This, if unrealistic, is a useful assumption for our purposes. Provided they both behave rationally and managers follow optimization criteria, they will adopt the same decisions on information acquisition and resource building (Makadok and Barney, 2001). In general, there is no reason for two identical firms to react differently to the same stimuli. Under such conditions, heterogeneity will not emerge and any inter-firm differentials can be somehow traced back to the influence of initial conditions.

This line of reasoning follows from a neoclassical view of economic decision-making. This is, however, a hardly useful view for depicting strategic behaviour (Powel and Wakeley, 2002; Mathews, 2006). Well on the contrary, managers, even if partially constrained and influenced by their organizational setting (we will return to this point later), have at any point a number of options available to influence firm evolution; previous research has shown that strategic initiatives may have a significant effect on profitability, controlling for initial conditions (e.g. Roper, 1999). Moreover, from an evolutionary perspective no real optimization can ever take place. There is no well-defined option set (Simon, 1955, 1959; Cyert and March, 1963; Nelson and Winter, 1974, 1982) and no choice can be objectively said to be best *a priori*. This leaves substantial room for subjectivism and managerial discretionality when facing strategic decision-making (Jacobson, 1992). Provided there is nothing such an optimal option, initially similar firms can take different routes trying to improve performance.

This assertion implies that, even if initial conditions of the firm could be fully observed and controlled for, there would remain a substantial amount of heterogeneity to emerge in their subsequent evolutionary paths. In other terms, a number of firm *idiosyncratic factors* will develop over time, influencing business performance in ways not related to the starting position of the company (Cockburn et al., 2000). Such idiosyncratic factors, to the extend that can be related to managerial discretion, provide an endogenous explanation for firm heterogeneity, which no longer needs to be treated as an exogenous condition.

However appealing arguments above may be, they need to be treated cautiously when operationalized in empirical research. The idea that managerial discretional choice creates inter-firm heterogeneity is implicit in most strategy literature. Nonetheless, it has rarely been tested, so that asking why makes full sense. A major problem arises from the fact that the whole set of a firm initial conditions, whatever the starting point considered, can never be fully observed, and nor can the discretionary element of managerial decisions. What proportion of firm success can be attributed to superior insight by senior managers? Analogously, what proportion of successful decisions is the result of the initial resource base of the firm? How can researchers disentangle if firms and managers are smart, or if they are merely lucky? (Rond and Thietart, 2007). There is still a long way to go in understanding the implications of managerial action and competitive dynamics for performance heterogeneity (Stinchcombe, 2000). Walking such a way may set the grounds for a whole research program, which exceeds by far the objectives of this study.

Acknowledging that discretionality cannot be observed, however, does not imply that nothing can be said about its effects, or that it should be ignored in strategy models. In the context of this study, it can be asserted that, *ceteris paribus*, a greater role of discretionary decision-making would result in increased inter-firm heterogeneity in the dynamics of business performance.

If discretional decision-making plays a salient role in the emergence of inter-firm heterogeneity, it is not less true that organizational change and learning do not take place in a vacuum, but are conditioned by the firm's history (e.g. March, 1991; Ghemawat and Ricart i Costa, 1993). This leads competitive dynamics to be partially path dependent, in at least two ways:

First, firm and industry characteristics at any time delimit the evolutionary paths available to managers; they set the frontier of the possible. Organization ecology has established a number of internal and external factors resulting in structural inertia within organizations (Hannan and Freeman, 1977, 1984). Search activities normally take place in the neighbourhood of existing routines (Nelson and Winter, 1982). Analogously, the RBV acknowledges that factor markets are inelastic and incomplete (Barney, 1986a; Diedrickx and Cool, 1989); therefore, managers cannot freely manipulate the resource base of the firm, which limits the scope of organizational change and provides a base for sustainable rents.

Second, initial conditions also provide the cognitive setting for managerial decisions. The history of the firm influences how managers define problems and subjectively interpret objective situations (Campbell, 1997). Consequently, the effects of the starting position of the firm can not only be expected to remain stable for some time, but also to be systematically linked to processes of organizational change.

Such links may provide the setting for a number of interesting research questions, which may explore the effects of different organizational and environmental characteristics on the evolution of firm profitability.

In the context of this study, we are able to control for initial performance of firms, which can be taken as a synthetic measure of a number of different factors influencing profitability; by no means can we identify every potential source of inter-firm differentials in initial conditions. Further heterogeneity in subsequent profit dynamics can be attributed to either unobserved initial heterogeneity (substantially different firms can exhibit nearly the same profit levels, thus being treated as similar in our model) or to different discretional decisions adopted by managers. These two explanations cannot be disentangled, nor can they be quantified; we will not claim to do so in our empirical analysis. We can suggest instead that larger inter-firm differentials in profit trends may point to a more significant role of managerial discretionary decisions aiming at improving performance; this is a rather safer, and we believe more sensible, qualitative assertion, which is based on the assumption that discretional choice and emergent heterogeneity are positive related.

5.2.1 Testing the hypothesis of convergence in profit rates

We have already made clear in section 4 above that existing literature on the dynamics of firm performance has analyzed the rate of converge/persistence in inter-firm profit differentials. Relying on equilibrium-based approaches, they treat superior returns as abnormal profitability, studying how long does it take for profit rates to return to equilibrium levels (and what they levels are). There is also appealing empirical evidence on profits converging significantly, if such convergence takes place at different rates across firms and industries and may not be complete.

Provided such evidence, and aiming at casting some more light on this debate, we incorporate this convergence hypothesis in our model. Nevertheless, we approach it from a substantially different perspective. We do not assume any long-term equilibrium that is to be reached, neither treat inter-firm differentials as abnormal returns. Doing so would be against our line of reasoning thus far. Instead, we treat converging profits as a particular case of a more general phenomenon: path dependency (at least partial) in processes of firm evolution (Magnusson and Ottoson, 1997). We have established above that past conditions of the firm do influence its future development, so that systematic relationships between initial conditions and change processes are likely to be observed. Profit convergence is nothing but one such relationship. Approaching the question from this perspective allows moving beyond mere ‘convergence’, and may stimulate further research on how business returns are likely to evolve, conditioned by any other initial characteristics of firms.

It has been argued that businesses performing well at some point will reinforce their current structural arrangements and routines, hindering organizational change (Hannan and Freeman, 1977; Boeker and Goodstein, 1991). On the other side, firms not reaching their satisfaction threshold will experience pressures to revise their decision rules. Unsatisfactory performance triggers search, organizational change and competitive reaction (Barnet and Hansen, 1996). Accordingly, firms with a less favourable starting position can be expected to show a more aggressive competitive behaviour (Miller and Chen, 1994; Usero, 2003). Whereas initially high-performing firms will experience, on average, stronger inertial forces (Hannan and Freeman, 1984; Henderson, 1993), companies with weaker initial statuses are more likely to engage in new strategic moves in order to disrupt competitive arrangements that are unfavourable to them.

Although there is some debate on the performance implications of organizational change, whereas it is adaptive or maladaptive (e.g. Greve, 1999), search and new strategic initiatives are likely to result into learning, which in turn strengthens the organization's competitive position (Barnett and Hansen, 1996). Furthermore, research on competitive dynamics supports a positive effect of competitive aggressiveness on firm performance (Young et al., 1996; Ferrier, 2001). Empirical evidence shows a positive association between the willingness of firms to engage in new strategic moves and performance levels; we develop this hypothesis in chapter 3 below.

The argument runs as follows: strong initial status reinforces organizational inertia, and creates inability of firms to adapt to environmental change and respond to new competitive challenges. Meanwhile, ill-performing firms engage in a number of strategic initiatives in order to catch up with stronger competitors; on average, such initiatives are likely to give rise to organizational learning and improve performance. As a consequence, it can be expected a negative relationship between a firm's initial profitability and its dynamic evolution, yielding a convergence effect through which low-performers at some point in time will tend to catch up (on average) with their competitors.

There is one last worth-mentioning difference between our approach and traditional arguments on profit convergence from neoclassical microeconomics. Equilibrium-based theories, as we have already mentioned, tend to ignore how profit differentials are created; economic rents are treated as abnormal returns that are eroded by competitive pressures. Meanwhile, we explicitly acknowledge that, along with such erosion processes, new sources of heterogeneity are continuously created, so that no equilibrium is ever to be reached. This implies that, even under strong competitive pressures, successful firms may show persistent profitability if they are able to continuously renew their sources of advantage as competition renders previous ones obsolete (Volberda, 1996; Roberts, 1999; Veliyath and Fitzgerald, 2000; Fiol, 2001). From this perspective, and unlike in equilibrium analysis, any propositions suggesting convergence in profit rates should take into consideration arguments on how past performance influences the competitive behaviour of firms, as well as their ability to create new advantages.

5.3. Short-term shocks to profitability and deviations from long-run dynamic paths

Following Nelson and Winter's (1982) argument on the nature of evolutionary theories, we have constrained ourselves to systematic process of long-term evolution. However, at any point the actual results of a company cannot be perfectly explained in terms of such long-term trends, however they are defined. There can also be a number of year-specific factors inducing deviations from the evolutionary path followed by the organization; these are somehow analogous to the incremental components of profitability induced by short-term, non-systematic, shocks (McGahan and Porter, 1999, 2003). In statistical terms, it can be considered that, whereas systematic effects drive the expected probability distribution of firm performance at some given time, actual profits will be determined as random draws from such distribution, resulting from largely unexpected short-term shocks to profitability. We will also need to consider the effect of such shocks in our empirical model.

6. RESEARCH METHODS

6.1. Data and sample

We tested the evolutionary model presented in the previous section on a sample of Spanish manufacturing firms. Data are obtained from the *Survey on Business Strategies,* an annual rotating panel survey conducted by *Fundación SEPI*, a Spanish publicly-owned foundation.

The survey collects a wide range of data on an average of approximately 1,700 manufacturing companies per year, classified in twenty different industries. The sampling frame includes companies with 10 or more employees; micro-firms are thus not sampled. Two different techniques are combined to build the sample; complete enumeration is used for firms over 200 employees and stratified random sampling for firms between 10 and 200 employees. Average response rate is slightly over 90%[12].

An unbalanced panel covering the 1991-2002 period was used for the analysis; thus, we have a maximum of 11 years of data for each firm. In order to obtain meaningful firm-specific dynamic trends, and to keep enough degrees of freedom, companies with four or less observations were removed from the sample. Additionally, some extreme outliers were identified and analysed; in most cases, they appeared to be originated by measurement error (e.g. firm data total assets were abnormally high or low compared to previous and subsequent years for the same firm, with no apparent explanation for the

[12] It is worth noting, however, that once a firm has failed to provide information in any given year, it is removed from the panel in subsequent periods. Response rates, therefore, are calculated considering only firms which replied in previous years, as well as new entries to the sample. The response rate provided must be interpreted accordingly.

difference), and were also removed from the sample. The final data set comprised 17,282 observations for a total of 1,868 firms. The average number of years per firm, thus, is 9.25.

A potential problem of panel data that is seldom considered in longitudinal studies of firm profitability is the potential bias arising from non-random attrition (Hsiao, 2003). In this research setting, if lower performance is systematically linked to firm failure, as it seems reasonable to assume, attrition is likely to affect mainly those companies with weaker initial status; only those among them that managed to significantly improve performance would remain in the sample. This may induce a spurious relationship misleadingly suggesting convergence in profit rates.

Although unbalanced panel designs may reduce the impact of selection bias, further tests were conducted following Fitzgerald et al. (1998) and Hausman and Wise (1979) to assure validity of conclusions. Results from the analysis suggest that lower firm profits in t-1 significantly increase probability of attrition in t. However, the effect is relatively small and only account for a negligible portion of variability in attrition (Nagelkerke R^2 = 0.003). Moreover, company results at t = 0 do not seem to be significantly related neither to the overall probability of attrition before 2002, nor to the number of years a firm remains in the sample. Overall, these analyses suggest attrition is not likely to affect validity of results.

6.1.1. Measuring firm performance

An accounting measure of firm return on assets (ROA) is used as dependent variable in this study. More concretely, it is defined as EBITDA / Average Total Assets[13,14]. This measure yields two advantages over more traditional ratios of return on assets. First, EBITDA excludes financial results, and it is thus fully neutral to the financial structure of the firm; second, it only includes operating profits, not considering extraordinary, and consequently year-specific, results. Therefore, it is more coherent with the definition of competitive advantage as the firm '*systematically* creating above average returns' (Schoemaker, 1990: 1179, emphasis added).

The focus in this study is on the firm-specific component of business performance, as a function of the competitive position of the firm. Consequently, profitability measures are normalized relative to their industry averages and standard deviations[15]:

$$\text{Perf}_{(i,j,t)} = [\text{ROA}_{i,j,t} - \text{Avg}(\text{ROA})_{j,t}] \,/\, \text{Stdev}\,(\text{ROA})_{j,t}$$

where the subindexes i,j,t account for firm, industry, and year, respectively. Unlike in most previous research, the performance measure used in this study accounts for industry differences, not only in average returns, but also on the relative dispersion of such returns across firms.

Accounting measures of performance have the distinctive advantage, when analyzing profit dynamics, of being based on the firm's current activity and not incorporating market expectations on future performance (Dubofsky and Varadarajan, 1987).

13 The Survey on Business Strategies does not provide information on the whole Profit / Loss Statements. However, a measure of earning before interests, taxes and depreciation of assets (EBITDA) can be obtained by subtracting operating expenses from total revenue.

14 Average total assets (ATA) were estimated as follows: $(TA_{i,t} + TA_{i,t-1}) / 2$, where $TA_{i,t}$ represents the reported assets of firm i at the end of year t. In order to maximize sample size, observations for first year were included in the sample, considering $ATA_{(i,1)} = TA_{(i,1)}$. This implies assuming that firm assets in the first year equal those of the last pre-sample period. This assumption seems reasonable and is unlike to affect results significantly, as the time series of firm assets showed to be highly correlated over time.

15 Industries were defined according to the classification provided by the Survey on Business Strategies, which is roughly equivalent to the two-digit NACE Rev. 1 system.

However, two potential shortcomings of accounting data must be considered. First, as book values are based on historical information, they can be influenced by the age of assets; secondly, accounting data do not consider inter-firm differences in risk-taking strategies. Higher profits may not be the result of better competitive positions, but simply the reward to higher risks taken by the organization. Overall, accounting data may misrepresent firm's true performance.

In order to test for potential biases arising from these two spurious effects, the performance measure defined above was regressed on the weighted average age[16] of the firm's assets and the average cost of the firm bank debt (as a proxy for financial risk). Results showed that both variables had a very limited impact on firm accounting profitability; the R-squared for the multivariate regression was as low as 0.002.

6.2. The empirical model of profit dynamics: a multilevel growth curve

We discussed in section 4 the limitations of autoregressive models commonly used in the literature in order to accomplish the objectives of this research. We next present an alternative methodological approach for operationalizing the model we have presented thus far. It is based on the application of multilevel[17] growth curves to the analysis of firm performance. This kind of models is common to the study of evolutionary processes in a number of fields, from biometrics to educational research. In management, an analogous model was proposed by Deadrick and her colleagues to examine the dynamics of individual performance within an organization (Deadrick et

[16] In order to account for biases arising from assets being accounted for at historical values, not only the physical age of assets was considered, but also when were their book values last actualized. Thus, we calculated age as the minimum of the average physical age of the firm's assets and the years elapsed since book values were last actualized.

[17] Multilevel models are also known as mixed-effects models or hierarchical linear models (HLM).

al., 1997)[18]. In its simplest form, the model runs as follows:

$$y_{it} = \alpha_i + \lambda_i t + \varepsilon_{it} \qquad (2)$$

$$\alpha_i = \alpha + u_{0i} \qquad u_{0i} \sim N(0,\sigma^2_{0i}) \qquad (2.a)$$

$$\lambda_i t = \lambda + u_{1i} \qquad u_{1i} \sim N(0,\sigma^2_{1i}) \qquad (2.b)$$

Where t accounts for periods, t = 0 corresponding to the first observation for each firm. Individual coefficients α_i and λ_i are obtained by random effects estimation; this technique allows obtaining firm-specific effects even with a limited number of observations per firm (Snijders and Bosker, 1999). It requires the extra assumption that individual effects are identically distributed, so that they are obtained as random draws from a common empirical distribution (equations 2.a and 2.b). This assumption holds when some empirical regularities can be expected across units (i.e. firms) in the factors governing effects in the model, as it certainly is the case here. Random effects for each group are thus based on specific information on units within that group, but also partially on information from the whole sample (leading to estimates that are somehow 'shrunken' towards the sample mean), therefore requiring fewer observations per unit[19] (Goldstein, 2003).

Equation 2 yields estimates for unit-specific intercepts, α_i , which can be interpreted as the firm's initial conditions[20], because it represents the estimated performance when t = 0; slope coefficients λ_i, in turn, correspond to the average yearly rate of change in economic returns for each firm, that is, its performance trend (Deadrick et al., 1997).

[18] The Journal of Management devoted a special issue in 1997 to the applications of hierarchical linear models to management research.

[19] Random effects estimation also requires assuming that unobserved individual effects and regressors are independent. This limits the use of this approach in dynamic panel data models (see, however, Rahiala, 1999), as the lagged dependent variable is by definition correlated with unit-specific effects, but should not pose any problems in this setting, in which time is used as the only covariate.

20 We remind that that the term 'initial conditions' does not need to refer to the time of founding (see note 1 above) the first observation.

They are proxies for the relative success of goal-seeking search activities of the firm. In other terms, they measure the effects of organizational change on profitability (or, more precisely, of the joint co-evolution of the organization and its environment). This is analogous to the use by Adner and Helfat (2003) of time-varying corporate effects as evidence of dynamic managerial capabilities.

The major interest in this study is not primarily on the average values of the coefficients, but on how they differ among firms, as the objective is explaining heterogeneous performance. More precisely, the variance terms σ^2_{0i} and σ^2_{1i} provide information on the inter-firm variability in the starting position and how they have evolved over time. Furthermore, the estimated intercept-slope covariance, cov (σ^2_{0i}, σ^2_{1i}) can be used to test hypotheses on the convergence of firm profitability.

Whereas intercept-slope covariance may prove the direction and significance of the relationship between initial conditions and dynamic evolution, it does not provide any information on the size of such relationship. Consequently, it does not allow researchers to study the rate of convergence in firm profitability; in this sense, eq. 2 compares disadvantageously with the fully autoregressive model presented in eq. 1.

An alternative comes from the fact that random effects (u_{0i}, u_{1i}) can be treated as latent variables, and thus explained in terms of other latent or observed variables (Skrondal and Rabe-Hesketh, 2004) . Equation 2 can be extended with a supplementary equation in which firm-specific time slopes are modelled as a function of firm intercepts, as a proxy for initial conditions:

$$u_{1i} = \alpha_1 + \beta_1(u_{0i}) + \varepsilon_i \qquad (3)$$

Equation 3 models the relationship between where firms start (u_{0i}), and how they evolve over time (u_{1i}) (Choi and Seltzer, 2005; Seltzer et al., 2002). The slope coefficient β_1 provides an estimate of the rate of convergence (or divergence) in firm returns. For any $\beta_1<0$, the absolute value of β_1 can be interpreted as the percentage of the initial differences in performance, on average, that is eroded every year. A remarkable feature of equation 3 is that the explanatory variable, u_{0i}, is not the actual profitability of firms at the time of the first observation, but the value estimated from equation 2. This value includes only the part of initial returns which is consistent with the organization's fitted dynamic path, and excludes year-specific effects on profitability.

Three consequences stem from this fact. First, the empirical approach is fully coherent with the evolutionary model proposed above, which distinguishes between systematic (i.e. long-term) and short-term dynamic effects on profitability; secondly, this measure of initial conditions is a better representation of the starting competitive (dis)advantage of the firm, understood as its ability to consistently achieve superior performance (Schuemaker, 1990); lastly, as all observations are considered for estimating a firm's starting competitive position, the model becomes much more robust to alternative choices of initial period, a concern that autoregressive models needed to address explicitly (Mueller, 1986).

A potential problem in model 2 is that, while it represents the long-term trend of a firm's profits, deviations from such trend, which can be interpreted as short-term shocks to profitability, are likely to endure for longer than one year. Therefore, the independence assumption for the error term is not likely to hold, probably leading to biased estimates (Wooldridge, 2006). In order to address this issue, eq. 2 can be extended to allow for the error term to follow a first-order AR(1) autoregressive process (Pinheiro and Bates, 2000). The autoregression coefficient is itself a parameter of interest in performance dynamics, accounting for the persistence of non-systematic effects. It might also be interesting studying potential heteroskedasticity of the error term across firms, as an inverse indicator of performance reliability (Grewal et al., 2004). It has to be noted, in this sense, that residuals in the empirical models account for much more than actual deviations from the firm 'true' evolutionary path. Measurement and specification errors, arising from the functional form in eq. (2) being a very rough representation of more complex dynamic processes are likely to account for a substantial share of residuals, which must be interpreted cautiously.

The empirical model presented in this section was run and tested by maximum likelihood estimation, using the *nlme* package of R (Pinheiro and Bates, 2000), an open-source statistical language and environment, based on S language. Such package provides a flexible setting for fitting multilevel models, and allows specifying different structures for the error term. However, it does not fit latent variable regressions in multilevel settings. In order to estimate eq. (3), thus, models were re-run in HLM statistical software (Raudenbush and Bryk, 2002).

7. RESULTS

In this section, we first present the results of a number of exploratory analyses conducted on raw performance data. We then test and discuss the empirical model presented in section 6 above, with separate attention to the latent variable regression specified in equation (3). Finally, the sample is divided according to the performance of firms at time = 0, in order to explore how forces driving the dynamics of firm profitability may differ across subsamples.

7.1. Exploratory analyses

Table 2.2 shows the correlation coefficients between values of the dependent variable, Perf(t), for different measurement occasions. Some relevant empirical regularities can be identified. Estimated correlations between Perf(t) and Perf(t+1) range between 0.33 and 0.496, with values decreasing steadily as the time lag increases up to five or six years. At this point, correlations stabilize at values ranging from 0.1 to 0.2.

These results suggest that profits, even if they seem to persist in the short term, are still remarkably unstable, so that firm performance at any given point in time has very little explanatory power as to performance five or more years later. Conclusions based on raw correlations, however, do not provide any information on empirical regularities in the processes of emergence and erosion of differential firm profitability. In order to do so, the sample was subdivided according to performance at the time of first observation. Then, the evolution of average profitability over time was traced back for both subgroups. This provides a first approximation to profit dynamics, distinguishing between originally high and low performers.

TABLE 2.2: Correlation of performance measures over time

Pearson correlation	Perf(0)	Perf(1)	Perf(2)	Perf(3)	Perf(4)	Perf(5)	Perf(6)	Perf(7)	Perf(8)	Perf(9)	Perf(10)	Perf(11)
Perf(0)	1											
Perf(1)	0.330	1.000										
Perf(2)	0.228	0.358	1.000									
Perf(3)	0.152	0.281	0.414	1.000								
Perf(4)	0.156	0.209	0.280	0.473	1.000							
Perf(5)	0.132	0.242	0.228	0.273	0.358	1.000						
Perf(6)	0.104	0.208	0.229	0.294	0.324	0.496	1.000					
Perf(7)	0.109	0.205	0.217	0.267	0.275	0.407	0.482	1.000				
Perf(8)	0.123	0.162	0.109	0.157	0.165	0.219	0.292	0.365	1.000			
Perf(9)	0.115	0.177	0.119	0.160	0.176	0.226	0.305	0.394	0.446	1.000		
Perf(10)	0.166	0.135	0.071	0.123	0.134	0.135	0.182	0.280	0.326	0.461	1.000	
Perf(11)	0.163	0.142	0.119	0.208	0.153	0.212	0.258	0.249	0.329	0.284	0.425	1.000

Results are presented graphically in figures 2.2.a and 2.2.b. The initial profit differential between both subsamples ascended to 1.27 (according to how the dependent variable Perf(t) was defined in section 5.1 above, this difference must be interpreted in terms of standard deviations from the industry average); it had diminished to 0.32 three years later, and to 0.20 in ten years (figure 2.2.a). Analogously, figure 2.2.b reports the probability of initially high performing firms to keep showing returns over their industry averages in the following years. Results show that higher performers had a good chance (over 60%) of obtaining above-average returns for the following two years, but this probability decreased to around 50% from then on.

Overall, the charts show a noticeable and fairly quick of convergence in profit rates. Nonetheless, the process is not complete, and some profit differential seems to remain in the long term. This observation is consistent with previous research on the topic (Ghemawat, 1991; Jacobsen, 1988). Additionally, it can be remarked that whereas convergence occurs for both high and low performance, it seems to be slightly more profound for initially higher performers. In other terms, competitive advantages seem to be somehow less persistent that competitive disadvantages.

FIGURE 2.2.a: Persistence of initial differences in profitability (I)

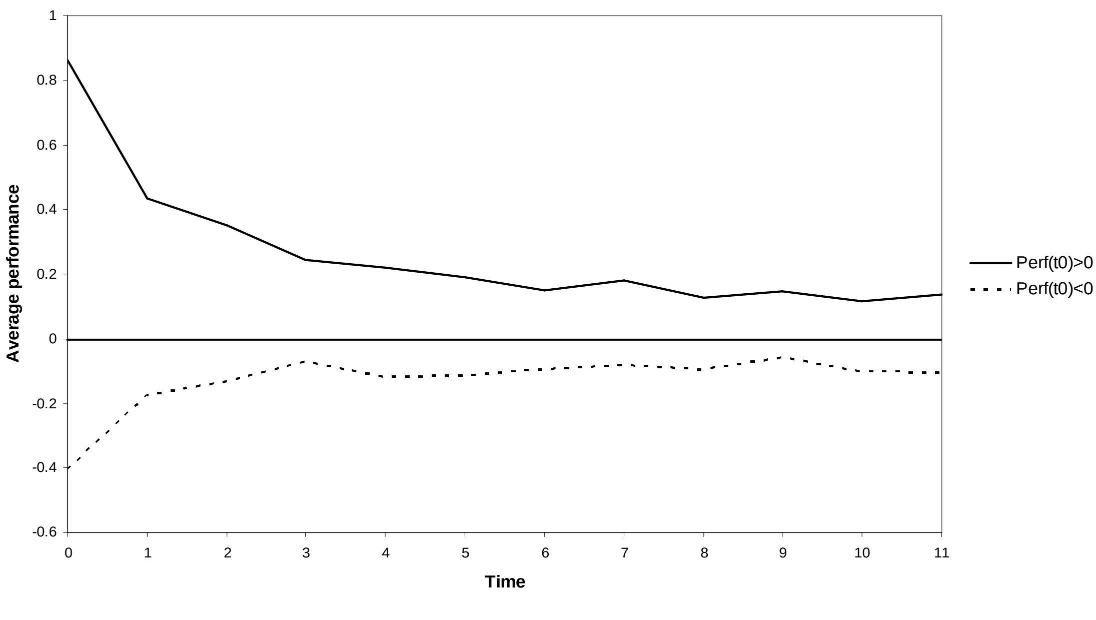
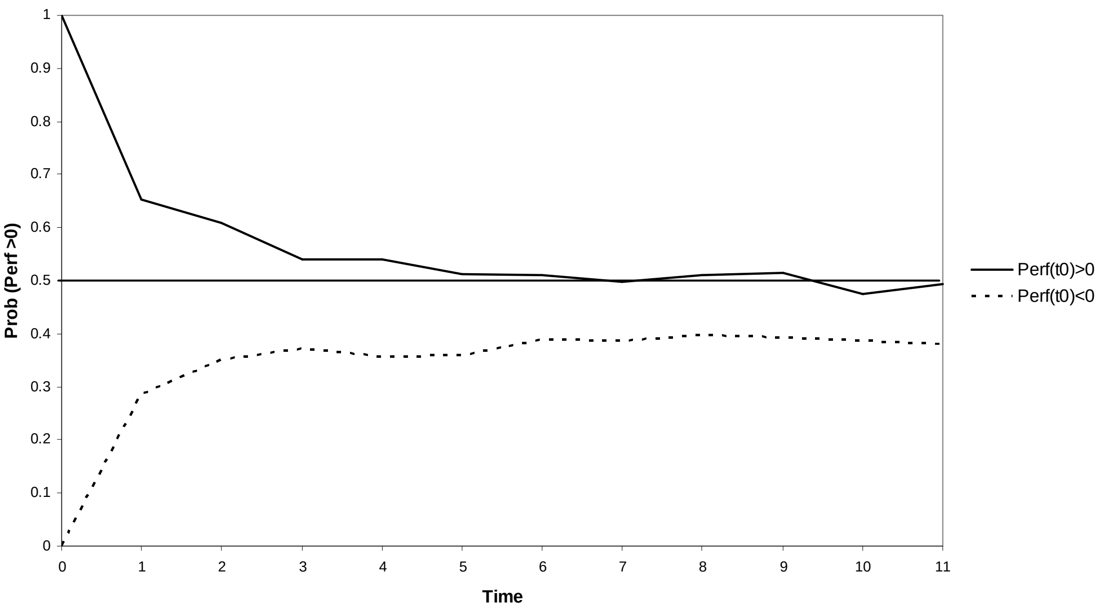


FIGURE 2.2.b: Persistence of initial differences in profitability (II)



Following McGahan and Porter (2003), the same analysis was conducted for subsamples divided on the basis of performance at the time of last observation in order to study the emergence of rent differentials. Figures 2.3.a and 2.3.b show results analogous to those of the sustainability analysis. Highly profitable firms have, on average, a history of high performance for the previous three to five years, but differences blur further in the past.

7.2. Empirical models on the dynamics of firm performance

Model in equations 2 to 2.b was fitted in order to explore the role of both heterogeneity in initial conditions (intercepts) and change processes (slopes). We are thus presenting results for the discussion on the main historical determinants of firm profitability, as developed in section 4.2 above. Different versions of the model are presented in table 2.3. The major interest in this work is not in the fixed effects (that is, the average intercept and time slope) as the performance measure is centred around 0 by design. Research question being not on average effects but on between-firm heterogeneity, focus is on the error structure in the random part of the model. It can be interpreted in terms of variance components, both static (time-invariant) and dynamic (time-varying), explaining heterogeneous firm performance.

FIGURE 2.3.a: Emergence of final differences in profitability (I)

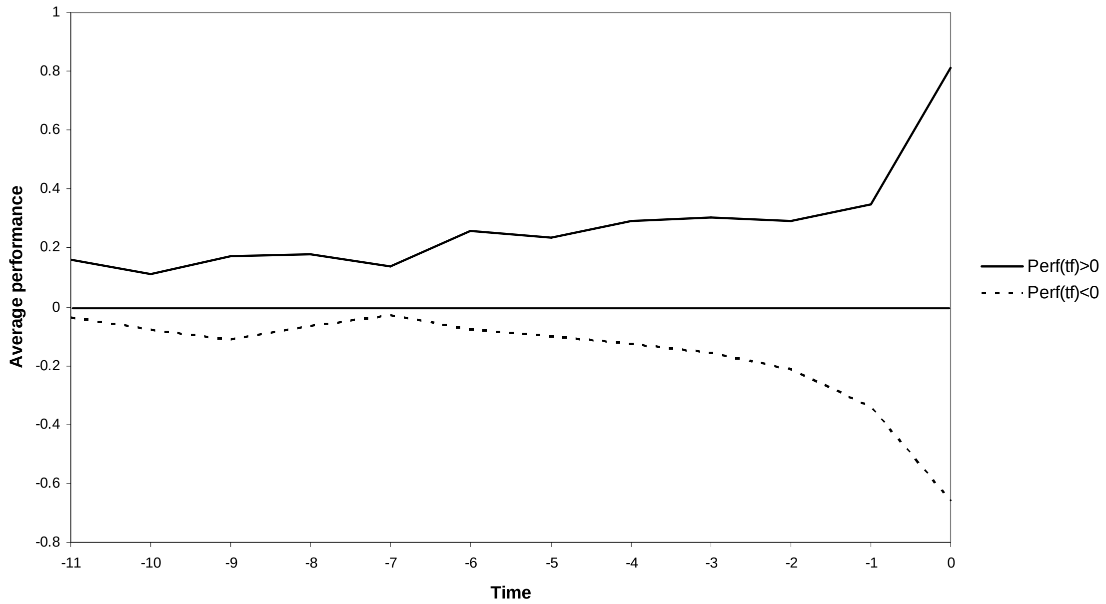
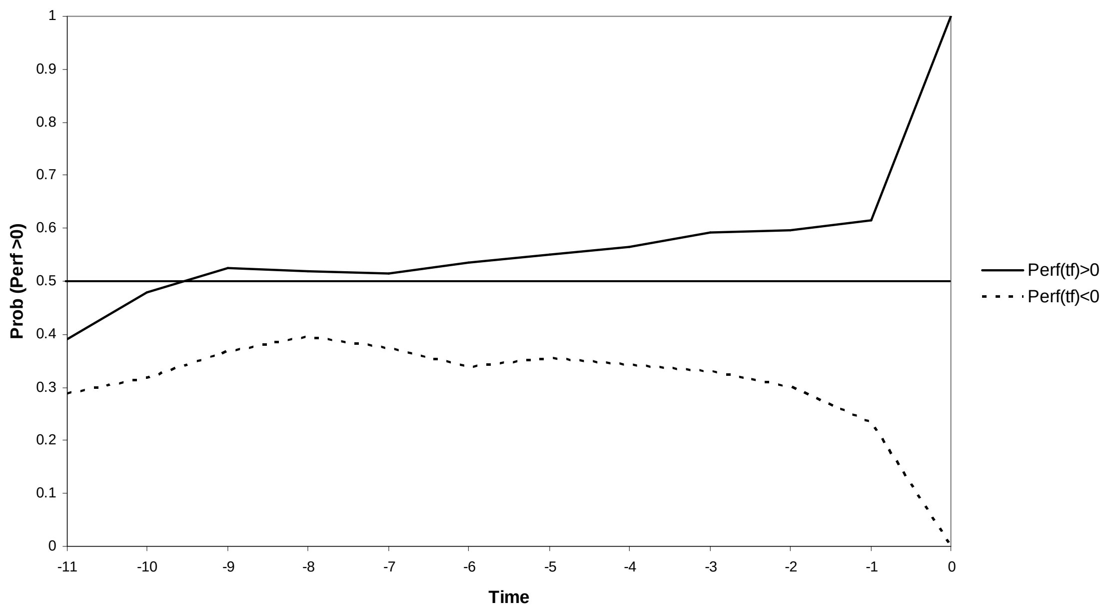


FIGURE 2.3.b: Emergence of final differences in profitability (II)



7.2.1. Persistence of initial conditions vs. heterogeneous profit dynamics

We will first concern ourselves with distinguishing between heterogeneity in initial conditions, represented by variance in firm-specific intercepts, and emergent heterogeneity, captured by inter-firm variation in time slopes. Studying and comparing both kinds of effects will provide useful insights into historical antecedents of current profitability, as presented graphically in figure 2.1 and discussed in section 5.1.

TABLE 2.3: Empirical models on the dynamics of firm performance

Fixed effects	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Intercept	0.0155 (0.0133)	0.0514 ** (0.016)	0.0562 ** (0.0171)	0.0533 ** (0.0169)	0.0563 **	-0.0236 (0.0187)
t (initial)		-0.0082 *** (0.002)	-0.0104 *** (0.0027)	-0.0093 *** (0.0027)	-0.0116	
t^2 (initial)					0.0002	
t (final)						-0.0084 ** (0.0026)
Error structure						
σ_{u0}	0.4988	0.499	0.5726	0.4529	0.53	0.5670
σ_{u1}			0.0732	0.0452	0.1884	0.0459
σ_{u2}					0.0161	
$corr_{u0u1}$			-0.497	-0.267	-0.435	0.716
$corr_{u0u2}$					0.314	
$corr_{u1u2}$					-0.957	
σ_e	0.8284	0.8279	0.7956	0.8430	0.809	0.8426
Phi (AR1)				0.2238	0.171	0.2234
Number of observations: 17282						
Number of groups (firms): 1868						

Column (1) shows the results of what multilevel literature refers to as 'empty model' (Goldstein, 2003) and is more generally known as one-way random effects ANOVA. The most remarkable finding comes from the intraclass correlation coefficient (ICC), which can be calculated as σ^2_{u0} / (σ^2_{u0} + σ^2_e) = 0.266. The ICC admits two complementary interpretations (Snijders and Bosker, 1999). First, it is the correlation between two randomly drawn observations in the same, randomly drawn, firm. Second, and perhaps more interestingly, it represents the proportion of total variance that is accounted for by the group (i.e. firm) level. This implies that nearly 27% of variance in business profits is explained by differences in average firm profitability, whereas 73% corresponds to intra-firm variability. In other terms, changes in performance within the firm across time account for almost three times more variance than permanent differences in average profitability between firms.

This 'empty model' is then extended by introducing time trends, representing rates of change in firm performance (columns 2 and 3). Finally, model (4) addresses issues concerning non-independent residuals, allowing the error term to follow a first-order autoregressive process. Likelihood ratio tests show these additions significantly improve fit of the model (see table 2.4).

TABLE 2.4: Model significance. Likelihood ratio tests

	Degrees of freedom	AIC	BIC	logLik.	Test	Likelihood Ratio
(1)	3	45241.51	45264.79	-22617.76		
(2)	4	45227.24	45258.27	-22609.62	1 vs. 2	16.2709 ***
(3)	6	44934.34	44980.89	-22461.17	2 vs. 3	296.8996 ***
(4)	7	44522.60	44576.90	-22254.30	3 vs. 4	413.7486 ***
(5)	11	44455.13	44540.46	-22216.57	4 vs. 5	75.4639 ***

P-values: *** < 0.001 ** < 0.01 * < 0.05 + < 0.1

Models (3) and (4) decompose profit dynamics in two elements according to the evolutionary model proposed above: first, the permanence of heterogeneous initial statuses (σ_{u0}), or persistent heterogeneity; second, differences in the firm-specific longitudinal processes (σ_{u1}), or emergent heterogeneity. Consequently, the ratio σ_{u0}/σ_{u1} provides key information regarding the evolutionary origins of competitive (dis)advantage. The larger the ratio, the greater the salience of initial conditions vs. change dynamics in determining differences in firm performance, and vice versa.

Estimated values for this ratio range from 7.8 (model 3) to 10 (model 4).

Let us, as a matter of illustration, consider the implications of results from model (3) for two hypothetical companies. Firm A has a fairly good starting position (+1 stdev, α_i = 0.63), but its performance weakens with time (-1 stdev, λ_i = -0.09), whereas firm B represents the opposite case (α_i = -0.5164, λ_i = 0.056). According to model estimates, expected profit differential would have diminished by 50% in less than four years, and firm B would outperform A in eight years on average; this time ascends to ten years when output from model 4, free from potential bias caused by non-independent residuals, is considered. From an evolutionary perspective these results suggest that heterogeneous organizational dynamics in the recent past are likely to be a key antecedent of differential performance, and may rapidly outbalance the effects of starting conditions.

7.2.2. Testing the 'convergence hypothesis': results from the latent variable regression.

It was argued above that, according to behaviouralist arguments as well as neoclassical theory, initial profit differentials can be expected to progressively disappear over time, so that firms with weaker initial conditions would tend to catch up, whereas observed competitive advantages would be eroded by the effects of competition. We test this hypothesis on profit erosion by fitting a model in which firm-specific slopes are regressed in firm-specific intercepts.

This interaction between initial (or persistent) and emergent heterogeneity can be observed by analyzing the variance-covariance matrix of the random effects, and more precisely the covariance or, alternatively, the correlation between the firm-specific intercepts ($\alpha+u_{0i}$) and slopes ($\lambda+u_{1i}$) in models (3) and (4).

Results show a negative and significant correlation of -0.27 (95% confidence intervals for the random effects are reported in table 2.5); this provides evidence supporting the convergence hypothesis. Companies with weaker initial competitive positions (lower u_{0i}) will, on average, exhibit better dynamic performance (u_{1i}), reducing the profitability gap with initially better-performing firms.

TABLE 2.5: 95% confidence intervals for linear random-coefficient model with AR(1) autoregressive residuals.

Fixed effects	**Lower**	**Estimate**	**Upper**
Intercept	0.0201	0.0533	0.0865
t0 (initial)	-0.0145	-0.0093	-0.004
Error structure			
σ_{u0}	0.4127	0.4529	0.4971
σ_{u1}	0.0364	0.0452	0.0562
$corr_{u0u1}$	-0.4328	-0.2671	-0.084
Phi (AR1)	0.2019	0.2238	0.2455

Linearity hypothesis assumed so far was relaxed in order to account for non-linear time trends by the inclusion of a cuadratic term t^2 in the model. Likelihood ratio tests (see table 2.4) also show a significant improvement in the fit of the model. Negative correlation between random effects for linear and quadratic terms suggests smoothing of convergence over time, which is fully consistent with preliminary evidence in Figures 2.a and 2.b. The quadratic model, however, obscures interpretability of results, as λ_i can no longer be interpreted in terms of average rate of profit change. Moreover, growth models have to consider carefully the possibility of overfitting (Byrne and Crombie, 2003), particularly the given limited number of observations per firm and the strong correlation between u_{1i} and u_{2i}, which is estimated to be -0.957. In subsequent analyses we will thus refer to the simpler, linear model.

Correlation data do not provide any information on the rate or speed of convergence processes. In order to address this issue, model (3) was modified in order to include the latent variable regression specified in equation (3) above. Results from the latent-variable models are presented in table 2.6. They confirm that systematic convergence in expected profitability occurs and is statistically significant. More interestingly, the size of the coefficient shows that the pace of convergence is also substantively important: on average, 6.35% of the initial systematic (i.e. long-run) differences in performance vanished every year. Considering that much of profit variability corresponds to short-lived deviation from long-term trends, the convergence rate of actual profits can be expected to be substantially higher.

Results also show that as much as 24.6% of variance in λ_i coefficients is explained by this latent variable regression. That is, different initial conditions account for a substantial fraction of inter-firm variation in the time trends of business performance.

TABLE 2.6: Latent variable regressions testing rates of convergence and emergence of profit differentials

Regression	Predictor	Est. Coefficient	Standard Error	T-Ratio	P-Value
Convergence	Intercept	-0.0069	0.0022	-3.085	0.003
	u_{0i} (inicial)	-0.0635	0.0051	-12.406	< 0.001
Divergence	Intercept	-0.0076	0.0019	-3.932	< 0.001
	u_{0i} (final)	0.0752	0.0036	20.757	< 0.001

Comparison of original and adjusted coefficients

Convergence analysis		**Emergence analysis**	
Original coefficient λ	-0.0104	Original coefficient λ	-0.0094
Adjusted coefficient λ	-0.0069	Adjusted coefficient λ	-0.0076
Difference	-0.0036	Difference	-0.0019
Standard error of difference	0.0035	Standard error of difference	0.0038
Original variance u_{1i}	0.00536	Original variance u_{1i}	0.00510
Adjusted variance u_{1i}	0.00404	Adjusted variance u_{1i}	0.00262
Reduction in variance u_{1i} (%)	24.6%	Reduction in variance u_{1i} (%)	48.6%

7.2.3. The dynamics of profit emergence and sustainability

A common feature of all models presented above is that they explore the effects of heterogeneous initial conditions; the intercept, that is, time = 0, was set for the first observation of the sample. We can slightly modify our empirical model, so that time = 0 is set for the last observation. No persistent effect of initial conditions is thus considered; well on the contrary, firm-specific intercepts now represent heterogeneity in final performance. This provides a useful approach to complete our analysis; unlike autoregressive models, our empirical approach is more flexible and does not need to be asymmetrical. This can provide further insights on how heterogeneity develops over time.

An interesting feature of the multilevel growth curve in eq. (2) is that centering of the time variable can be modified according to substantive research needs (Singer and Willet, 2003). The first observation for each firm was originally codified as time = 0, so that α_i corresponded to initial differences in performance and the growth model analyzed the persistence of such original heterogeneity. Alternatively, the zero-point can be attributed to the last observation. The model thus would estimate the process by which profit differentials observed at the end of the sample period arose, an essential issue that is too often overlooked in strategic management research (Cockburn et al., 2000).

Results are shown in column (6) of table 2.3, and are somehow symmetrical to those of the sustainability of firm profits. This is consistent with a view of market process as a matter of competitive interaction (Smith et al., 1992; Warren, 2002), in which the dynamics of firm profitability are determined by its co-evolution relative to its competitors (Barnett and Hansen, 1996): the emergence of new higher-performing firms parallels the erosion of previously existing profit differentials.

It is worth highlighting the high correlation between the firm final performance and its dynamic evolution over time (0.716). This finding, even if unsurprising (firms improving their performance over time will obviously tend to perform better in the future), provides further evidence on the importance of dynamic heterogeneity *vis a vis* initial conditions, particularly given the size of the coefficient. Profit differentials seem to arise mainly from recent success in performance-improving efforts, rather than from isolating mechanisms (Rumelt, 1984) protecting stronger initial status from the effects of competition.

The rate of emergence of new profit differential was also studied by means of the latent variable regression defined in equation 3. Consistently with previous analyses, the effect of firm-specific intercepts was found positive and significant. Comparison of coefficient sizes showed that emergence of final profit heterogeneity seems to occur at a slightly faster rate than convergence of initial differentials (7.52% vs. 6.35% per year).

7.2.4. Persistence of non-systematic shocks to profitability

It has already been argued that no dynamic model can provide a perfect account of the evolution of firm performance (see section 5.3); at best, it can constitute a sensible representation of the expected profitability distribution of a firm at a given time. Actual draws from such distribution will be to a great extent determined by period-specific events that take place in a non-systematic and greatly unexpected manner. They will take the form of deviations from the long-term profit trend for the firm, contributing to determine its actual performance.

This argument is analogous to the idea of abnormal shocks to profitability (McGahan and Porter, 1999, 2003). We have labelled them *non-systematic* shocks in order to highlight the fact that, unlike in previous literature, we do not model them as deviations from the firm average profitability, but from its estimated long-term (i.e. systematic) path, as defined in eq. (2). This does not imply that these shocks cannot persist from longer than one year, and studying their persistence becomes a topic of substantive interest itself.

Results from columns (4) in table 2.3 show that residuals from the model are significantly autocorrelated over time (for the 95% confidence intervals see table 2.5). The estimated autocorrelation coefficient, however, is rather low: 0.2238. This implies that only around 22% of the year-specific effects persist in the following year, and its endurance after two or three years is nearly negligible. This estimated value is remarkably lower than those in previous literature using the autoregressive model in equation (1) (see, for example, Cuaresma and Gschwandtner, 2006 for a review of some works using USA data).

This finding suggests that autoregressive approaches may have failed to capture long-term dynamics affecting firm performance, entangling abnormal shocks to profitability and systematic changes in firm average returns. This would explain higher persistence rates. When both effects are more accurately distinguished, however, firm-year effects seem to be rather short-lived.

This conclusion is confirmed by results from the polynomial model in column (5). As the fit of the model improves, residuals become more closely tied to actual shocks to profitability, and less to the inability of the model to represent the true performance path of the organization. It is symptomatic, thus, that the estimated autocorrelation coefficient for the better-fitting quadratic model is as low as 0.171

7.3. Are the dynamics of profit heterogeneity heterogeneous? Testing the models on different subsamples.

Previous research has found that the dynamics of firm profitability are not necessarily homogenous, and can vary across industries (e.g. Cubbin and Geroski, 1987; Waring, 1996) and firm subsamples. We are interested in extending our research in order to explore if the dynamic processes we have unveiled are general and common across firm subsamples, or if they differ on the basis of certain firm characteristics. Accordingly, we split the sample according to the initial performance of firms.

First, companies with positive firm-specific effects at the time of the first observation ($Perf_{t=0} > 0$) were separated from those with negative effects ($Perf_{t=0} < 0$). In other terms, profit dynamics of initially high and low performers were compared. Analogous analyses have been conducted in a number of ways in previous research on this topic (Jacobsen, 1988; McGahan and Porter, 2003; Yurtoglu, 2004).

Secondly, we subsampled firms which initial status was near average ($Perf_{t=0}$ within the interquartile range) separately from those with more extreme values for initial profitability. ($Perf_{t=0}$ out of the interquartile range). It has been suggested that there may exist a ‘band of inactivity’ leading to non-linearities in the dynamics of firm returns (Cuaresma and Gschwandtner, 2006). Small performance differentials would not trigger competitive forces leading to erosion of profits. Due to fixed costs of market entry or organizational change weaker competitors may not have strong enough incentives for competitive reaction. As a result, within these ‘inactivity bands’ the behaviour of the time series may be substantially different from the whole sample (Taylor, 2001).

TABLE 2.7: Analysis of subsamples

Fixed effects	**(1)** **$Perf_{t=0}$ = IQ**	**(2)** **$Perf_{t=0}$ = NOIQ**	**(3)** **$Perf_{t=0}$ > 0**	**(4)** **$Perf_{t=0}$ < 0**
Intercept	-0.0463 **	0.1612 ***	0.5549 ***	-0.2232 ***
t (initial)	-0.0004	-0.0212 ***	-0.0596 ***	0.0166 ***
Error structure				
σ_{u0}	0.2242	0.7662	0.6138	0.2785
σ_{u1}	0.0546	0.0905	0.0744	0.06
$corr_{u0u1}$	0.293	-0.649	-0.53	0.16
σ_e	0.6732	0.9122	0.9324	0.7077
Num. observations	9072	8210	6114	11168
Num. firms	934	934	675	1193

P-values: *** < 0.001 ** < 0.01 * < 0.05 + < 0.1

Evidence in table 2.7 supports arguments above. Within the interquartile range, correlation between firm-specific initial conditions and rate of change becomes positive (0.293), suggesting not only the absence of profit convergence, but also some divergence. These results can be explained in terms of organizational behaviour as firms in this subsample may experience similar levels of 'satisfaction', so that their incentives to engage in goal-seeking search routines are similar. Furthermore, under allegedly similar behavioural patterns, those firms with stronger resource base would exhibit a better dynamic as well as static performance. Indeed, their observed higher profitability at t=0 may result from more successful learning processes in the pre-sample period, which effects would continue to span over the sampled years.

Reversely, the intercept-slope correlation becomes strongly negative (-0.649) for firms with initial returns out of the interquartile range. As some authors have argued before, there seems to exist a trade-off between static and dynamic efficiency (Ghemawat, and Ricart i Costa, 1993). Optimizing current performance requires maximizing fit between the organization and its current environment, which, in turn, makes the firm more vulnerable to environmental changes. The paradox is that the core competencies of a firm may also be its core rigidities (Leonard-Barton, 1992). In analogous terms, literature on organizational learning acknowledges that exploration of new strategic alternatives requires detracting resources from the firm current operations (March, 1991). Empirical evidence in this study is consistent with the existence of this trade-off: the static best seems to come at the expense of the dynamic good.

Results also show that the correlation between initial status and rate the of profitability change is positive when only low-performing firms are considered. Companies exhibiting very poor initial profitability appear to be locked in their unfavourable competitive positions and show weak dynamic performance (Villalonga, 2004). Whereas they do have strong incentives for engaging in profit-enhancing efforts, they may also lack the capabilities necessary to overcome their disadvantageous position.

8. CONCLUSIONS, LIMITATIONS, AND SUGGESTIONS FOR FURTHER RESEARCH.

In this chapter, we have adopted a dynamic perspective in order to explain inter-firm differences in performance in longitudinal terms. We have presented two major arguments explaining how superior returns may be originated and sustained. Firstly, the effects of a more favourable bundle of resources or market structure at some point in the past can span over time and yield persistent profitability if some conditions are met (Kim and Park, 2006). Some such conditions (structural inertia, non-replicable resources, and mobility barriers, among others) are well established in the management literature. Secondly, firms engage in profit-seeking initiatives aiming at improving their performance. Successful managerial choice and organizational learning processes may significantly improve performance relative to competitors. We have labelled these two factors as initial (i.e. persistent) and dynamic (i.e. emergent) heterogeneity, respectively.

We argue that the two sources of heterogeneity above are not properly disentangled, neither by the largely dominant cross-sectional research on the topic, nor by previous literature on the persistence of abnormal profitability. In order to address this issue, we define and test an evolutionary model in which firm performance is explained in terms of a combination of heterogeneous initial conditions (represented by the firm past profitability) and more or less successful change processes undertaken by the organization (determining the rate of change in firm returns). An essential feature of our model is that, while accepting the enduring effect of the firm's past, it also acknowledges the role of managerial discretional choice in altering the course of the firm's history and shaping its future performance.

Additionally, drawing mainly from behaviouralist arguments, both *persistent* and *emergent* effects on profitability are assumed to interact, so that firm dynamics are partially path dependent. More concretely, we formulate a hypothesis suggesting a process of convergence in firm returns.

Most empirical research on the dynamics of profitability is based on autoregressive panel models. We, however, find such models to be inadequate for testing the different effects defined in our theoretical model. We define an alternative methodology by extending standard multilevel growth models in order to define a latent variable regression accounting for the relationship between initial conditions and dynamic evolution (Seltzer et al., 2002). We apply this model to a panel of 1,878 Spanish manufacturing firms, spanning from 1991 to 2002, and econometric analyses revealed a number of relevant empirical regularities regarding the processes of creating and sustaining superior returns:

a) Relative over or under-average rents are rather unstable phenomena, so that firm returns at any time seem to be quite a poor predictor of returns for the same company five or more years later.

b) Inter-firm variability in return rates can be meaningfully decomposed into three components: a time-invariant effect, relating to the persistence of heterogeneous initial status, an average yearly rate of profit change, and a year-specific component. The first two represent systematic long-term processes influencing performance, and correspond to decomposition suggested in our model for analysis; they explain around 30-40 % of inter-firm variance. Year-specific effects correspond to short-term shocks to profitability generating deviation from the systematic path followed by the organization.

c) When the relative effects of *persistent* (i.e. initial) and *emergent heterogeneity* are compared, it becomes apparent that there is substantial room for firms to engage in learning processes and influence their performance. Firms differ significantly not only in their profitability levels, but also in their profitability trends; companies showing weak initial conditions could rapidly achieve stronger competitive positions if they are successful in their profit-improving initiatives. Our results suggest that a proper understanding of antecedents of superior profitability requires in most cases referring to a successful strategic orientation in the recent past of the organization (Slater et al., 2006), rather than to unique conditions holding at the time of founding, or any remote time in the past of the firm.

d) Consistently with previous findings, a significant process of convergence in business returns is observed. Unlike existing literature, our proposed empirical model allows de-averaging such a convergence process into two components. Deviations from the estimated long-term path for the organization (i.e. shocks to profitability) were hardly persistent, so that a negligible effect remained after two or three years. On the other hand, long-term paths also show some convergence in expected returns, even if this process is rather slower, with some profit differentials remaining for over a decade. These results suggest that previous empirical research may have confounded these two effects, which respond to different evolutionary rationales, when merely studying convergence towards firm mean returns.

e) We also tested our model considering, not the persistent effect of initial profit differentials, but only how final heterogeneity emerges. Our findings are basically analogous. Empirical evidence, however, suggests that the processes are not fully symmetrical, and that originating new competitive advantages (i.e. emergence of profit differentials) may be somehow faster than the erosion of existing ones (i.e. convergence of initial heterogeneity). A plausible explanation comes from the Schumpeterian depiction of the competitive process (Schumpeter, 1942). Whereas new competitive advantages may arise from successful innovation in just one focus firm, significant erosion is driven by the adoption of the innovation by a large enough number of competitors, a process that would normally develop progressively and require some time to complete (Brower, 2000).

A word of caution is needed when interpreting our results and drawing our conclusions; we have argued that our analysis is somehow analogous to more traditional decompositions of profit variance. We define a linear dynamic model and study how different effects in the model, as well as its residuals, vary across firms. Whereas we sensibly interpret that actual shocks to profitability generate deviations from estimated trends, it cannot be sustained that model residuals cannot be assumed to derive only from such shocks, but also from less-than-perfect modelling of systematic trends. Additionally, actual inter-firm heterogeneity in initial conditions goes much beyond differences in starting profitability. It is perfectly legitimate arguing that two companies with similar initial performance may still have very different resource bundles. Diverging performance paths may thus arise, not only from true emergent heterogeneity reflecting different managerial choice and organizational learning processes, but also from the different ways initial firm resources fit environmental change.

Observed evolutionary patterns cannot be *always*, for each and every firm, attributed to the effects we are suggesting this study. Observing a firm significantly improves performance over time does not necessarily imply successful learning processes and managerial choices; well on the contrary, it may well be that environmental change favours its initial bundles of resources, without calling for further action. Fortunately, drawing inferential conclusions as those above does not require assuming such thing. Two much weaker and plausible assumptions will suffice: first, firms share more organizational resources and characteristics, *on average*, with those competitors attaining more similar return levels; consequently, their dynamic behaviour will tend to be also more similar unless further elements of heterogeneity. Second, better dynamic performance (i.e. profit improvements) is be associated, *on average*, and regardless the effects of initial conditions, with more successful processes of organizational search and change; thus, heterogeneity in profitability trend can be attributed, if at least partially, to differences in such processes. The interpretation we provide above for our empirical findings will hold provided these two assumptions are fulfilled.

Arguments and evidence cast in this study can provide motivation for further research on the origins and dynamics of superior performance. Firm above and under-average profits are shown to be rather unstable phenomena. Moreover, they are subject to intense evolutionary processes showing empirical regularities that are susceptible to systematic analysis. No only the *what*, but also the *how* of competitive advantage and firm success provides grounds to formulating interesting research questions (Levitas and Chi, 2002), that cannot be fulfilled by cross-sectional research designs. The evolutionary model proposed here can constitute a useful framework for approaching such questions.

Some relevant insights can also be extracted for practitioners. Empirical results are consistent in showing that firms differ no only in their profitability levels, but also, and perhaps more importantly, in their profitability trends. Whereas in some cases advantageous positions may be protected from competitive erosion through isolating mechanisms, there seems to be substantial room for weaker competitors to catch up through better time-varying effects. Managers should not just rely on sustaining initial advantages; persistent profitability seems to require also a good dynamic performance. In other terms, it demands renewing the sources of advantage (or creating new ones) by means of continuous innovation and a succession of competitive moves (D'Aveni, 1995). This conclusion is consistent with arguments from the Schumpeterian model of competition (Roberts, 1999, 2001), the 'Austrian school' of strategy (Jacobson, 1992), the competitive dynamics approach and the so-called 'hypercompetitive paradigm' (D'Aveni, 1994).

Nevertheless, careful interpretation is needed not to overstate the ability of this work to generate normative implications. The evolutionary patterns of firm performance provide useful but limited information on causal relationships driving superior returns. The model is neutral as to what firm and market-based factors ultimately underlie profit differentials. The explanatory power of no independent variables (other than past performance) is considered. As a consequence, conclusions above come from a reasonable and consistent interpretation of empirical findings, but should be taken cautiously, as they haven't been subject to explicit empirical testing.

It is worth remembering that this work addresses the dynamic, but not the static, dimension of strategy; the *how*, but not the *what* of heterogeneous performance. This is a relevant limitation, as both problems are correlative links in the same causality chain. In that sense, this is a one-dimensional approach to a two-dimensional problem; as we have argued, our interest lied in providing a useful approach to the by far less-understood side of the question.

Further research may build on this work in order to construct integrative frameworks combining static and longitudinal relationships. The empirical model proposed here may provide a useful starting point. Whereas most strategy research has simply modelled the consequences of certain variables on profitability rates, our framework allows testing their effects on the various dynamic components in which such rates are decomposed: permanent effects, change trends, pace of convergence and short-term shocks (deviations from trends). Research efforts in this line can improve our understanding of the causes and origins of competitive advantage and superior business performance. Some such efforts are undertaken and presented in the following chapter.

CHAPTER 3. RESOURCE-BASED AND AUSTRIAN PERSPECTIVES ON COMPETITIVE ADVANTAGE AND FIRM PERFORMANCE: TOWARDS AN INTEGRATIVE APPROACH

1. INTRODUCTION

The field of strategic management has observed in recent years the rise of academic debate around the very concept of 'sustainable competitive advantage' (or, to be more precise, around the idea that competitive advantages can be sustained in the long term). A number of scholars (e.g. D'Aveni, 1994, 1995; Bettis and Hitt, 1995; Fiol, 2001) have argued that environmental change and intense competitive pressures may result in rapid erosion of competitive positions (see, for example, contributions to the edited book by Ilinitch et al., 1998). Under such conditions, sustainable advantages can hardly be achieved; if firms are to attain long-term competitiveness, they need to focus on continuously renewing their sources of advantage, rather than in trying to protect them from the effects of competition (Wiggins and Ruefli, 2005 find empirical evidence in this sense). This statement has profound implications for strategy research, and most saliently for those works that explicitly address the causes of firm superior performance.

The resource-based view of the firm (RBV) offers a number of well-developed arguments linking certain firm resources and capabilities to sustainable competitive advantage. Such arguments certainly provide the most widely accepted academic view on inter-firm differences in performance: some firms consistently outperform others in the long run because they enjoy superior endowments of resources. By disputing the concept of sustainable advantage, new research streams are also challenging this view; their focus is no longer on the resources that firms own, but on the dynamic competitive behaviour they develop. That is, on their ability to continuously find and exploit market opportunities in order to create new advantages; this line of reasoning is closely tied to theoretical antecedents from the Austrian school of economics. We will thus refer to an 'Austrian perspective' (Jacobson, 1992) on competitive advantage that is challenging basic arguments from resource-based views on the topic.

Any discussion on the causal antecedents of competitive advantage should start by acknowledging two basic findings repeatedly confirmed by seminal empirical studies on firm performance. First, profitability consistently varies across firms; second, most such variability takes place within, rather than across, industries (Rumelt, 1991). Accordingly, research on heterogeneous business performance, which had long relied on IO microeconomics, was in need of alternative explanations articulated around firm-level variables. The resource-based view of the firm came to provide the first comprehensive and self-contained theoretical framework for addressing this need. According to resource-based theorists, companies are heterogeneous in terms of their bundles of resources; moreover, some such resources, provided they satisfy certain conditions, can yield sustainable competitive advantage to the firm, resulting in persistent superior performance.

The RBV has arguably become the dominant paradigm in strategic management research, as well as the canonical view for studying sources of competitive advantage. It has not been free from criticisms, though (e.g. Foss et al. 1995; Priem and Butler, 2001; Bromiley and Fleming, 2002). Indeed, a number of scholars have questioned the very concept of sustainable advantage. They claim that in today's "hypercompetitive" environments (D'Aveni, 1994, 1995), penetrable industry barriers, rapid innovation and constant change quickly render obsolete any competitive advantage. Under such conditions, firms can only attain long-term competitiveness by stringing together a series of temporary advantages (Volberda, 1996; Veliyath and Fitzgerald, 2000; Fiol, 2001).

Consistently with this view, some authors have taken focus away from resources and capabilities as sources of superior profitability. Instead, they pay great attention to the dynamics of strategic manoeuvring and competitive interaction. Firms continuously undertake strategic moves and manoeuvres, disrupting the competitive *status quo* and introducing market imperfections, through which they expect to gain temporary advantages. Such advantages will last until competitive reaction takes place and further disruptions are introduced by competitors. Research streams on competitive dynamics and action-based strategy, unlike traditional perspectives on strategy and competitive advantage, are deeply rooted into the Austrian school of economics and its contributions to the field of strategy (Jacobson, 1992; Roberts and Eisenhardt, 2003; Mathews, 2006).

While comparing traditional strategy frameworks with Austrian contributions to strategy research, Roberts and Eisenhardt (2003) argue that the former may miss key aspects of a business reality characterized by rapid change, uncertainty and disequilibrium. They claim for Austrian-based strategic logics, focusing on 'seizing opportunities in turbulent markets'. As Mathews (2006) poses it, "the Austrian economic approach has much to offer strategy in that it provides a fresh view of markets as a process in disequilibrium, where real strategizing in conditions of uncertainty takes place" (Mathews, 2006: 97).

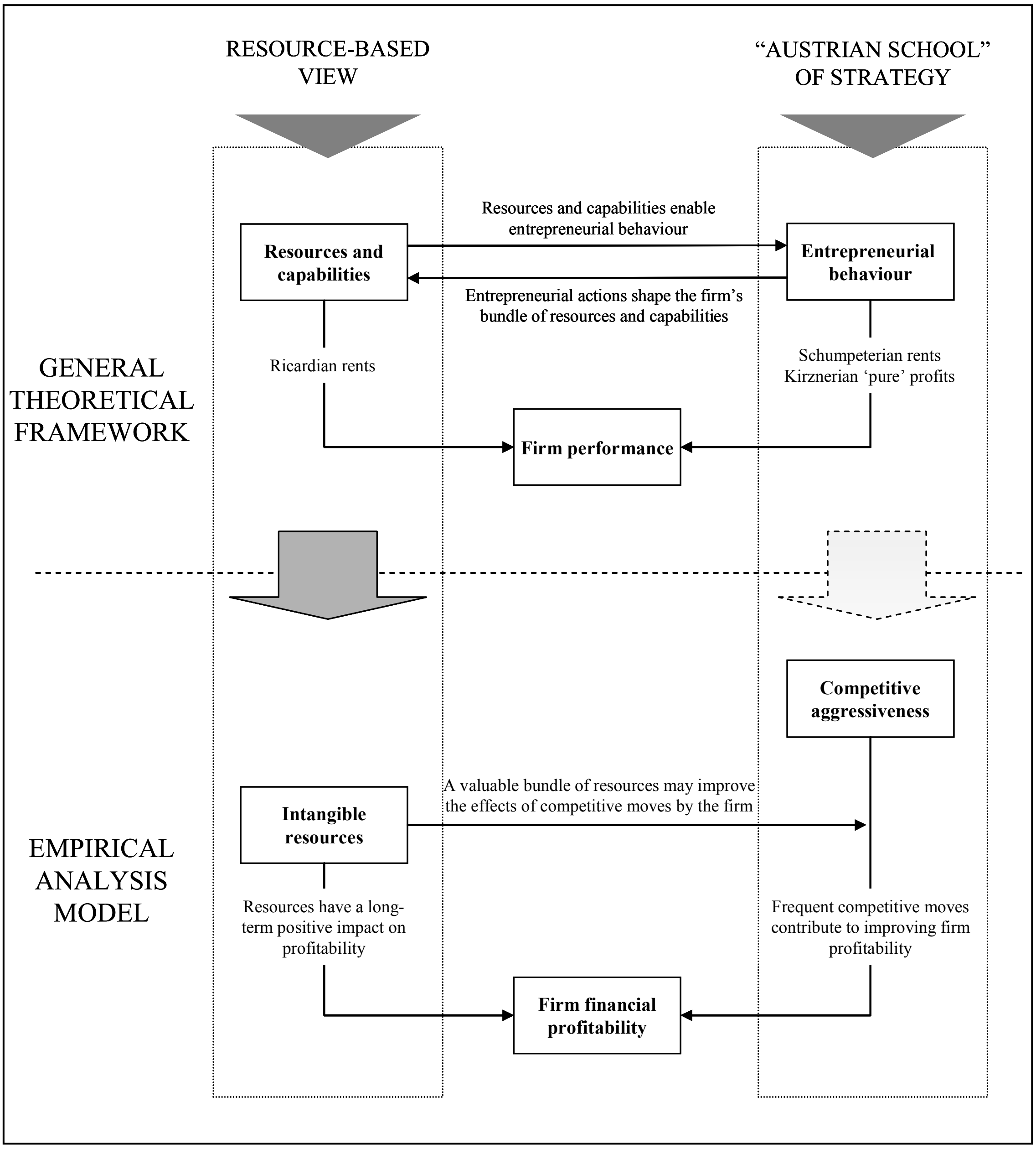
Overall, research streams focusing on disruption, market disequilibria and competitive dynamics (what we refer to as 'Austrian perspectives') represent a challenge that should not be ignored by more traditional schools of thought. Differences between such streams and resource-based approaches to competitive advantage, in terms of both assumptions and implications, could hardly be overstated. However, both of them provide appealing explanations for differences in firm performance; explanations that are also supported to a greater or lesser extent by a body of empirical evidence. They not only do coexist, but such coexistence is indeed fruitful, as they cast light on different aspects of strategy and competition. Thus, a dialogue between resource-based and Austrian approaches becomes necessary. As soon as in 1986, Jay Barney contended that "… Schumpeterian competition is an empirically valid form of competition that should be integrated with more traditional IO and Chamberlinian concepts in the development of a normative theory of strategy" (Barney, 1986b: 796).

In this chapter we aim at contributing to such dialogue by analyzing and comparing resource-based and Austrian perspectives on competitive advantage and firm performance. More concretely, we can neatly distinguish two different objectives for the chapter, which we summarize in figure 3.1.

The first objective is mainly theoretical. We discuss potential relationships and complementarities between the RBV and Austrian-based approaches to strategic management and competitive advantage. Our aim is deducing a theoretical framework that integrates arguments from both schools of thought in order to explain firm performance. We argue that they are complementary views, rather than opposing ones. Although drawing on substantially different conceptions of competition (Barney, 1986b), their views on the sources of superior performance (i.e. Ricardian rents vs. Schumpeterian rents and entrepreneurial profits) are not mutually exclusive. A comprehensive framework aiming at explaining inter-firm profit differentials could, and probably should, consider both sources of profitability. We also suggest that resource-based and Austrian claims may also complement each other from a theoretical standpoint. On the one hand, entrepreneurial discovery of new economic combinations may help in explaining why firms develop heterogeneous bundles of resources; on the other hand, entrepreneurial decisions do not take place in a vacuum, but within organizational contexts that are strongly influenced by firm assets, so that resources and capabilities enable and condition entrepreneurial action.

As our second objective, we aim at moving from theoretical discussion to empirical verification of our arguments. The major difficulty involved in doing so is that there exists an overwhelming imbalance in how resource-based and Austrian arguments have been incorporated into empirical strategy research. As a matter of fact, Austrian economics has often been criticized for its lack of empirical agenda (Roberts and Eisenhardt, 2003); focus on subjectivism and the situation-specific character of causal relationships (Witt, 1992) leads Austrian economists to disregard research methods aiming at finding general empirical homogeneities (Mises, 1949). As a result, differences in terms of empirical research agenda between resource-based and Austrian views on firm profitability and competitive advantage could hardly be overstated. This poses serious problems for establishing empirical comparisons and testing all our theoretical arguments, forcing us to set goals that are rather more modest.

FIGURE 3.1: Research objectives of the chapter



There is, however, a stream of empirical research in strategy that is deeply indebted to Austrian antecedents (Young et al., 1996; Quasney, 2003). We argued above that literature on competitive dynamics and action-based strategy adopts an Austrian-based perspective on markets, competition and firm performance. We thus translate the arguments in our theoretical model into a number of testable research hypotheses examining the relationships between firm intangible resources and competitive dynamics (and more concretely, aggressiveness of the competitive behaviour by the firm) as sources of inter-firm profit differentials.

We test our hypotheses on a sample of Spanish manufacturing firms, which represents a substantial extension, in terms of sample breadth, of previous literature on competitive dynamics. We also develop new methodological approaches regarding both measures of key constructs and statistical approach, which are based on the evolutionary model presented in the previous chapter.

In summary, we argue that RBV and Austrian approaches differ in terms of their assumptions, theoretical frameworks, methodological strategies and predictions. However, we also suggest that they are not mutually exclusive, and that both of them may provide meaningful insights into the origins and causes of superior firm performance. Consequently, we explore their linkages and complementarities; as for the empirical analyses, we redefine our discussion in terms of the relationship between firm resources and competitive dynamics. Our ultimate goal is being able to integrate, at least to some extent, arguments from both schools of thought in order to explain heterogeneous profitability.

2. THE RESOURCE-BASED VIEW OF COMPETITIVE ADVANTAGE.

Most cited antecedents of resource-based theories of the firm can be traced back to Penrose (1959) and Wernerfelt (1984). These works focused on the relationship between resources and firm growth strategies, most saliently diversification. In parallel, RBV scholars also engaged in competitive analysis, developing a formal discourse linking firm resources to competitive advantage and economic rents (Coyne, 1986;

Itami, 1987). In his seminal work, Jay Barney (1991) argued that valuable, rare, imperfectly inimitable, and not substitutable resources can result in sustained competitive advantage, consistently yielding superior returns to the firm. Thus, it can be argued that “a resource-based approach to strategic management focuses on costly-to-copy attributes of the firm as sources of economic rents and therefore, as the fundamental drivers of performance and competitive advantage” (Conner, 1991: 121).

It should be noted that insights on differential firm performance are at odds with neoclassical models of perfect competition, which yield a zero-profit competitive solution. In some sense, studying causes of abnormal returns implies searching for sources of market imperfections. Whereas industrial organization had traditionally focused on oligopolistic market structures, theoretical background for Barney’s approach lies on Chamberlinian economics; for Chamberlin, competition in industries takes place between firms with different resources and characteristics, which may allow some of them to implement unique strategies leading to superior performance (Barney, 1986b). In other terms, perfect competition models assume a large number of relatively small, homogeneous competitors; whereas IO-economics relaxed assumptions on the number and size of players, the RBV relaxed those on competitor homogeneity.

Two major explicit assumptions, thus, are central to the RBV. First, firms are heterogeneous in terms of their bundles of resources and competences (Prahalad and Hamel, 1990). Second, such heterogeneity may and do result in long-term profit differentials. This approach was fuelled by strong empirical evidence showing that a significant share of profit differentials among firms takes place within, rather than across, industries (e.g. Rumelt, 1991). Whereas previous literature, rooting in the structure-conduct-performance paradigm, had focused on industry structure, empirical results called for theoretical frameworks accommodating firm-specific factors influencing performance. Resource-based theorists came to address this need.

The main contribution of such new literature stream, relative to positioning theories, was opening the firm's "black box". Firms were no longer treated as homogeneous economic agents responding to heterogeneous market conditions, as in the SCP paradigm. Indeed, firm heterogeneity was not only explicitly addressed, but brought to the centre of the stage in explaining economic performance.

Sustainable competitive advantage being the main *explanandum*, it should come to no surprise that theoretical developments within the RBV have focused on studying the factors influencing the relationship between firm resources and performance. As mentioned above, Barney (1991) requires assets to be valuable and not easily acquirable by competitors. Peteraf (1993) develops this line of argument in a slightly more formal manner. She claims that long-term competitive advantage, in addition to asset heterogeneity, requires both *ex post* and *ex ante* limits to competition. The argument relies on Ricardian assumption that some resources are inelastic in supply, and cannot easily be expanded; access to economically superior resources is limited, providing a basis for competitive advantage. Abnormal profitability thus takes the form of Ricardian rents. Moreover, *ex post* limits to competition assure that competitive forces do not quickly dissipate abnormal profits, constituting a pre-condition for sustainability.

One last question remains, and it is that of value appropriation; for a firm benefiting from superior resources, *ex ante* limits to competition in the factor markets need to be assumed; otherwise, in presence of efficient markets for strategic factors (Barney, 1986a), any economic value a resource may provide will be offset by the cost of acquiring it in the market; in other words, competitive advantage needs *ex post* value of resources being greater than the *ex ante* cost of acquiring them (Rumelt, 1987).

Resource-based literature has identified at least two conditions driving rents appropriability, namely asset specificity and complementarity (Amit and Schoemaker, 1993). In both cases, the rent-creation capacity of a given resource is assumed to differ across firms, being partially dependent on some other organizational characteristics and assets. Therefore, the value of the resource for in-house exploitation may be greater than that of its best alternative use. Provided such best alternative use would set market price for the asset, the firm can appropriate the quasi-rents it generates; that is, the difference between its trade value (i.e. market price) and its firm-specific strategic value (i.e. potential to generate economics rents within the firm).

Economic antecedents of the RBV can be traced back to the Chicago School of industrial economics (e.g. Brozen, 1971; Demsetz, 1973, 1974; Peltzman, 1977). This approach explains persistence performance differentials, not in terms of market power and barriers to competition, but of efficiency rents; that is, they acknowledge competitors are indeed heterogeneous and refer to firm-level factors explaining differences in terms of efficiency.

In summary, in order to generate long-term advantage, resources have to satisfy three conditions. First, they have to be unevenly distributed across firms, giving rise to what Chamberlin names ‘monopolistic competition’; just like market power in IO economics, resource heterogeneity generates market imperfections and profit differentials. Secondly, there is a need for isolating mechanisms (Rumelt, 1984) protecting sources of superior performance from competitive reaction; more concretely, inelastic supply of strategic assets prevents replication of strategies and competitive advantages. Third, resources should be imperfectly tradable (if tradable at all) in strategic factor markets, so that economic value of a resource is not offset by its cost of acquisition.

We will argue in section 5 below that, given such conditions, intangible resources are particularly well suited for resulting in persistent competitive advantages (Itami, 1987; Hall, 1993, 1999; Fernández et al., 2000; Villalonga, 2004). Consequently, we will derive a research hypothesis linking intangible resources to superior firm performance in the long term.

3. ENTREPRENEURSHIP, INNOVATION AND PROFIT IN THE AUSTRIAN SCHOOL OF ECONOMICS

3.1. Profiting from market disruption: the Schumpeterian model of competition

In Schumpeterian economic thinking[1], competition involves continuous changes in competitive conditions and the economy is in permanent disequilibrium. Economic change is not fuelled by exogenous circumstances, neither by accumulation of production factors. The driving force of change is innovation[2], which results from entrepreneurial profit-seeking activities.

Schumpeter shares traditional neoclassical assumption that within 'circular flow' market equilibrium resources are assigned optimally, so that costs equal marginal

[1] Similarities between the Austrian school of thought and the Schumpeterian model of competition (Hebert and Link, 1982) have driven some authors to include Schumpeter in that school (Jacobson, 1992); this may be a reasonable choice when analyzing their implications for strategic management, as they greatly overlap. However, it should be noted that there are also significant differences in focus and theoretical foundations (Kirzner, 1973); in a strict sense, Schumpeter is not a member of the Austrian school.

[2] Schumpeter held a comprehensive view of innovation as an economic phenomenon, which comprised five categories: new goods (or new good qualities), new production methods, new markets, new sources of supply and new industry structures.

productivities, and there are no economic rents (Schumpeter, 1934).

However, the Schumpeterian idea of equilibrium departs from neoclassical tradition in one fundamental way (Sweezy, 1943): optimizing does not take place among every possible alternative, but only among those that have already been tried and experimented by economic agents. There is always room for competitors modifying conditions of profit assignation.

In their search for profits, entrepreneurs 'break pre-existing market rules' and generate new and superior economic combinations, which yield productivity of resources over equilibrium levels. Innovators can profit from such excess productivity, as they enjoy monopoly power regarding the innovation they have introduced (Schumpeter, 1934, 1942; Nelson and Winter, 1982). Such power, however, is temporary. Extraordinary rents attract competitors, who imitate innovation, so that it spreads across the market until a new equilibrium is reached, in which any excess profits dissipate. Moreover, innovations displace previous technologies out of the market, in a continuous process of 'creative destruction'.

In the Schumpeterian framework, profits originate from innovation and are essentially temporary. Superior firm performance is achieved by creative disruption of market equilibrium, and disappears as competitors react to such disruption. Reaction can come in two forms: firstly, by adopting the new technology, thus breaking monopoly power by the innovator. Second, by developing subsequent innovations (which further fosters the process of creative destruction), so that the former ones do not longer yield any productivity gains. Consequently, even when innovating firms are able to raise barriers to imitation (e.g. patents), this does not assure sustainable economic rents, as further innovations by rivals may still jeopardize current competitive positions. If firms are to achieve long-term advantage, particularly in highly innovative environments, they need to introduce a constant flow of innovations, so that new rents from temporary monopolies are obtained as previous ones dissipate (Roberts, 1999, 2001).

Strategy research, particularly as far as competitive advantage and business performance are concerned, can extract two major insights from the Schumpeterian model. First, competition is a dynamic process, which results from constant market disruptions introduced by profit-seeking entrepreneurs. Secondly, this process explains how firm profits arise from innovation and are eroded by competitive reaction. Schumpeterian rents provide a plausible explanation of performance heterogeneity among firms (Barney, 1986b). It should also be noted that, whereas the RBV focuses on sustainability issues, from this perspective superior performance is by nature temporary.

3.2. Entrepreneurship and profit in the Austrian school[3].

Neo-Austrian scholars share much of Schumpeterian ideas on economic systems as disequilibrium phenomena, markets as change processes, and entrepreneurship as the driving force of economic change. Their theoretical background, however, is quite different.

The ideas of bounded rationality, ignorance and true uncertainty (Knight, 1921) play a central role in Austrian thinking. Economic agents decide and act while ignoring preferences and choices from other market players, so that maximization criteria are not available. Thus, economic decisions are in general suboptimal, when not fully mistaken

[3] For the shake of precision, we should note that we are concretely referring to the so-called 'neo-Austrians'. Rooting into Misean conception of human behaviour (which, in turn, pays tribute to Hayek's subjectivism) (Mises, 1949), Kirzner's work on entrepreneurship and competition provides the basis for a neo-Austrian theory of firm behaviour and profitability (Witt, 1992).

(at least considered *a posteriori*).

As a result, any market at any time is in a state of disequilibrium, with imbalances and inefficiencies arising from ignorance by market players. Such inefficiencies provide opportunities for profitable entrepreneurial action. On the one hand, economic ends that markets attend could be equally satisfied with less costly resource combinations; on the other hand, current resources could attend potentially more valuable ends (Kirzner, 1973). Most individuals are unaware of such opportunities; attitudes towards market inefficiencies and opportunities are not univocal, but depend on knowledge and expectations by economic agents, which are highly subjective and heterogeneous (Hayek, 1937).

Discovering and exploiting market imbalances is the role of the entrepreneurial element in human behaviour, understood as the "…alertness to previously unnoticed changes in circumstances which may make it possible to get far more in exchange for whatever they have to offer that was hitherto possible" (Kirzner, 1973: 15-16).

In other terms, Kirznerian entrepreneur acts as an arbitrageur (Choi, 1995), who finds and exploits market imbalances. Arbitrage may involve diverse and complex activities (e.g. R&D activities are typically entrepreneurial), particularly in modern economies, in which most businesses involve combining and transforming a large number of resources. Consequently, entrepreneurship does not take place instantly, but spans along relatively long time periods and involves great uncertainty (Mises, 1949).

This concept of entrepreneurship relies on an approach to human behaviour that is very far from the idea of optimization within a given set of resources and potential uses that underlies neoclassical economic thinking (Robbins, 1932). Austrian scholars share the

Misean concept of “human action” (Mises, 1949); identification of means and ends is never *given*, but lies within the scope of individual behaviour. There is thus room for discovering both new resources and new uses for known resources; in other words, there is room for entrepreneurship.

From an Austrian perspective, entrepreneurship has two major consequences. At an aggregate level, it reduces inefficiencies and drives markets towards equilibrium. Kirznerian entrepreneur-arbitrageur, unlike Schumpeterian entrepreneur-innovator, drives economic systems towards equilibrium state (Kirzner, 1973; White, 1990; Choi, 1995; Gick, 2002); equilibrium, however, is a mere hypothetical state and is never fully achieved (it would require perfect knowledge of the value of every possible economic combination). At an individual level, entrepreneurs obtain economic rents from being the first to perceive price imbalances between product and factor markets (Mises, 1949; Kirzner, 1973) arising from sub-optimal use of resources[4]. In other words, entrepreneurs make profits by creating value where there was none (Pasour, 1989).

There is, thus, an Austrian theory of firm profitability based on entrepreneurial action. It has two important implications for strategic management. First, firms make their profits from discovering market inefficiencies; such discovery does not require a previous endowment of resources, but the ability to unveil new and valuable combinations of production factors (we will refer in section 4.1.2 to how such ability is treated within the RBV). This greatly depends on subjective factors (Witt, 1992), and knowledge and attention to market opportunities are ultimately the key drivers of economic rents.

Secondly, such rents are always temporary, as they are self-destroying by nature. Profits

[4] In this theoretical context, optimal decisions are a pure hypothetical state that can never be attained.

rely on inefficiencies arising from ignorance of market players. However, by exploiting previously unexplored opportunities, entrepreneurs unveil them and reduce ignorance of other market agents. As a result, competitors as well as suppliers and customers can adjust their behaviour to this new information, progressively squeezing the "arbitrage margin" of entrepreneurs.

Differences between Kirznerian and Schumpeterian entrepreneurs are far from negligible. The Kirznerian approach is typically subjectivist (Witt, 1992), and focuses on economic discovery. Schumpeterian competition, meanwhile, is based on objective creation of new economic combinations; little, if anything at all, is said on the subjective processes resulting in the emergence of novelties (Kirchhoff, 1991; Choi, 1995). As far as mechanisms governing firm profitability are concerned, however, similarities are much more remarkable than divergences. Market disequilibrium brings, at any time, opportunities for rent-creation to entrepreneurs; the very same competitive dynamics, however, implies such rents are generally short-lived. Long-term firm success will thus be tied to an entrepreneurial posture (e.g. Covin and Slevin, 1991), and will require firms being able to take advantage of market opportunities and engage in relentless change and a regular flow of innovations (Jacobson, 1992; Roberts, 1999, 2001). We will make use of these Austrian insights when developing arguments in support for our model for analysis.

3.3. Bringing Austrian arguments into the analysis of competitive strategy: the role of competitive dynamics

Literature on competitive dynamics approaches strategy as a series of competitive actions and reactions undertaken by firms aiming at improving profitability by over-manoeuvring their rivals (Chet at al., 1992; Chen and MacMillan, 1992; Smith et al., 1992). Firms are constantly engaging in different moves[5], by which they try to disrupt the competitive *status quo* (Ferrier et al., 1999) and create new market imperfections from which they can build temporary advantages and extract profits (Grimm et al., 2005). Such advantages will last until competitive reaction takes place and further disruptions are introduced by rivals; then again, firms engage in new manoeuvres in an iterative process. Unless competitive reaction can be prevented, long-term competitiveness will require stringing together a series of temporary advantages (D'Aveni, 1994; Veliyath and Fitzgerald, 2000). Competition is thus depicted as a dynamic market process, which results will ultimately depend on the interaction of the different moves undertaken by rival firms (Smith et al., 1992).

Tribute of these approaches to strategy to Austrian economic theory is substantial: assumptions of competitive disequilibrium, interest in market imperfections introduced by innovating firms, competition as a dynamic process and economic rents as short-term phenomena, are among the major Austrian contributions to this school of thought. Indeed, research streams on technological innovation, competitive dynamics and strategic manoeuvring are central to what Jacobson (1992) refers to as "the Austrian school of strategy".

More concretely, and regarding the aims of this study, competitive dynamics explain profit differentials in terms that are fully consistent with Austrian views of economic rents. Firm performance is indeed explained not in terms of superior availability of scarce resources, as in the RBV, but of firms being able to improve their position in markets by means of successful competitive moves. A basic premise of this literature is

[5] For the aims of this chapter, we will use the terms "move" and "action" indistinctly. We do not distinguish between "action" and "reaction", as part of the competitive dynamics literature does. This is coherent with our interest lying not on the specific pattern of competitive interactions, but on the overall willingness of the firm to act aiming at improving performance.

that strategic actions do influence performance, so that a firm's profitability would mainly be a function of its competitive behaviour. In the terms posed by Austrian economics, actions would be the means by which firms make effective entrepreneurial discoveries and obtain profits from them (Kirzner, 1973, 1992, 1997).

In order to characterize dynamic competitive behaviour and gain better understanding of its links to business performance, scholars in this stream have formulated hypotheses at three levels of analysis (He and Mahoney, 2006): first, variables that characterize individual actions (e.g. magnitude, speed or timing, visibility and likelihood of response); second, variables that correspond to sequential moves, conformed by a number of related actions (e.g. duration, complexity and unpredictability), in which is sometimes referred to as the 'competitive attack' level; third, variables that summarize the firm's overall competitive behaviour at an aggregate level, such as competitive simplicity, heterogeneity and aggressiveness.

Not all these variables, nor their hypothesized effects, enjoy the same degree of theoretical support, nor are equally soundly based on Austrian economics. Our empirical model for analysis will focus on the effects of competitive aggressiveness (Ferrier, 2001; Ferrier et al., 2001; Ferrier and Lee, 2002; Rountree, 2004).

4. BRIDGING THE GAP: TOWARDS AN INTEGRATIVE MODEL OF FIRM PERFORMANCE

Differences between such "Austrian school of strategy" and resource-based theories could hardly be overstated. Indeed, it has been claimed that traditional theories of firm performance are no longer valid in the current dynamic competitive environment, the "sustainable competitive advantage" concept is obsolete and alternative, dynamic competition frameworks should occupy their place in management research (D'Aveni, 1994, 1995). Such a strong claim is based on the assumption that markets are not in equilibrium, but change in competitive conditions is permanent and fast. Thus, firms cannot expect to achieve sustainable competitive advantages on the basis of their bundles of resources; rapid change in the environment can render assets obsolete, even in durable and inimitable, as value of resources is contingent on environmental conditions (Brush and Artz, 1999; Priem and Butler, 2001). In dynamic competitive settings, relying on a given bundle of resources, may not only prove useless, but also be a burden for the organization (Barnett et al., 1994; D'Aveni, 1994; Fiol, 2001), hindering change and adaptation to environmental change.

It might even appear from some such arguments that both schools of thought represent opposite scientific paradigms, so that validity of one of them must be defended against the other. Table 3.1 contrasts both perspectives and highlights their major differences.

It is true in a sense that they provide somewhat conflicting views of differential business performance. A salient role of strategic manoeuvring and competitive dynamics implies that firms can hardly sustain superior profitability merely on the basis of a given set of resources, and vice versa. In Shumpeterian models of competition, the 'gale of creative destruction' fuelled by innovations, not only creates economic rents, but also threatens pre-existent competitive positions (Schumpeter, 1939), and renders obsolete previously valuable resources. On the other hand, implications from the RBV of competitive advantage suggest that some resources, provided that they satisfy certain conditions or isolation mechanisms are held up, yield favourable positions that can be satisfactorily defended from pressures by competitors.

TABLE 3.1. Resource-based and Austrian-based approaches to competitive advantage and firm performance

	Resource-based view	Austrian-based perspective
Explanatory factors of firm success	Superior endowments of resources and capabilities	Market disruptions introduced by successful competitive moves Innovation and entrepreneurial discovery
Nature of competitive advantage and firm performance	Sustainable competitive advantage leads to long-term superior performance	Advantages are temporary. Long-term competitiveness requires stringing a series of advantages
Nature of abnormal profitability	Ricardian rents	Schumpeterian rent Entrepreneurial profits
Role of management	Enhancing the development and deployment of firm resources Creating isolating mechanisms to protect firm resources from the effects of competition	Attention to changes in environment and discovery of profit opportunities Leadership of innovation process
Assumptions on management decision-making	Rational. Optimization of firm resources given a set of potential uses	Misean 'human action': subjective determination of new combinations of resources and uses
Assumptions on competitive environment	Equilibrium Stable or moderately dynamic (incremental change)	Disequilibrium Frequent change in competitive conditions (highly dynamic)
Theoretical antecedents: models of competition	Chamberlinian model of monopolistic competition	Austrian school Schumpeterian competition
Typical empirical methodologies	Cross-sectional statistical analyses	Longitudinal analyses. In-depth case studies

Moreover, frameworks from the RBV usually assume that constructing new competitive advantages is a complex task; the very characteristics that allow some resources to sustain superior performance make them difficult to acquire or develop. The process is highly history specific, and it is subject to time-compression diseconomies and substantial uncertainty (Diedrickx and Cool, 1989). This has led some authors to suggest that sustainable competitive advantage is a relatively rare phenomenon (Wiggins and Ruefli, 2002, 2005); critics of the RBV have also pointed that this seriously limits actionability of strategic normative prescriptions resulting from resource-based research (Priem and Butler, 2001). Management efforts are likely to result more productive if directed to sustain the advantage over time, protecting it from the effects of competition, than finding new sources of advantage. Austrian-based views of competition make just the opposite assumption: isolating mechanisms are useless in order to sustain advantageous positions, and firms should put their efforts on renewing their sources of economic rents by means of continuous entrepreneurial action.

Resource-based and Austrian approaches to strategy-making and firm profitability are very different in terms of their theoretical antecedents and underlying assumptions. Therefore, it should come to no surprise that both schools have commonly been presented separately in previous research (among other reasons, because of their different methodological approaches, as mentioned in the introduction to this chapter). However, there is much to gain in exploring relationships and complementarities between them (Rosen, 1997; Foss and Ishikawa, 2007).

4.1. Austrian and resource-based theories as empirically complementary

It has to be noted that, while being different in terms of focus, background and implications, resource-based and Austrian approaches are not logically exclusive. They provide alternative, and somehow complementary, perspectives on heterogeneous firm performance, just as the RBV came to complement, rather than substitute, positioning-based theories. Companies do enjoy different resource bundles as well as they engage in different competitive behaviour, and both sources of firm heterogeneity are likely to impact performance. In other terms, both Ricardian and entrepreneurial rents may and do play a role in explaining firm results (Mahoney and Pandian, 1992, consider these two kinds of rents, along with quasi-rents, as sources of inter-firm profit differentials).

From this perspective, a fully integrative framework should incorporate three potential sources of performance variability. Structure-related factors can explain differences in average profitability among industries (or, more precisely, among strategic groups). Within-industry variability, on the other hand, can be explained in terms of both differences in firm resources and dynamic competitive behaviour[6]. Each of these explanations relies on different types of rents (Barney, 1986b): monopoly, Ricardian, and entrepreneurial (or Schumpeterian) rents. We argue that the relevance of each of them is mainly a matter of empirical evidence. Indeed, if the RBV and Austrian approaches to strategy rely on rather different views on the nature of competition, this only implies that their relative salience may depend on contextual variables, which further calls for building empirical evidence on the subject.

Thus far, however, there is a substantial lack of empirical research incorporating arguments both from the RBV and from the competitive dynamics, Austrian-based, research stream. A number of reasons can be suggested. Seminal studies on performance differentials are based on variance decomposition analyses (e.g. Rumelt, 1991), thus splitting profitability in industry, corporate and business-level effects. Results showed significant and persistent inter-firm variability, which was soon taken as evidence of sustained competitive advantage and attributed to heterogeneous assets and capabilities; this claim was mostly uncontroversial, as the RBV became a dominant paradigm in strategic management. Competitive dynamics and Austrian rents were out of the picture.

Hypercompetition theory, however, disputes this view. D'Aveni (1994) defines hypercompetition as 'an environment characterized by intense and rapid competitive

[6] In this study we focus exclusively on firm-level sources of competitive advantage; thus, we do not address industry-related factors and limit ourselves to the study of resources and competitive manoeuvres.

moves, in which competitors must move quickly to build advantage and erode the advantage of their rivals' (D'Aveni, 1994: 217-218). In this setting, there is little room (if any at all) for sustainable competitive advantage, and focus shifts from firm resources to competitive behaviour. As mentioned above, hypercompetition scholars challenged key assumptions of the RBV, and called for new frameworks to replace, rather than complement, traditional approaches. Integrating them in eclectic models was not a priority for this research stream.

This brings one additional issue of relevance. We mentioned above that, resource-based and Austrian arguments being not incompatible, their relative salience in explaining firm performance may depend on contextual variables. Needless to say, the competitive environment provides a key contextual factor for strategy (Ansoff, 1965; Lawrence and Lorsch, 1969; Tosi et al., 1973). As D'Aveni (1999) poses it, strategic paradigms that are successful in fairly unstable environments may no longer be valid in unstable and turbulent ones.

Profound and rapid change, intense competitive pressures, and constant challenge to established players, as characterizing hypercompetitive environments (D'Aveni, 1994), favours strategic paradigms based on innovation and relentless competitive moves (Eisenhardt and Martin, 2000). Therefore, by comparing the roles of 'static', resource-based arguments vis-a-vis 'dynamic', Austrian ones, we may be able to develop insights on the nature of competition[7]; if advocates of an 'hypercompetitive shift' are right, static resource bundles should have a limited effect on long-term performance, which would

[7] Whereas there are certain similarities between Austrian-based strategy frameworks and the literature on hypercompetition, both research streams must not be confounded. The 'Austrian school of strategy' (Jacobson, 1992) is based on a general and self-contained theory of competition and firm profitability. Literature on hypercompetition, meanwhile, explores the strategic implications of an alleged change in the characteristics of competition in certain markets.

rather depend on the ability of the firm to generate new competitive advantages by a series of competitive moves. This is of particular relevance since the existence of such a shift is still subject to substantial empirical dispute (Thomas, 1996; McNamara et al., 2003; Wiggins and Ruefli, 2005).

Lastly, but probably not less importantly, there are methodological reasons for the lack of communication between schools. Traditional approaches to the concept of sustainable competitive advantage are based on neoclassical models (rents stem from imperfect equilibrium in either product or factor markets), and are typically coupled with cross-sectional empirical analyses (Volberda and Lewin, 2003). On the contrary, the Austrian school of strategy develops around the idea of permanent disequilibrium, and calls for longitudinal empirical research (Jacobson, 1992). Indeed, unless appropriate dynamic models are defined, the effects of competitive manoeuvring and firm resources cannot be properly disentangled. The empirical model we present below builds on the evolutionary model we defined in the previous chapter and distinguishes between the initial status of the firm, in terms of bundle of resources, and its later competitive behaviour.

4.2. Austrian and resource-based theories as theoretically complementary

We have argued so far that resource-based and Austrian arguments are complementary from an empirical standpoint. There is also a theoretical, perhaps more interesting, and surely subtler, relationship between these two approaches.

A major contribution of the RBV is providing an explanation to differential performance on the grounds of firm resources; the theory thus assumes that firms enjoy heterogeneous endowments of resources and capabilities, an assumption that is taken as an exogenous precondition for superior performance. Some authors have criticized resource-based arguments arguing its inability to explore the ultimate causes of firm heterogeneity (Stinchcombe, 2000). Whereas some firms enjoy competitive advantage arising from superior assets, it is not so clear how firms achieve such superiority. Resource-based scholars acknowledge that 'history matters' (Diedrickx and Cool, 1989), and also that resource deployment is path-dependent, but theory is much less developed as to how heterogeneity arises in the first place. Moreover, it has been noted that imperfect and/or incomplete factor markets are necessary condition for resources to yield superior performance (Peteraf, 1993); otherwise, the acquisition costs of any tradable asset would offset any potential rents that could be obtained from it (Rumelt, 1987). Again, this gives rise to the need to understand what the sources of market imperfections are and why some firms, and no others, are able to take advantage of them. We believe that Austrian-based arguments can contribute to a better understanding of this phenomenon.

Let us assume initially homogeneous firms, which involves similar access to strategic factor markets; we thus assume that both the costs and the value of any assets they can acquire or develop are the same for both of them. Under these conditions, why may these two firms evolve in different manners, as to end up having heterogeneous asset endowments and competitive positions?

Barney (1986a) addressed this issue by analyzing competition in factor, rather than product, markets. He argued that potential value of resources is far from straightforward, so that firms differ in terms of their expectations on the value of assets. Those firms having more accurate expectations (or being luckier) will be able to build superior resource endowments and create competitive advantages. This argument answering one question, it still opens a new, different one. Why do firm expectations differ? Or, in analogous terms, how can some firms develop more accurate expectations, leading to competitive advantage? This is particularly troublesome as, if optimizing behaviour is assumed, identical firms would ultimately invest in the same resources (Makadok and Barney, 2001). Assuming heterogeneous expectations, thus, requires also assuming heterogeneous firms competing in factor markets; Makadok and Barney (2001) explore strategic factor market intelligence and its impact on information acquisition capabilities. Their argumentation represents a relevant contribution to the RBV and pushes the boundaries of the strategy formulation problem (extending the focus from resource deployment to resource acquisition). Unfortunately, it also falls into circular reasoning: firms differ in terms of resources and capabilities because their expectations when competing in factor markets are heterogeneous; however, heterogeneous expectations do indeed require assuming firms previously differing in terms of some (i.e. information-acquisition) resources and capabilities.

We contend that the problem ultimately lies on the reliance of dominant strategic paradigms, including most literature within the RBV, on neoclassical economic theory and its assumptions on optimizing behaviour (Powell and Wakeley, 2003).

In Austrian theory of entrepreneurship and competition, however, firms act under conditions of 'true uncertainty' (Knight, 1921)[8]. At any point, they cannot follow any single 'optimal' course of action. There is significant room for managerial discretional decisions (subjectivism), which in turns creates firm heterogeneity. Even if starting

[8] Knightian theory distinguishes between statistical risk, which can be estimated and insured *a priori* (and which corresponds to the concept of uncertainty in neoclassical economic reasoning) and ignorance or 'true uncertainty' (Rosen, 1997). Whereas risk is fully compatible with neoclassical maximizing behaviour (even if assumptions on limited rationality may be needed), Knightian true uncertainty precludes optimization and provides the basis for entrepreneurial rents (Mathews, 2006).

from equivalent initial conditions (i.e. same resources and capabilities, similar access to factor markets), two firms may well behave differently and engage in very distinct evolutionary paths. Amit and Schoemaker (1993) explicitly acknowledged the role of discretionary managerial decisions on resource development and deployment as a source of inter-firm heterogeneity. We claim that incorporating Austrian frameworks can cast light on the origins and mechanisms of such discretionary decisions (Foss and Ishikawa, 2007).

More concretely, resource superiority arises from (Schumpeterian) innovation and (Kirznerian) entrepreneurial discovery (Kirzner, 1973). As stated above, Kirznerian entrepreneurs discover either new, more valuable uses for existing resources, or new, more efficient combinations of resources for satisfying current economic purposes. Markets, and this includes factor markets, are never in equilibrium, and prices of factors do not correspond to their potential economic value, but just to the value unveiled by market players so far. By discovering new and superior relationships between resources and ends, the entrepreneur unveils information on the potential value of resources that remains hidden to other players; in Barney's terms, he develops superior expectations on the value of resources, resulting in an advantageous position for competing in strategic factor markets.

In summary, from an Austrian perspective, factor markets (as any other market) are always imperfect due to suboptimal behaviour of economic agents (Kirzner, 1973). It is ignorance of potential value of resources what creates market imperfections, and entrepreneurial discovery what allows some firms to seize those opportunities and make profits from them. Austrian economics provides the RBV with both a general theory on the origin of factor market imperfections (a theory, moreover, that does not need to rely on previously heterogeneous firms) and an explanation of how firms can seize profitable opportunities created by such imperfections.

While studying how firms appropriate economic rents, scholars in the RBV have distinguished two mechanisms (Makadok, 2001). First, from the "resource-picking" perspective, firms create rents by being more effective than their rivals at selecting resources. In a way, managers outsmart factor markets in picking resources. They are able to purchase resources for less than their (possibly firm-specific) marginal productivity. Secondly, under the "capability-building" perspective, managers create organizational systems that enhance productivity of resources (Makadok, 2001). These two perspectives are somehow analogous to the Austrian view of the entrepreneurial function. Moreover, Schumpeterian and Kirznerian theoretical developments may provide insights on how firms, by acting entrepreneurially, can outsmart markets ("resource-picking") and create new productivity-enhancing resource combinations ("capability building"), thus improving understanding of rent-creation mechanisms.

From this perspective, entrepreneurial initiatives are the ultimate cause of firm heterogeneity, and may explain how firms develop unique bundles of resources and achieve competitive advantages (Janney and Dess, 2006). In other terms, whereas the RBV answers the *what* of competitive advantage (i.e. superior resources), Austrian-based arguments may help addressing the *how* (i.e. entrepreneurial actions leading to superior resources). They are certainly complementary, as they focus on consecutive links of the causality chain of competitive advantage (Porter, 1991). From this perspective, some authors have suggested that above-average profitability stemming from resources and capabilities is not ultimately a matter of Ricardian rents, but of Knightian profits (Mathews, 2006). That is, economic profits arise from superior insight and decisions in a context of true (Knightian) uncertainty; it is such insight which, in turn, may provide the firm with unique resources leading to Ricardian rents.

Having established that entrepreneurial discovery drives resources advantages, the consideration the role of the entrepreneur has received within the RBV deserves a word of its own. Some authors have already suggested that entrepreneurial actions can contribute to resource-based advantages by suggesting alternative uses of resources that have not been previously discovered leading to heterogeneous assets and thus to competitive advantages (Alvarez and Busenitz, 2001; Ireland et al., 2001; Alvarez and Barney, 2002). However, most resource-based research has given little consideration to the role of entrepreneurship (Alvarez and Busenitz, 2001), so that the RBV largely fails to integrate implications of creativity and the entrepreneurial act (Barney, 2001).

It is perfectly possible, on the other hand, to introduce the role of entrepreneurs in resource-based frameworks by considering they constitute strategic resources themselves; as a matter of fact, they happen to be good candidates for sustaining competitive advantages. However, by doing so we would be again at risk of falling into circular theorizing, a criticism which is not unknown to resource-based arguments (Priem and Butler, 2001): superior resources arise from entrepreneurial insight, which in turn is itself considered as a resource. At some point, we need to leverage on some external, non-resource-based theoretical arguments, in order to explain how heterogeneous assets develop.

The process described above (discovery-resources-profits) is completed by a backward feedback loop; once heterogeneity is generated, unique firm resources may influence further managerial action. Strategy can be understood as an iterative process (Noda and

Bower, 1996). The dynamics are thus double-sided: entrepreneurial discovery creates heterogeneity, and heterogeneous resources and capabilities set the conditions for further entrepreneurial actions. In terms of the competitive dynamics literature, firm resources partially set the range of competitive moves available to the firm (Grimm and Smith, 1997). Therefore, a proper understanding of the ultimate origins of competitive advantage requires unveiling the intertwining between firm resources and entrepreneurial discovery.

4.3. Towards a synthesis of resource-based and Austrian theories? The role of dynamic capabilities

Analogous conclusions can be reached from the dynamic capabilities literature, which is indeed a stream within the resource-based view (Barney, 2001; Acedo et al., 2006). Dynamic capabilities are defined as "…the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments. Dynamic capabilities thus reflect an organization's ability to achieve new and innovative forms of competitive advantage" (Teece et al., 1997: 51).

The relationship between dynamic capabilities and business performance is indirect. They enhance firms creating new combinations of resources and operational capabilities, which, in turn, give rise to (temporary) competitive advantage. It is such combinations, and not the dynamic capabilities *per se*, which ultimately sustain advantage (Eisenhardt and Martin, 2000; Zott, 2003). This has led some authors, assuming capabilities follow a hierarchical structure (Collins, 1991; Teece et al., 1997; Grant, 2008), to claim that dynamic capabilities are indeed second-order competences (Kogut and Zander, 1992; Teece et al., 1997), which operate over the base of firm static (first-order) capabilities and resources.

From this perspective, firms attain long-term rents by a succession of short-lived advantages; persistent profitability depends on the ability of the firm to continuously renew its organizational competences (Fiol, 2001). Dynamic capabilities (which are themselves a subcategory within firm competences) support such renewal. They also enhance firm innovative responses to competitive changes (Teece et al., 1997).

Similarities between this approach and Austrian arguments are apparent: "creating new combinations of resources" is analogous to Kirznerian entrepreneurial discovery or Schumpeterian innovations. Indeed, it can be suggested that the dynamic capabilities view somehow represents a synthesis between the resource-based and Austrian schools of strategy.

Conclusions from this perspective are similar to those posed by Grimm and Smith (1997): some competences (namely, dynamic capabilities) enhance competitive behaviour of the firm, which is able to improve performance by acting innovatively and creating new combinations of resources. Such competences help firms navigate competitive dynamics, so that firms enjoying better dynamic capabilities will be more effective when undertaking a series of competitive moves. Moreover, dynamic capabilities are knowledge-based competences (Grant, 1996; Teece et al., 1997), so that they build on the basis of knowledge available to the firm. Therefore, there is a positive, if indirect (knowledge – dynamic capabilities – competitive dynamics), relationship between knowledge-based resources and the effectiveness of action-based strategies.

5. RESEARCH HYPOTHESES

In the previous sections of the paper, we have reviewed resource-based and Austrian perspectives on competitive advantage and superior firm performance; we have devoted special attention to comparing both approaches and analyzing their possible relationships. Two main conclusions have arisen: first, both perspectives are compatible and should be incorporated into integrative models of firm profitability. We have showed certain shortcomings that might follow otherwise. Secondly, there are empirical and theoretical complementarities between them that may be well worth exploring. Furthermore, we contend that efforts in this direction are still scarce and limited in the literature.

Consistently with this line of reasoning, we next present a model investigating firm-level factors influencing profitability. We simultaneously consider the effects of a more favourable bundle of intangible resources and of the firm challenging its rivals by means of an innovative and aggressive competitive behaviour. Whereas the former is a classical proposition within the RBV, the later derives from arguments within the entrepreneurship and competitive dynamics literatures, which are ultimately based on Austrian theoretical frameworks. We argued above that existing literature has often treated resource-based and Austrian arguments separately. Unlike previous research, we consider both kinds of effects in the same model of analysis; this reduces the risk of biases arising from overlooking relevant sources of economic rents (Huselid, 1995).

We also aim at exploring interrelations between intangible assets and action-based strategies; indeed, we will argue that the impact of a firm's competitive moves on performance may be moderated by its initial bundle of intangible assets. This implies that resources not only have a direct effect on profitability, but also an indirect one by supporting successful strategies (defined in terms of a set of competitive actions). This extends previous literature on organizational antecedents of competitive dynamics (e.g. Smith et al., 1991; Miller and Chen, 1994, 1996; Ferrier, 2001), and contributes at exploring theoretical relationships (and not only empirical complementarities) between the RBV and Austrian-inspired strategy research.

5.1. Competitive aggressiveness and firm profitability

Competitive aggressiveness has been defined as a firm's willingness to challenge its market rivals directly in order to gain market share (or, more generally, to improve performance) (Lumpkin and Dess, 1996); in other terms, as 'the intensity of a firm's efforts to outperform industry rivals' (Lumpkin and Dess, 2001: 431). It relates to the firm's total level of competitive activity; firms showing a more 'aggressive behaviour' (i.e. a greater level of competitive activity) will be more likely to undertake competitive moves aiming at improving competitiveness. Indeed, aggressiveness is directly linked to the number of actions in a given period (Ferrier et al., 1999) (more on this in the "research methods" section). Some authors claim that this has been found to be the most robust construct in competitive dynamics research literature (Ferrier et al., 2002). Moreover, it is also the most soundly based on the Austrian theoretical antecedents of such literature.

We have argued that entrepreneurial rents arise from competitive actions creating market disequilibrium. Moreover, and given that such rents are unlikely to persist, firms would need to launch many competitive moves in order to achieve long-term competitiveness (D'Aveni, 1994; Volberda, 1996). Competitive aggressiveness increases likelihood of a firm being able to challenge competitive status quo, so that we can expect a positive relationship with overall firm performance.

It has also been suggested that aggressive behaviour prevents reaction from competitors and enhances organizational learning (Grimm and Smith, 1997; Ferrier et al., 1999). A large number of initiated moves and competitive responses can pre-empt important strategic positions and weaken rivals' ability to respond (Smith et al., 1992).

The effects of the level of competitive activity become clearer when the roles of the environment and environmental change are considered. Strategy is a matter of achieving dynamic fit between the firm and its environment (Teece, 1984); provided markets are in disequilibrium, and particularly wherever environmental change is rapid and profound, such fit demands continuous strategic manoeuvres; therefore, firms will need to be highly active in order to cope with changes in market conditions.

Similar arguments are drawn from the literature on entrepreneurship. It has been suggested that more entrepreneurially-oriented firms will be more likely to succeed in markets (e.g. Covin and Slevin, 1991). Competitive aggressiveness can be considered one of the key dimensions of an entrepreneurial orientation (Lumpkin and Dess, 1996); moreover, it is a dimension closely related to actual entrepreneurial actions undertaken by firms (Lyon et al., 2000).

The conclusions seems clear at this point; if arguments above hold, more aggressive firms are likely to experience higher performance levels. Indeed, empirical evidence, if not fully consistent, shows that companies engaging in more competitive moves score better in differ performance measures (e.g. Chen and MacMillan, 1992; Miller and Chen, 1994; Young et al., 1996; Ferrier, 2001; Ferrier and Lee, 2002).

We draw hypothesis 1 from discussion above:

Hypothesis 1: The aggressiveness of a firm's competitive behaviour (i.e. engaging in more competitive moves) has a positive effect on its long-term financial performance.

5.2. Intangible resources as a source of sustainable competitive advantage.

Strategy research within the RBV has paid great attention to intangible resources as sources of sustainable superior performance (e.g. Itami, 1987; Aaker, 1989; Hall, 1993; Hitt et al., 2001). It has even been argued that "…intangible assets, such as a particular technology, accumulated consumer information, brand name, reputation and corporate culture, are invaluable to the firm's competitive power. In fact, these invisible assets are often the only real source of competitive edge that can be sustained over time." (Itami, 1987:1)

Statements such those above are common and largely undisputed among resource-based theorists. The reason becomes clear when characteristics of most (if not all) intangible assets are confronted with requisites for sustained competitive advantage.

The most valuable intangible resources do not exist naturally in the market (Fernández et al., 2000), so that they must be created and accumulated within the firm (e.g. brand names and corporate reputation). As far as resource development is subject to substantial time-compression diseconomies (Diedrickx and Cool, 1989), this provides a strong basis for persistent resource heterogeneity among firms, and protects sources of advantage from imitation by competitors (*ex post* limits to competition). Moreover, some intangible assets (e.g. human capital, organizational culture) heavily rely on knowledge that is typically tacit and hard to codify (Kogut and Zander, 1992; Conner and Prahalad, 1996), so that they are difficult to be identified and understood, further hindering replication.

Even when intangibles are tradable in factor markets, decisions on asset acquisition are adopted within the constraints of cognitive biases and causal ambiguity (Amit and

Schoemaker, 1993; Peteraf, 1993). Economic value of intangible resources is hard to estimate *a priori,* and can differ significantly from firm to firm due to asset specificity and complementarities (Amit and Schoemaker, 1993; Makadok and Barney, 2001). As a matter of illustration, for those knowledge-based assets that can be codified and traded in markets (e.g. patents and other IP rights), it is likely that markets are subject to substantial transaction costs (Williamson, 1991); limited saleability of such resources favours in-house development and exploitation rather than acquisition in markets (Cohen and Kepler, 1996).

Thus, factor markets for this kind of assets are imperfect and incomplete, giving rise to the *ex ante* limits to competition required by the RBV as a condition for superior performance.

Statements above have long been present, either implicitly or explicitly, in resource-based research. However, empirical research testing the effects of intangible resources on long-term profitability still has important limitations; we next review some of the most important of them.

A common empirical approach involves selecting a limited number of intangible factors (if not just one) and exploring their effects on performance (Galbreath and Galvin, 2006). Whereas this kind of research can still yield interesting results, some authors claim that isolating a limited number of resources misinterprets the implications of the RBV (Levitas and Ndofor, 2006). Constructing competitive advantages usually requires combining a number of different resources in rather complex ways.

The argument becomes clear when we consider the literature on firm competences and capabilities. Most resource theorists would have not reluctance in accepting that competitive advantage ultimately depends on firms combining their endowments of resources in order to build superior capabilities (Grant, 1996). If intangible assets are indeed important is because they are likely to result in persistent capability differentials (Hall, 1993). Studies considering individual assets are not likely to capture the true nature of resource-based competitive advantages, and may incur in severe biases from ignoring other relevant factors driving performance (Huselid, 1995).

A second limitation of the vast majority of previous research is that it does not properly disentangle profit *existence* from profit *persistence* (Mueller, 1986). Two complementary statements are implicit in the proposition that intangible resources generate sustainable competitive advantages. First, that they indeed result in superior performance; second, that 'extraordinary' rents stemming from intangible resources are highly persistent (or at least, more persistent that other sources of profitability). This distinction has been too often overlooked in the literature, so that RBV statements on 'advantage sustainability' still lack substantial empirical support. This is an important shortcoming since, as we have suggested, some researchers are increasingly challenging the idea of advantages being sustainable. Only very recently, some works have made use of dynamic models of profitability to test the effects of firm resources and capabilities on profit persistence (Acquahh, 2003; Villalonga, 2004); following Villalonga (2004), we consider that intangible resources controlled by a firm will have an impact, not only on performance levels, but also on persistence of such performance.

Third, we also depart from previous works in one additional aspect. Whenever assessing the effects of firm-level variables, it is standard practice controlling for industrial sectors, in order to control for all industry-level variables that may have an effect on performance, thus biasing results. However, as far as tests of the RBV are concerned, other firm-level, non-resource variables influencing performance are normally not considered; this may be related to the clear preponderance of the RBV when explaining inter-firm profit differentials. We have argued thus far that the competitive dynamic behaviour of firms may also give rise to entrepreneurial rents. Ignoring such sources of rents might cause results to be biased (Huselid, 1995). Along with resources, we also consider in our model for analysis the effects of competitive aggressiveness. We extend previous literature and integrate both Ricardian rents and entrepreneurial profits in the same model, which provides a test for the robustness of propositions from the RBV: we can verify if they still hold when considering at least some other (non-resource) potential sources of performance variability. The opposite argument also holds: we can test if our predictions on the effects of aggressiveness are robust to inclusion of intangible resources as a source of superior performance.

Drawing from discussion above, we derive the following two hypotheses:

Hypothesis 2: The bundle of intangible resources controlled by a firm has an impact on its long-term financial performance, so that firms with more valuable intangible resources will achieve, on average, higher returns.

Hypothesis 3: The bundle of intangible resources controlled by a firm has an effect on the sustainability of performance differentials, so that firms with more valuable intangible resources will experience higher profit persistence.

5.3. The interaction between firm resources and competitive moves: resources as action-enablers.

Competitive dynamics scholars have not ignored evidence that firms differ in their bundles of resources, and that this fact does affect strategy and performance. As Grimm and Smith (1997) pose it: "… actions stem from resources. It follows that a firm's relative resource position will affect the type of action that a firm can undertake. In particular, a firm with limited market share and no relative resource advantage will have limited strategic options; whereas a firm with a strong market position and strong relative resource advantages over the competition may pursue a variety of actions" (Grimm and Smith, 1997).

Firm resources enable competitive action, so that assets accumulated by the firm may constitute the driving force of competitive moves. The relationship between resources and performance, from this perspective, is indirect and mediated by firm competitive behaviour. Following He and Mahoney (2006), it can be argued that resources having a *potential* value for the firm, their *actual* realized value depends on the ability of the company to leverage such resources by engaging in a series of successful competitive moves.

While not being the central question in this literature, competitive dynamics research does acknowledge the influence of firm-level assets and capabilities, and particularly of the availability of idle (i.e. not currently used) resources, on firm-level competitive behaviour (Smith et al., 1991; Ferrier, 2001).

It is worth noting that this line of argument is quite different from the classical RBV of competitive advantage, which tends to ignore the mediating role of competitive dynamics. It is indeed closer to seminal works by Penrose (1959) and Wernerfelt (1984) works relating idle resources to firm growth strategies.

Previous research has focused on how resources influence firm competitive behaviour, by shaping the repertoire of moves available to the firm (and also its incentives to act).

However, there is a second implication from arguments above that remains largely unexplored: resources have an effect not only on competitive behaviour, but also on the results obtained from such behaviour. On the one hand, competitive dynamics may mediate the relationship between resources and performance (He and Mahoney, 2006); on the other hand, it seems sensible to sustain that firm resources moderate the relationship between competitive dynamics and performance. In this sense, we argue that those firms with better availability of resources enjoy a wider range of possible competitive actions at their disposal. It can be expected, thus, that they choose superior moves and obtain greater returns from their competitive behaviour.

Let us consider two examples, regarding different types of competitive actions:

First, we can argue that the effectiveness of advertising campaigns or communication activities, among other promotional and marketing-related competitive actions, will be partially dependent on the firm's previous reputation (i.e. strong brand name). Analogously, implementing and communicating price cuts or point-of-sales promotional initiatives require good positioning within distribution channels. The ability of firms to effectively reach their customers by means of this kind of competitive manoeuvres depends on their previous endowment of reputational assets.

Secondly, the literature on technological innovation also shows that R&D and innovative efforts transform the firm's internal capabilities (Geroski et al., 1993), making it more flexible and enhancing its absorptive capacity (Cohen y Levinthal, 1989, 1990; Geroski, 1994). In other words, firms learn to innovate. Thus, firms already holding a solid innovative track are more likely to succeed when engaging in new product launches or process improvements. For our purposes in this work, we can claim that technological firm assets enhance effectiveness of innovation-based competitive manoeuvres.

We have developed thus far two kinds of arguments. First, competitive moves aim at unveil the unrealized value of firm resources; the greater such value, the greater also the potential positive impact of actions on firm performance. Second, certain intangible resources (such as reputation, brand name, trade relationships, technological capital, etc.) may allow firms to choose more successful manoeuvres. We can thus conclude that those firms enjoying more valuable resource endowments will obtain, on average, greater returns from the competitive moves they engage in, which leads to the following hypothesis:

Hypothesis 4: The bundle of intangible resources controlled by a firm has a positive moderating effect on the relationship between the firm's competitive aggressiveness and its long-term financial performance.

6. RESEARCH METHODS

6.1. Data and sample

Empirical testing of research hypotheses presented above is based on a sample of Spanish manufacturing firms, covering the 1991-2002 period. Unlike in the previous chapter, a complete panel is used here, the reason being the need for guaranteeing reliability of information on business competitive behaviour. This yields a final sample of 578 firms, covering 20 different industries[9]. Data are obtained from the *Survey on Business Strategies*, further described in chapter 2 above.

[9] The Survey on Business Strategies defines its own industry classification, which closely resembles the 2-digit NACE Rev.1 system. The twenty industries in the sample correspond to twenty-two different 2-digit NACE codes.

A reasonable criticism to works linking resources and competitive advantage refers to the tautological nature of research questions. Provided there is no exogenous measure of resource value, valuable resources are usually defined in terms of their contribution to firm performance (that is the case of using Tobin's Q as a measure of intangible assets); further inquiries on their effects on profitability would thus fall into circular reasonings. In order to avoid this problem, we split our panel of data in two periods; first, we define a 'pre-sample' stage, covering three years from 1991 to 1993, for which intangible assets are observed and measured[10]; this provides an estimation of the initial status of firms, in terms of bundles of resources, which is taken as an explanatory variable. Secondly, we test the effects of such initial status on profitability trends over the 1994-2002 period. In other terms, we explore the contribution of firm intangible assets at the beginning of the time span to be studied to subsequent performance dynamics. This approach is analogous to that proposed by Cockburn et al. (2000); they explore the persistent effects of the firm's initial status on its ulterior competitive achievement. It is worth remembering that, in this context, 'initial status' is not synonymous of founding conditions. We use the term 'initial conditions', as Cockburn et al. (2000) do, not to refer to those holding at the time of founding, but at the beginning of the sampling period. This two-stage approach leaves us with 5,202 observations of the dependent variable (nine observations per firm, corresponding to every year from 1994 to 2002).

6.2. Variables and measures

While measuring firm performance is far from being a trivial task, it has been approached in a number of more of less satisfactory ways in the literature. We use an accounting ratio of return of assets, defined as in chapter 2 above; again, we are

[10] We thus base our estimation of firms' initial bundles of resources on data from three consecutive years, which should provide rather robust estimates, while keeping the sampling frame as long as possible (1994-2002).

interested exclusively in ‘excess profits’, or ‘abnormal profitability’, so that we normalize measures of return of assets around their industry averages. Despite their shortcomings, accounting measures of profitability are predominant in studies of profit dynamics (for a review, see Wiggins and Ruefli, 2005), therefore enhancing comparability of findings across studies. Meanwhile, finding valid indicators for explanatory variables proposed in this study, namely intangible resources and competitive dynamism, has proved to be quite a troublesome question.

6.2.1. Intangible resources.

Two major approaches to measuring intangible assets can be found in the literature. The first one involves using data on firm inputs, such as R&D investments or advertising expenditures, which presumably contribute to building intangible resources. These indicators, however, provide poor proxies for the construct, for a number of reasons. First, the concept of intangibles includes a number of heterogeneous assets, many of which are based on tacit knowledge and routines, and are thus difficult, if possible at all, to observe and quantify. That is the very nature of intangible resources, and to a great extent the cause underlying their potential for sustaining competitive advantage. Any measure based of quantifiable inputs provides a partial, and sometimes substantially incomplete, account of the firm endowment of intangible assets. Additionally, inputs do not provide a direct measure of resource value, as some firms make a more efficient use of them than others, so that the same amount of inputs may result in very different resource values. It is well known, for example, that productivity of R&D investments may differ substantially across firms (Griliches, 1984).

The second measuring strategy does not engage in directly observing and quantifying intangible resources, but rather their effects on firm value. From this perspective, the difference between market value of the firm and the replacement cost of its tangible assets can be attributed to intangible resources; thus, Tobin's Q or market to book value ratios are commonly used as measures of firm intangibles. This approach is theoretically sound and has delivered good results in different research questions, but it poses serious problems when studying profit dynamics.

Villalonga (2004), in the work cited above on intangible assets and profit persistence, use Tobin's Q ratio in order to measure resource intangibility. However, this approach presents two major problems. First, market value of the firm does not only depend on its current competitive position, but also incorporates market expectations on future developments, which seriously hinders interpretation of results. Any empirical associations can be interpreted as a consequence of reverse causal relationships. If value of intangible assets incorporates market expectations on future revenue flows, any research question regarding the effects of intangibles on firm profitability becomes immediately tautological[11]. She addresses this concern by re-fitting her models using *'hedonic q'* as the main independent variable. That is, addittionally to actual Tobin's Q, she takes the fitted value from a regression using accounting data on intangible assets as covariates. This approach overcomes possible discrepancies between book value and actual value of assets, but may still be flawed as most intangible resources remain invisible to accounting policies.

Second, and more obviously, market value data are only available for publicly-traded firms, thus greatly limiting the range of sampling frames. Coupled with the difficulty of obtaining data on competitive dynamics, this fact constitutes a major limitation for

[11] This is not necessarily true, as Villalonga (2004) suggests, if interest lies not on performance levels, but exclusively on their persistence over time. Unfortunately, this is not the case with our hypotheses.

empirical research, especially as far as small and medium-sized firms are concerned.

We propose in this study an alternative measure based on application of the Cobb-Douglas production function. In traditional economic theory, output is modelled as a function of two production factors, physical capital and labour[12]. Empirical results, however, showed that a substantial fraction of output growth cannot be attributed to accumulation of these factors (Solow, 1957). Drawing on these findings, Griliches (1979) extended the model and used a third factor, technological capital, to partially explain inter-firm differences in productivity. The RBV further argues that some other resources can also influence firm productivity (e.g. reputation, managerial capabilities, organizational arrangements, etc.). Consequently, Geroski's argument can be extended in order to sustain that the fraction of firm-level productivity not accounted for by physical capital and labour can be attributed to its bundle of intangible resources. This is consistent with the negative definition of intangible investments proposed by the OECD: basically, any investment not in physical assets (OECD, 1992). Analogously, any firm output that does not result from either physical assets or labour can be attributed to intangible resources. In other terms, such resources would explain inter-firm differences in productivity, controlling for their physical capital and labour.

We define the following production function:

$$q_{it} = a_i + \lambda t + \beta_1 c_{it} + \beta_2 l_{it} + D_j + e_{it} \qquad (1)$$

$$a_i = a + u_{0i} \qquad u_{0i} \sim N\,(0,\sigma^2_{0i}) \qquad (1.a)$$

[12] Labour is measured as the number of equivalent full-time employees (or alternative, in terms of man-hours). It does not incorporate any differences in personnel knowledge or skills (i.e. human capital), which is still captured by our approach as part of the firm's intangible assets.

Where q_{it} represents logarithm of production[13] (measured as total sales) of firm i at year t and c_{it} and l_{it} logarithms of physical assets and labour (i.e. number of equivalent full-time employees), respectively. Dj is a vector of industry dummies, in order to isolate firm-level effects, and t represents a linear time trend of productivity.

Regression intercept, a_i, is composed of an overall intercept a, and a firm effect, u_{0i} (equation 1.a). Firm-specific intercepts are obtained by random effects estimation using 1,734 observations between 1991 and 1993[14]. From this model, we obtain estimates of the contribution of intangible assets to total productivity for each of the 578 sample firms. Such estimates can be interpreted as firm output attributable to invisible assets, and provide an adequate and theoretically sound proxy for the endowment of intangible resources of firms at the beginning of the 1994-2002 period. We will thus use them as an explanatory variable in our model.

6.2.2. Competitive aggressiveness.

The competitive dynamics literature has often operationalized the construct as the number of competitive actions of any type undertaken by a firm in a given period (Ferrier et al., 1999; Young et al., 1996).

In order to measure competitive aggressiveness, we first need to identify the kinds of actions a firm can initiate. Whereas different classifications have been used, a review of previous literature identifies at least five major types of actions: introduction of new products or services, price changes, promotional or advertising activities, capacity changes and legal actions (Smith et al., 1991; Chen and MacMillan, 1992; Derfus, 2001;

[13] The Cobb-Douglas function has been linearized by taking logarithms of the original variables.

[14] Random effects model have the distinctive advantage of being able to estimate reliable individual-specific effects with a limited number of longitudinal observations, by assuming a common distribution of individual effects (equation 1.a) (Snijders and Bosker, 1999).

Quasney, 2003; Usero, 2003). Not all of them, however, are equally relevant in all industry settings[15]. In general, product, price and promotional actions should provide a satisfactory account of competitive dynamics. Additionally to these three types of actions, we will consider technological innovations, either product or process, introduced by the firm[16], in order to incorporate Schumpeterian insights on technological innovations potentially being a major source of economic rents.

All the five types of moves we consider are proxied by items asked within the *Survey on business Strategies* that aim at characterizing firm behaviour. Measures are consequently based on self-reported information on firm willingness to engage in competitive actions of different types. A description of the items is presented in table 3.2.

All different kinds of actions in table 3.2 are susceptible to fit under the "competitive aggressiveness" label. However, we will first explore the dimensionality of the concept. This step is usually overlooked in the competitive dynamics literature, so that every competitive move is equally added up in order to measure aggressiveness. We ran an exploratory factor analysis and found that the five items considered can be satisfactorily summarized in two main dimensions.

Preliminary results show that application of factor analysis to the data is appropriate. KMO measure of sample adequacy is 0.548, slightly above the heuristic cut-off value of 0.5, and Bartlett's test of esphericity is highly significant (p-value < 0.001).

[15] We can think of capacity and legal actions being particularly relevant within oligopolistic and highly regulated industries (e.g. Quasney, 2003; Usero, 2003), where players are able to influence market structure and regulation.

[16] This explicit inclusion of technological changes might be redundant if a full account of competitive moves were available, because innovations normally result in some other kind of competitive actions, such as price changes or new product launches. However, as the available information is limited, introducing these items may also improve reliability of measures.

TABLE 3.2: Types of competitive actions (dimensions of competitive behaviour)

Type of action (variable code)	Survey question	Possible answers	Periodicity (number of observations, 1994-2002)	Final scale
Product change (PROD)	Does the firm normally change the type of products it offers?	1 – yes 0 – no	Every four years (3)	0 - 3
Price (PRICE)	Number of times the firm changed prices in the year	0 – none 1 – one 2 – two 3 – more than two	Every year (9)	0 – 27
Promotion (PROM)	Does the firm engage in promotion activities?	1 – yes 0 – no	Every four years (3)	0 – 3
Product innovation (INN_PROD)	Did the firm achieve product innovations in the year?	1 – yes 0 – no	Every year (9)	0 – 9
Process innovation (INN_PROC)	Did the firm introduce important modifications to production processes in the year?	1 – yes 0 – no	Every year (9)	0 – 9

Results are presented in table 3.3. Two factors with eigenvalues greater than one are extracted. This two-factor solution accounts for 55,4% of initial variability. Commonalities show that all original variables are satisfactorily represented, but for promotional activities. This is unsurprising, as mean value for PROM is 2.66 (out of 3). That is, a very high percentage of firms report promotional actions, regardless of the value of other variables. Factor loadings for this variable are also relatively low.

It follows from this analysis that competitive aggressiveness is actually a two-dimensional construct, according to the types of actions a firm initiates. Factor loadings show that the first factor corresponds to moves involving product changes and technological innovations introduced by the firm; price changes and, to a lesser extent, promotional activities, load mainly on the second factor. It appears that firms choose to undertake competitive moves either by changing the product mix they offer and introducing technological innovations, or by manipulating other variables of their marketing strategy, such as price and promotion. Treating competitive aggressiveness as one-dimensional concept, a common approach in the literature, seems empirically inadequate.

TABLE 3.3: Dimensionality of the 'competitive aggressiveness' construct: results from factor analysis

KMO measure of sampling adequacy	0.548
Bartlett's test of sphericity	
Approx. Chi-square	245.931
d.f.	10
Sig.	< 0.001

Communalities	Initial	Extraction
PROD	1.000	0.541
PRICE	1.000	0.650
PROM	1.000	0.234
INN_PROD	1.000	0.727
INN_PROC	1.000	0.618

Total Variance explained

Factor	Eigenvalue	% variance	cumulative %
1	1.700	33.991	33.991
2	1.070	21.400	55.391
3	0.957	19.142	74.533
4	0.812	16.248	90.781
5	0.461	9.219	100.000

Rotated component Matrix

	Component 1	Component 2
PROD	0.640	-0.362
PRICE	-0.076	0.803
PROM	0.187	0.446
INN_PROD	0.838	0.155
INN_PROC	0.708	0.341

Component score coefficient matrix

	Component 1	Component 2
PROD	0.425	-0.386
PRICE	-0.118	0.737
PROM	0.075	0.389
INN_PROD	0.500	0.066
INN_PROC	0.404	0.247

Extraction method: PCA
Rotation method: Varimax with Kaiser normalization

Following results from factor analysis and consistently with previous literature (Smith et al., 1991; Chen et al., 1992; Miller and Chen, 1994), we distinguish between *strategic* and *tactical* actions. Strategic moves involve serious commitments of resources and are hardly reversible (at least, not without incurring in high sunk costs). They include technological changes, which require long-term efforts and relevant investments, and important modifications in products or services. Tactical ones, on the other hand, can be easily reversed and modified, do not imply profound organizational changes and do not demand a lot of resources (e.g. price cuts or promotional campaigns). There is a close analogy between this typology and the results from our factor analysis. We will thus label the first dimension (factor 1) as strategic aggressiveness and the second one (factor 2) as tactical aggressiveness in further analysis.

We must acknowledge that the source of data we are using involves a number of significant trade-offs. Information is obtained just at the level of overall firm behaviour, and it is not as detailed as in most previous studies[17]; additionally, measures are not specifically designed for this research, so that they provide less-than-optimal indicators for the constructs of interest. However, the longitudinal structure of the survey and the scope of the sample, covering a wide range of manufacturing industries, outbalance the limitations of available data.

7. RESULTS

Empirical results are based on the multilevel (observations grouped within firms) regression techniques we described in detail in the previous chapter. We use random-effects estimation in order to fit individual growth curves; we thus account for any potential bias arising from residuals not being independent for observations within the same firm (Snijders and Bosker, 1999; Goldstein ,2003).

Main results are presented in table 3.4. We first explore the effects of competitive

[17] Most competitive dynamics literature characterizes for collecting very detailed information at the action level, so that competitive aggressiveness is normally measured by a comprehensive count of competitive moves. Whereas this approach collects very fine grained information, it is not flaw-free (see Lyon et al., 2000). As our study only aims at characterizing competitive behaviour at the firm level, we do not require such detailed information. Instead, we report on self-reported survey information on competitive activity, which is in line with most literature on entrepreneurial orientation (Lumpkin and Dess, 1996; Lyon et al., 2000).

aggressiveness on firm performance, as formalized in hypothesis 1 (model 1). Results are mixed. Strategic aggressiveness shows a positive and significant effect (p-value < 0.05), as hypothesized; tactical aggressiveness, however, presents the reverse coefficient, its estimated effects on financial profitability being negative and non-significant.

TABLE 3.4: Effects of competitive aggressiveness and intangible resources on long-term firm performance

Fixed effects	(1)	(2)	(3)	(4)	(5)
intercept	0.0242 (0.0276)	0.0242 (0.0270)	0.0575 (0.0361)	0.0283 (0.0276)	0.0326 (0.0295)
time	-0.0037 (0.0051)	-0.0037 (0.0051)	-0.0037 (0.0051)	-0.0037 (0.0051)	-0.0037 (0.0051)
strategic agresiveness (str.agres.)	0.0445 * (0.0216)	0.0386 + (0.0211)	0.0372 (0.0247)	0.0361 + (0.0213)	0.0111 (0.0243)
tactical agresiveness (tac.agres.)	-0.0112 (0.0216)	-0.0475 * (0.0221)	-0.0399 + (0.0137)	-0.0437 + (0.0224)	-0.0414 + (0.0250)
intangibles		0.3242 *** (0.0588)	0.3340 *** (0.0588)	0.3298 *** (0.0595)	0.3293 *** (0.0628)
strategic agresiveness sqrd.			-0.0008 (0.0197)		
tactical agresiveness sqrd.			-0.0325 * (0.0137)		
intangibles sqrd.					-0.0220 (0.0924)
intangibles X str.agres.				0.0463 (0.0590)	0.0462 (0.0594)
intangibles X tac.agres.				-0.0444 (0.0492)	-0.0159 (0.0561)
intangibles sqrd. X str.agres.					0.1927 * (0.0954)
intangibles sqrd. X tac.agres.					-0.0248 (0.0728)
Error structure					
σ_{u0}	0.3292	0.3029	0.3016	0.3047	0.3071
σ_{u1}	0.0361	0.0360	0.0361	0.0356	0.0361
$corr_{u0u1}$	0.405	0.489	0.479	0.474	0.438
σ_e	0.7693	0.7693	0.7693	0.7694	0.7693
Phi (AR1)	0.2290	0.2891	0.2890	0.2892	0.2889

Number of observations: 5202
Number of groups (firms): 578
P-values: *** < 0.001 ** < 0.01 * < 0.05 + < 0.1

Results above do not consider firm intangible assets, which are however introduced as an explanatory variable in model 2. Their estimated coefficient is positive, of considerable size, and highly significant (p-value < 0.001). The initial endowment of intangible resources (measured for the 1991-1993 period) does have a positive and significant impact on long-term performance (operationalized as profitability levels between 1994 and 2002). Moreover, the inclusion of this additional covariate seriously influences regression coefficients for competitive aggressiveness.

Willingness to initiate strategic moves does still show a positive, although somewhat smaller, impact on firm performance. The coefficient, however, becomes just marginally significant (p-value < 0.1); as for tactical aggressiveness, the size of the negative effect gets greater and, more importantly, becomes significant. Overall, empirical findings suggest that controlling for initial intangible assets does have an impact on estimates for competitive dynamic behaviour. These results provide strong evidence confirming hypothesis 2, while they support only partially hypothesis 1; estimated coefficients show the expected sign for strategic actions, but they are weakly significant once intangible resources are introduced in the model. Tactical moves, however, seem to have a negative (and significant) effect on performance.

Testing hypothesis 4 requires adding two interaction terms to the model, accounting for the joint effects of invisible assets and competitive aggressiveness, either strategic or tactical. Such is the aim of model 4. Again, results do not confirm the hypothesis we have formulated, as coefficients are substantially insignificant. The effects of competitive manoeuvres do not seem to be affected by the set of intangible resources initially owned by the firm.

A possible explanation for lack of significance of regression coefficients is that relationships are indeed not linear. In order to investigate this possibility, we define and test two models incorporating quadratic terms for some of the variables (models 3 and 5) in search for non-linearities. Statistical output suggests that relationships with firm performance are indeed U-shaped for two explanatory variables: tactical aggressiveness and the intangibles*strategic aggressiveness interaction term. We will further comment on these results and offer some arguments that might explain non-linear effects in the discussion section below.

One research hypothesis remains to be tested. Do intangible resources enhance sustainability of superior performance? Contrasting this proposition requires exploring the effects of resources not only on profitability *levels*, but also on profitability *trends*. We showed in chapter 2 that performance tends to converge over time; those firms with stronger initial positions presented on average weaker dynamic performance, and vice versa (profitability growth was negatively correlated with initial profitability). Testing hypothesis 2 involves two separate, while related, questions. First, is the effect of invisible assets on initial performance more persistent than overall differences in performance? If so, does this result in a significant impact on profit persistence?

We address the first question by comparing the coefficient of the interaction term between time and intangible assets with that showing the relationship between initial status and time trends. This requires extending the empirical model by adding a supplementary latent variable regression, as described in the previous chapter. Consistently with findings presented in chapter 2, results show a significant process of erosion of initial profit differentials at a rate of approximately 8% per year[18] (see table 3.5). The effects of the initial endowment of intangible resources, on the other hand,

[18] More precisely, the estimated latent variable coefficients correspond to the rate of convergence in profitability rates *that cannot be attributed to initial heterogeneous intangible resources*.

also seem to decrease over time, as the coefficient for the interaction term (intangibles*time) is negative. The rate of convergence, however, is remarkably lower: -0.01/0.3256 = 3.1%. Moreover, such coefficient is not significant, so that we cannot reject the hypothesis that initial intangible resources had a similar effect on returns along the whole period studied (which amounts to nine years). Therefore, it appears that heterogeneous performance that can be explained in terms of initial bundles of intangible assets is indeed more persistent than that originating from other causes. This seems to confirm predictions from the RBV on the relationship between some firm resources and sustainable competitive advantage. This assertion is illustrated in figure 3.2.

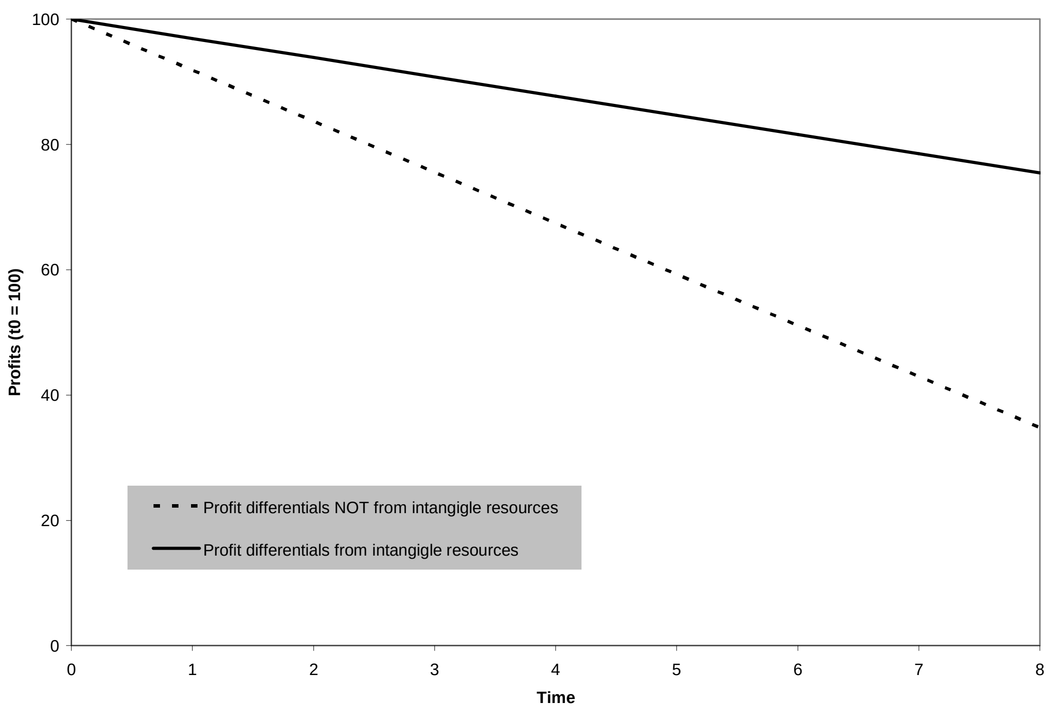
TABLE 3.5: Intangible resources and sustainability of performance differentials

Fixed effects	**Full sample**	**High performers**
intercept (B_0)	0.0278	0.4015 ***
	(0.0276)	(0.0209)
time (B_1)	-0.0050	-0.0464 ***
	(0.0053)	(0.0080)
intangibles	0.3256 ***	0.4007 ***
	(0.0725)	(0.0967)
intangibles x time	-0.0100	-0.0121
	(0.0140)	(0.0210)
Variance components		
σ_{u0}	0.5037	0.4631
σ_{u1}	0.0884	0.0923
σ_e	0.7021	0.6965
Latent variable regression (outcome = B_1)		
intercept	-0.0027	-0.0172
	(0.0042)	(0.0107)
B_0	-0.0815 ***	-0.0728 **
	(0.0115)	(0.0207)
intangibles	0.0165	0.0171
	(0.0118)	(0.0209)
σ_{u1}	0.0061	0.0074
	5202 observations	2331 observations
	578 firms	259 firms

P-values: *** < 0.001 ** < 0.01 * < 0.05 + < 0.1

It remains to be tested if such differences are indeed important enough as to improve overall profit persistence. We tested if intangible resources significantly influence profitability trends, controlling for the effects of initial performance (i.e. controlling for the process of profit convergence). Estimate for the coefficient (0.0165) showed the expected positive sign, but was not significant (p-value = 0.16). Fitting the model in the whole sample of firms, however, does not really help contrasting hypothesis 3, as two effects are confused within the coefficient: increase in profit persistence for initially high-performing firms, but also increase in catch-up rate for low-performing ones (McGahan and Porter, 2003). In order to separate them, and properly isolate the effects of intangibles on sustainability of competitive advantage, we split the sample according to initial profitability of firms, and re-fitted the model exclusively for high performers (firms reporting return on assets above their industry average in 1994). Results did not differ greatly from the full sample model. Invisible assets seem to somehow slow down the process of rent erosion, but this effect was not found to be significant.

FIGURE 3.2: Sustainability of initial differentials in profitability



A summary of empirical findings is presented in table 3.6.

8. DISCUSSION AND CONCLUSIONS

This chapter aimed at defining and testing a model integrating arguments and hypotheses from both the resource-based and Austrian schools of strategy, and more particularly from the literature on competitive dynamics. Both streams of research have tended, at best, to ignore each other, when not explicitly to present themselves as conflicting views. We suggest, however, that they not only are not contradictory, but can also be complementary in understanding causes of superior firm performance. Consistently with this view, we defined two research objectives.

Table 3.6: Summary of hypotheses and results

Hypothesis	Results	Comments
H1: The bundle of intangible resources of a firm has a positive effect on its long-term financial performance, controlling for the aggressiveness of its competitive behaviour.	Supported	Empirical results showed a positive and highly significant effect of the initial bundle of intangible resources (measured between 1991 and 1993) on long-term (1994-2002) levels of profitability.
H2: Intangible assets enhance sustainability of superior performance, controlling for the aggressiveness of the firm's competitive behaviour.	Not supported	Superior performance stemming from valuable intangible assets is indeed more persistent than other sources of above-average profits. However, they not significantly improve persistence of overall firm performance.
H3: The aggressiveness of a firm's competitive behaviour has a positive effect on its long-term financial performance, controlling for its initial endowment of intangible resources.	Partial support	Results support a positive relationship between strategic aggressiveness and performance, although it is just marginally significant when controlling for invisible assets. As for tactical aggressiveness, results showed the opposite sign than expected; the relationship seems inversely U-shaped.
H4: The initial bundle of intangible resources by the firm has a positive moderating effect on the relationship between the firm's competitive aggressiveness and long-term financial performance.	Not supported	Overall, a superior bundle of intangible resource does not significantly improve the effects of competitive aggressiveness on firm performance. Positive and significant coefficient for the quadratic interaction term suggests a U-shaped relationship

First, we developed a theoretical framework in order to explore possible relationships between the RBV and the Austrian school. Secondly, we proposed an empirical model for analysis in which we translate our arguments into testable hypothesis on the linkages between intangible resources and competitive dynamics. We analyze the effects of competitive aggressiveness on firm performance controlling for the firm's intangible resources (and vice versa); additionally, we also studied the moderating role of intangibles on the aggressiveness-performance relationship.

We tested our model on a wide sample of Spanish manufacturing firms. This sample is much more heterogeneous, in terms of both industry and firm characteristics (most saliently, firm size), than those in previous literature on competitive dynamics. This significantly improves external validity of results, which is of particular importance given the potential influence of contextual variables.

Empirical findings strongly suggest that intangible resources do have a positive and significant effect on the long-term performance of the firm. Special care has been taken in order to assure validity of causal inference. First, we guarantee the proper time sequence by defining a two-stage approach: the effects of pre-sample intangible resources, measured from 1991 to 1993 are tested on firm profitability from 1994 to 2002[19]. Secondly, unlike works using Tobin's Q or market-to-book value ratios, we rely on a contemporaneous measure of intangible assets, which is based only on current, and not future, revenue flows.

We found strong support for hypothesis 2, so that we can sustain that intangible assets can generate competitive advantage resulting in better long-term performance.

[19] Otherwise, doubts regarding direction of causality could be cast, and propositions of the RBV might become to some extent tautological (Priem and Butler, 2001).

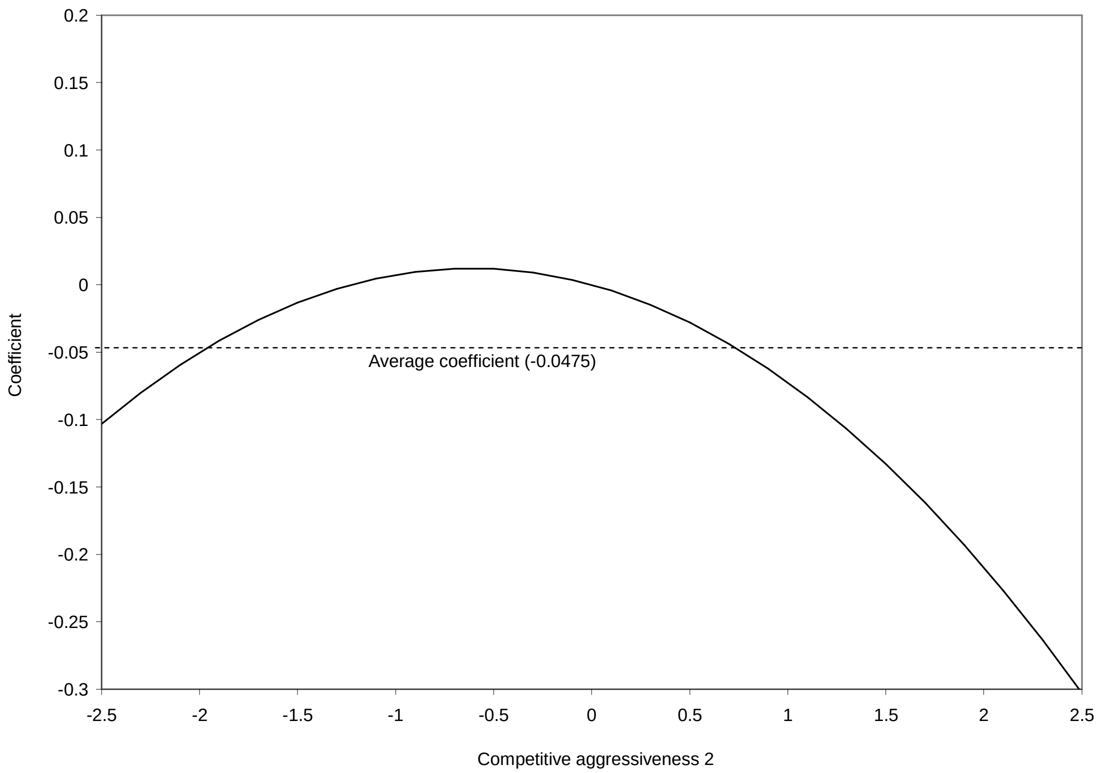
However, we could not find support for our hypothesis suggesting they improve not just profitability levels, but also profitability persistence (hypothesis 3). Actual empirical findings point to greater sustainability of competitive advantages arising from intangible resources, but this do not have a significant impact on overall profit persistence. Our results differ from those by Villalonga (2004), and mixed findings call for further research on this question. It is worth noting that there are a number of methodological differences between both studies. First, as we have already noted, we measure intangibles in a different, 'future-neutral', way. Secondly, we use a distinct empirical model. Villalonga (2004) tests her hypotheses on an autoregressive profitability model (Mueller, 1986). This approach, which is dominant within literature on profit persistence, presents a number of pitfalls that we discussed in the previous chapter. Most saliently, it does not really study persistence of overall firm performance, but rather of incremental components to profitability (McGahan and Porter, 2003), so that interpretation of results shall be substantially different.

Results are mixed regarding propositions based on competitive dynamics arguments. We found partial support for hypothesis 1, suggesting that frequent strategic moves by the firm do seem to improve performance, which is in line with findings in most previous literature (for a comprehensive review, see Usero, 2003). Nonetheless, the opposite showed to be true for tactical manoeuvring. A plausible explanation of these results is that strategic moves are more difficult to match by competitors, as they require significant financial and organizational resource commitments. Tactical moves, meanwhile, are easier to match; therefore, as far as competitive reaction takes place, they will not yield any durable advantage. They might even erode profitability by triggering strong competitive pressures. In this sense, empirical research shows that tactical moves are more likely to be followed by intense and rapid response (Chen et al., 1992; Smith et al., 1991), which ultimately increases competitive pressures faced by the firm and reduces profitability (Barnett and Hansen, 1996). There is thus a double-edged effect of competition on firm returns, as suggested by Thomas (1996); the 'negative edge' of rapid reaction and increased competitive pressures seems to be stronger for tactical moves than for strategic ones. Unfortunately, our data did not allow us to capture the dynamics of inter-firm competitive interaction; this interpretation of empirical results, thus, remains to be verified by further research efforts.

There is little discussion that managers engage in competitive manoeuvres seeking to improve firms performance. The question is less clear as to the actual consequences of such manoeuvres. Despite arguments from the Austrian school and competitive dynamics literature, there is still some debate on the consequences of firms changing frequently, and competitive moves are a form of organizational change. It is discussed if change is adaptive, that is, if it is likely to improve firm performance, or maladaptive (Barnett and Hansen, 1996). Some population ecology scholars suggest that frequent moves by the firm disrupt organizational arrangements and procedures and create adjustment costs, so that change does reduce, rather than increase, efficiency within the organization (Hannan and Freeman, 1984; Barnett and Carroll, 1995).

In summary, different research streams support arguments pointing at opposite directions as to the potential effects of frequent competitive moves. Some of our results suggest that both lines of reasoning receive empirical support, if at least partially. Figure 3.3 shows the coefficient for tactical aggressiveness as estimated from model 3. The inverted-U shaped relationship implies that best results are obtained by firms reporting average levels of competitive activity. A possible interpretation of this finding is that increasing aggressiveness yields better performance up to the point where the negative effects suggested by organization ecologists outweigh the temporary advantages predicted by competitive dynamics for further moves.

FIGURE 3.3: Effects of tactical competitive aggressiveness on firm performance (quadratic model)



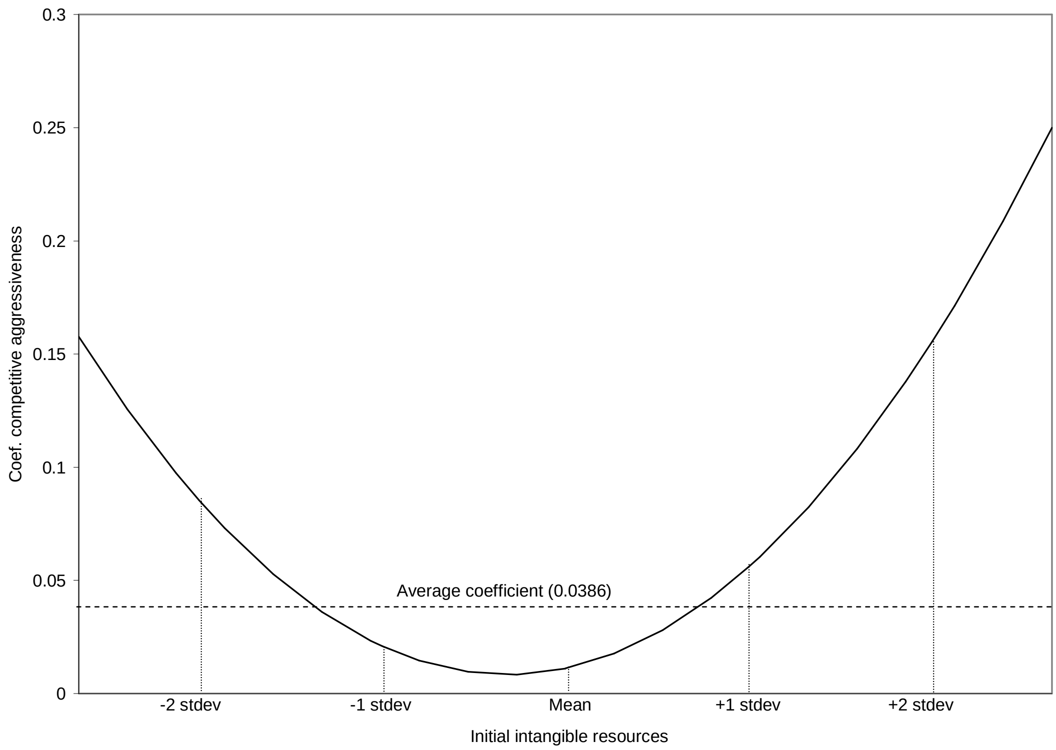
We did not find support for hypothesis 4 either. Results do not confirm that the bundle of intangible resources of the firm enhances effectiveness of competitive manoeuvring, neither strategic nor tactical. We also checked for non-linear effects (model 5 in table 3.4) and found a U-shaped relationship between intangible assets and the performance implications of strategic competitive aggressiveness (figure 3.4): firms with abnormally strong or weak initial endowments of resources seem to undertake more successful competitive moves. This finding suggests a more complex relationship than hypothesized. Initiating a new competitive move (or reacting to it) requires the combination of three organizational variables (Miller and Chen, 1994): motivation to engage in a competitive move, knowledge of available options, and capabilities to actually undertake action. Successful manoeuvring is a matter of incentives as much as it is of resources. A strong initial status stemming from a superior bundle of resources has a double edged effect. Whereas it may enable some competitive moves that are not available to weaker firms, it also restrains search routines looking for new strategic alternatives (Barnett and Hansen, 1996). Valuable sets of assets may encourage defensive competitive behaviours, which aim at protecting existing advantages, rather than engaging in creative, innovative, paradigm-breaking initiatives. In other terms, core resources and competencies may well become core rigidities for the organization (Leonard-Barton, 1992), reducing effectiveness of new competitive moves.

Our empirical findings suggest that best results from strategic manoeuvring seem to be obtained, on the one hand, by firms seriously lacking initial resources, which will presumably be highly motivated to engage in new profit-seeking initiatives; on the other hand, by some best-practice firms that are able to exploit opportunities provided by an initially outstanding bundle of intangible resources.

Overall, our results may seem somewhat disappointing for advocates of a ‘hypercompetitive shift’ (Thomas, 1996) in markets. A growing current of thought is claiming the obsolescence of the concept of ‘sustainable competitive advantage’. They argue that, in current competitive environments, firms cannot achieve long-term competitiveness on the basis of a set of rare, valuable, non-imitable resources. Instead, they suggest the key to success is undertaking frequent competitive moves in order to gain and renew a series of temporary advantages. However, we have found evidence on some degree of long-run advantage on the basis of intangible resources. For a matter of illustration, we regressed the 2000-2002 average firm (excess) return on assets on our measure of 1991-1993 intangible resources, and confirmed our previous results (beta =

0.135, p-value = 0.01). Moreover, long-term effects of firm resources do not seem to depend on the mediating role of successful competitive manoeuvres. We confirmed predictions by RBV theorists on the relationship between intangible assets and competitive advantage.

FIGURE 3.4: Effects of strategic competitive aggressiveness as a function of initial intangible resources



We also found frequent manoeuvring not to be a strong driver of firm returns. Tactical aggressiveness did not show a significant impact on performance (and, for the models it did, such effect was negative). Meanwhile, results for strategic competitiveness partially supported our hypothesis, but the estimated effect was still small and just marginally significant. We drew out hypothesis onto a common argument from the literature on competitive dynamics, which (somewhat simplified) states that firms perform better, on average, when they undertake a larger number of competitive moves; however, in the light of our empirical results, we may argue such relationship is somehow more complex. This might come explained by some trade-offs between the number and the effectiveness of competitive actions. It may well occur that firms choosing to initiate fewer moves are in better disposition to undertake precisely the kind of manoeuvres that ultimately drive competitive advantage.

We must note, however, that our findings are strongly conditioned by the limitations of our indicators. First, we could not directly observe manoeuvres undertaken by firms, but we had to rely on a proxy measure constructed from self-reported information. Second, and more importantly, we could only assess the effects of total competitive activity (i.e. aggressiveness). The literature on competitive dynamics (also in entrepreneurship, see Lumpkin and Dess, 1996, 2001) supports a positive impact of aggressiveness on profitability; it is not less true, however, that it has reached far greater levels of sophistication in exploring the effects of competitive behaviour. Not just the total number of moves, but also factors such as their sequence, impact, visibility, interaction and probability of reaction, among others, determine results from competitive dynamics (for a review on this topic, see Usero, 2003). We could not consider these developments in our empirical analyses. Therefore, there is still substantial room for further research to extend this work and overcome its limitations by making use of finer-grained information.

In this chapter, we have advocated for integrating arguments from the resource-based view with those from the competitive dynamics literature. We argued that, being two plausible explanations of heterogeneous firm performance, they may be complementary in explaining the causes of competitive advantage. Moreover, ignoring one of them might induce significant biases in empirical results. From a theoretical standpoint, this is a significant departure from most previous literature, which has tended to treat these two approaches as opposing views. We tested our arguments on a sample of Spanish firms that expands available evidence in terms of the scope of industries and typology of firms. Empirical evidence comes to confirm appropriateness of the integrative approach we propose. Estimates for competitive aggressiveness show to be highly sensitive to the inclusion of intangible assets in the model. Controlling for the initial status of firms, in terms of resource endowments, and its enduring effects on performance significantly influenced our results. We have showed that ignoring them might induce spurious relationships and lead to seriously misled conclusions.

CHAPTER 4. EFFECTS OF ENVIRONMENTAL DYNAMISM AND FIRM SIZE ON THE ECONOMIC PRODUCTIVITY OF R&D

1. INTRODUCTION

Innovation fuels economic growth and drives competitive advantage. Some authors indeed claim that firms cannot attain sustainable competitive advantage but by means of continuous innovation (D'Aveni, 1994; Roberts, 1999). Understanding the factors determining innovative success has thus become a major interest for both management scholars and practitioners. This paper claims not only that both environmental and firm variables are relevant to explaining the productivity of research and development (R&D) efforts, but also that they interact, influencing each other.

Regarding industry-level factors, most existing research has compared scientific vs. non-scientific, knowledge-intensive vs. non-knowledge-intensive industries. The major interest in these works lies on the effects of alternative technological regimes (Castellaci, 2007), defined mainly in terms of appropriability (for a review of the concept of appropriability, see Winter, 2006), product market demand and technological opportunity (Cohen, 1995). Being traditionally rooted into macroeconomic growth models, existing research on R&D and productivity strategic and organizational effects of different environmental conditions have often been neglected.

This study aims at addressing this research gap by incorporating the concept of 'environmental dynamism'. Management literature has consistently shown dynamism to be a key dimension of the competitive environment (Duncan, 1972; Dess and Beard, 1984; Burgeouis, 1985; Li and Simerly, 2002, among others). It can be argued that, whereas innovation and technological change may not be priority in stable industries, they become key to competitive success, if not mere survival, in rapidly-changing environments (D'Aveni, 1994, 1995; Brown and Eisenhardt, 1997; Eisenhardt and Martin, 2000). We expect the effect of R&D efforts on firm productivity to increase with industry dynamism.

Moreover, we also claim dynamism may not only have a direct influence on R&D productivity, but also play a significant moderating role on the relationship between firm size and innovation. Since the alternative Schumpeterian hypotheses were formulated[1] (Schumpeter, 1934, 1942), this topic has been among the most vastly studied by research on innovation (the seminal work being that by Arrow, 1962). However, both theoretical and empirical literatures have proved inconclusive in assessing how firm size affects innovative efforts (Cohen, 1995). We approach this question by suggesting that such relationship may indeed be contingent on competitive conditions, and that environmental dynamism constitutes a suitable candidate for a contingency factor; indeed, we argue that smaller firms may benefit from lower organizational rigidities.

[1] On the one hand, Schumpeter (1934) suggested that technological change is likely to be fuelled by small entrepreneurial firms, typically new entrants. On the other hand, he also posed that big incumbents with market power may enjoy innovative advantages, as they benefit from easier access to resources and better appropriability regimes (Schumpeter, 1942).

Research hypotheses will be analysed using extensions of a Cobb-Douglas production function, as suggested in seminal work by Griliches (1979). This empirical approach, which is standard to the literature on productivity, becomes rather innovative when referring to the relationship between firm size and innovation; compared to alternative approaches, it has the distinctive advantage on analyzing the economic returns to R&D efforts. We test our hypotheses on a dataset comprising a panel from 1991 to 2002 of 1,340 Spanish firms engaging in R&D efforts, grouped in 17 different manufacturing industries.

In summary, we can identify three major contributions of this study. First, we extend previous works on inter-industry differences in R&D productivity by considering the moderating role of environmental dynamism. Second, we add evidence on the long-studied relationship between firm size and innovation. Unlike most previous studies on this topic, we are able to provide a direct estimation on how size affects economic returns on R&D investments. Third, we provide a contingent framework for assessing the consequences of firm size, as we contend that relative advantages of larger firms may depend on the characteristics (and, more concretely, dynamism) of the competitive environment conditions. From a theoretical standpoint, this work incorporates concepts and arguments from the literature on management to the study of a problem that, being of high relevance for managers, has usually been observed with the lens of economic theory.

The chapter is structured as follows. Drawing from the review of the relevant literature, research hypotheses are presented and supported in section 2. Sections 3 and 4 are devoted to the definition of the econometric model and the methodological approach. Empirical results are reported and conveniently discussed in section 5, leading to the conclusions, presented along with the limitations of the study and suggestions for further research in section 6.

2. BACKGROUND AND RESEARCH HYPOTHESES

Robert Solow's (1957) classical work on economic growth found that most such growth remained unexplained by the accumulation of classical production factors (i.e. labour and capital[2]), a plausible alternative explanation coming from technological change. This idea was already central to the powerful Schumpeterian intuition that innovation is the ultimate driving force of capitalism (Schumpeter, 1942). Ever since, substantial academic effort has aimed at explaining 'Solow's residual'; in this line, a large number of works have analysed the impact of R&D investments on productivity and productivity growth, normally including some form of knowledge or technology stock in the Cobb-Douglas production function. Seminal empirical studies on the topic date from the 1960s (e.g. Mansfield, 1965), the methodological framework being substantially developed in the late 1970s (Griliches, 1979). The vast majority of econometric research on the topic in the last decades is deeply rooted in Griliches's work, the present study being no exception.

We can distinguish two major research streams on this matter; first, those works assessing the average contribution technological capital to total output[3]. Secondly, those others that explore what variables (i.e. market concentration, institutional settings, firm

[2] Traditional economic theory included land as a third input. Modern approaches tend to neglect this factor which, on the other hand, does not contribute to growth, as in modern economies it remains stable.

[3] In this sense, empirical findings have showed a positive and significant contribution of R&D to productivity; regarding the size of such contribution, estimates of R&D elasticity in different cross-sectional studies using firm-level microdata3 range from 0.03 to 0.25 (Kafouros, 2003), time-series estimates being normally lower (Mairesse and Sassenou, 1991). Other methodological choices by researchers may also affect results significantly, which limits comparability of findings and hinders the development of a cumulative body of knowledge. More on these methodological and econometric issues will follow in section 4.4 below.

size, etc.) may moderate such contribution; they aim at responding to empirical findings showing that, whereas there seems to be somewhat of a common story across studies, estimates of productivity of R&D investments differ substantially across samples (Mairesse and Sassenou, 1991; Griliches, 1995; Kafouros, 2003). Whereas the former works contribute mainly to macroeconomic growth models, the later are of particular interest for strategists and management scholars. Within this research stream, we next focus on how industry dynamism and firm size can make a difference when it comes to economic returns to R&D investments.

2.1. Industry effects and R&D productivity: the role of environmental dynamism

There is substantial research on why industries differ in their levels of innovative activity. First, scholars working on the Schumpeterian tradition evaluated the effects of market structure and market power on R&D efforts (Williamson, 1965; Scherer, 1967 and Mansfield, 1968 are examples of seminal works on this debate). Later, in a rather more elaborated discourse, researchers have come to identify a number of industry-related explanatory variables, which can be grouped in three categories (Cohen, 1995): product market demand, technological opportunity and appropriability conditions.

Such literature is vast and reviewing it lies well beyond the scope of this work, but there is one point worth mentioning. Previous studies on the topic have referred to innovative intensity as its dependent variable. That is, they are concerned with how much firms invest in R&D, and not with how productive those investments are; comparatively with this literature, little effort has been made to formally assess how environmental factors may moderate the impact of R&D on productivity.

There is, on the other hand, extensive exploratory evidence suggesting that industry does indeed play such moderating role. Some researchers have compared sub-samples of firms belonging to scientific and non-scientific firms (Griliches and Mairesse, 1984; Cuneo and Mairesse, 1984; Harhoff, 1998; Wang and Tsai, 2003), whereas others have conducted studies focusing on specific industries, such as chemical products (Minasian, 1969; Schankerman, 1981) or electronics (Tsai and Wang, 2004). The evidence is robust, if unsurprising: productivity of R&D is typically higher for those firms operating in scientific, knowledge-intensive and technology-based industries.

The present study builds on this evidence and extends previous research in order to undertake explicit tests relating industry factors to the elasticity of technological capital. Particularly, we focus on the concept of environmental dynamism, very widespread and rather well understood within the management literature, but essentially new to the study of this topic. We believe that, innovation being a strategic activity that involves complex organizational processes, the understanding of how firm productivity is enhanced by R&D investments can greatly benefit from incorporating concepts and arguments from management literature.

Ever since seminal works by Lawrence and Lorsch (1969) and Duncan (1972), both theoretical and empirical literatures have established that the level of dynamism is one of the most important dimensions characterizing business environments (Li and Simerly, 2002). Although the issue of definition is not totally uncontroversial, a dynamic environment could be defined as one which is subject to frequent changes, especially when such changes are profound and unforeseeable (Navas and Guerras, 2007).

Rapidly environmental change has substantial implications for strategy and competition.

Most relevant to our purposes is that it does affect organizational characteristics, resources and capabilities (Volberda, 1996; Brown and Eisenhardt, 1997; Teece et al., 1997; Eisenhardt and Martin, 2000) linked to competitive success.

There are two main ways in which a firm may achieve sustainable competitive advantage (i.e. long-term superior performance). First, establishing barriers that isolate its sources of advantage from competitive pressures (Rumelt, 1984); second, innovating regularly so that new sources of advantage replace those eroded by competition (Roberts, 1999).

In dynamic environments, where instability and change may easily render resources obsolete, isolating mechanisms can be not only useless, but also counterproductive (D'Aveni, 1994; Fiol, 2001). Firms not changing as their environments do will soon see their competitive position jeopardized. Under conditions of rapid change, innovation thus becomes the cornerstone of long-term competitiveness. This idea has been extended by the dynamic capabilities literature; firms need to be able to create new resource configurations in order to successfully respond to environmental change (Brown and Eisenhardt, 1997; Teece et al., 1997; Eisenhardt and Martin, 2000).

It has been argued that innovative efforts can modify the firm's internal resources, creating a more perceptive, flexible and adaptable firm (Geroski, 1994; Volberda, 1996). R&D investments significantly contribute to organizational learning processes, increasing the firm's absorptive capacity. That is, its ability to assimilate and use externally-generated new technologies and information (Cohen and Levinthal, 1989, 1990). Organizational characteristics such as flexibility and absorptive capacity are more valuable in highly dynamic environments, as they allow firms to adapt to and even take advantage of competitive and technological change.

Hypothesis 1 is drawn from arguments above.

Hypothesis 1: The economic productivity of R&D investments increases with environmental dynamism.

2.2. Firm size and innovative advantage

A number of arguments have been proposed in support of the relative advantages of bigger firms in performing R&D. Cockburn and Henderson (2001) identify three major benefits of size.

Firstly, large firms enjoy a better position in securing finance for research projects, as size is positively correlated with availability of internally-generated funds; this is particularly relevant since R&D may be highly risky and capital markets are subject to imperfections arising from information asymmetries[4].

Secondly, larger firms may be able to exploit technical economies of scale and scope in the conduct of research itself; whereas the former rely on the claimed greater technical efficiency of R&D activities conducted at a great scale (e.g. the use of better equipped laboratories or pilot production lines), the later arise from the potential extension of research output to a number of different products and economic activities. It is a well established stylized fact that firm size is positively associated with diversification. Therefore, larger firms will be better positioned for exploiting economies of scope in research across a number of product lines. In terms of innovation literature, they enjoy

[4] Information asymmetries arise from potential fund providers having limited information in order to assess the potential benefits and risks involved in R&D projects. They risk opportunistic behaviour from the firm conducting the project, as it benefits from insider information it may not disclose.

appropriability advantages when new technologies are extended beyond their original scope.

Thirdly, larger firms may not only be technically more efficient in producing innovations, but also enjoy advantages in translating such innovations into profits. Larger companies are able of distribute the fixed costs of research over a larger sales base, resulting in lower per-unit costs of R&D programs. This cost-spread argument had already been developed in Cohen and Kepler (1996). Previous literature has also suggested that R&D is more productive as a result of complementarities with other activities (e.g. marketing and finance) that are needed to fully exploit technological innovations in the market. Such complementary activities and resources are typically more developed within large firms (Cohen, 1995).

Classical work by Arrow (1962) considers two additional benefits of size. Firstly, the possibility of diversifying the risk inherent to R&D projects across a larger number of products. Secondly, a greater ability to establish barriers to imitation from competitors (e.g. property rights). Arrow's conclusion is that small competitive firms will tend to underinvest in R&D.

It becomes apparent that arguments from authors defending the innovative advantage of large firms are founded mainly (but not only) on the economic theory. On the other hand, a number of works have suggested counter-arguments, supporting the idea that large firms may actually have a disadvantage in performing technological innovation. Unlike the former ones, these authors mainly (but not only) argue on the grounds of organization theory.

The concept of organizational inertia captures the idea that firms have an intrinsically limited capacity to change, to the extent that the very nature of an organization requires some degree of stability (Hannan and Freeman, 1984). A revision of the sources of inertia (see Hannan and Freeman, 1977) leads to the conclusion that the ability to change is inversely proportional to firm size, other things equal. Larger firms are more complex and bureaucratic, information and power are more disperse across the organization, and knowledge and behaviour become increasingly codified and standardized. These organizational characteristics discourage the kind of creative thinking and risk-taking behaviour demanded by successful innovation. It has also been sustained that employees in smaller firms tend to show greater technical competence (Schmookler, 1972); they also have greater incentives to innovate, as they enjoy a better appropriability regime of the rents generated by innovations (Qian and Li, 2003). Overall, these works suggest large firms do not provide a favourable organizational environment for technological changes, particularly for radical, paradigm-breaking ones (Koberg et al., 2003).

Theoretical arguments pointing to opposite directions, empirical evidence should have the last word in the debate. However, despite the impressive body of research on the topic, results are still largely inconclusive and in some cases apparently contradictory. It is generally accepted that R&D has decreasing technical returns to scale (Cohen, 1995); that is, innovative output (i.e. new product launches, patents, process improvements) grows less than proportionally to increases in R&D expenditure (for a review, see Griliches, 1998). This is normally taken as evidence of relative disadvantage of large firms, probably because they provide less favourable organizational setting for innovation. It must be noted, however, that such results do say nothing about the alleged greater ability of bigger firms to extract economic profits from the innovations they actually produce (cost spreading, better appropriability conditions, barriers to imitation, etc).

On the other hand, there is a vast empirical research examining the relationship between firm size and R&D intensity (not productivity). Some early studies found larger firms investing relatively more in technological innovation (e.g. Horowitz, 1962; Hamberg, 1964), which was taken as evidence of their innovative advantage, thus contradicting findings above. On the whole, however, evidence is largely inconclusive, and there is some consensus that, beyond a given threshold, relative R&D efforts do not change with firm size (Cohen and Kepler, 1996). Other authors find the opposite relationship, and some even an inverted-U shape, with R&D intensity growing steadily until some point and declining for larger firms (for in-depth reviews on this topic, see Cohen, 1995 and Subodh, 2002).

It is worth noting that previous literature, with a few exceptions (e.g. Kafouros, 2003; Kwon and Inui, 2003; Tsai and Wang, 2004), has not directly measured how firm size affects returns to R&D investments. There is very still limited evidence establishing the relationship between size and the economic productivity of R&D.

Kwon and Inui (2003) fit a transformation of a Cobb-Douglas function separately for small, medium and large firms; Kafouros (2003) uses similar methods (two subsamples, divided according to firm size). Analogously, Graversen and Mark (2005) divide firms in four categories according to number of employees, and estimate interaction effects between R&D and size categories. A different approach is taken by Tsai and Wang (2004, 2005), who introduce in the production function an interaction between physical and technological capital in order to explore the effects of firm size. Results, again, are mixed. Findings by Kwon and Inui, using a sample of 3,830 Japanese manufacturing firms, suggest the economic productivity of R&D to be greater for large firms. Kafouros gets analogous results from a 14-year panel of 78 firms in four different industries. On the other hand, Tsai and Wang, whose sample is limited to 83 large firms in the electronics industry, find a negative influence of firm size on research productivity. Graversen and Mark also report negative effects of size on a economy-wide sample of 2,228 Danish firms.

The opposite theoretical arguments presented above, along with the inconclusive empirical evidence, lead us to formulate the following alternative hypotheses:

Hypothesis 2.a. The economic productivity of R&D investments increases with firm size.

Hypothesis 2.b. The economic productivity of R&D investments decreases as firm size increases.

2.3. The moderating role of environmental dynamism on the relationship between firm size and R&D productivity.

Thus far, we have separately hypothesized the effects of environmental dynamism and firm size on R&D productivity. We next consider the moderating role that dynamism may have on the consequences of size. Some empirical evidence indicates that the size-innovation link does differ across industries (Cohen, 1995). Consequently, we can argue that such relationship may be contingent on a number of environmental factors. More concretely, we argue that industry dynamism may significantly moderate the relative advantage (or disadvantage) of larger firms when conducting R&D.

As noted by Cockburn and Henderson (2001), an implicit assumption underlying some arguments supporting large-firm advantages is that technological assets are highly specific (Li and Simerly, 2002); they are deeply embedded within the firm in which they are developed, as they interact with several firm-specific resources and capabilities, many of them intangible (co-specialization). Their value would be lower if they were to be transferred to any other organization. This asset stickiness will cause inter-firm technological markets to be subject to substantial transaction costs (Williamson, 1991). Consequently, in-house development and exploitation of R&D-related assets become relatively more efficient (Coase, 1937).

Let us consider a firm developing a new technology. It has two main alternatives available to exploit it: it can either incorporate the innovation to its activities or sell it in the market (e.g. technology licensing). Consequently, the advantages of firm size when profiting from new technologies equals the minimum of the following two amounts:

value in large firms – value in small firms (of in-house exploited new technologies)

value of in-house exploited new technologies (in large firms) – market value of new technologies

If we assume efficient markets, market price will equal marginal utility of the innovation for the firm that is most efficient in using it. Under such conditions, smaller firms could make use of market mechanisms in order to overcome the potential disadvantages of size (smaller sales base, limited scope of activities, lack of complementary resources, etc.) when extracting revenues from innovation. Limited saleability of technological resources thus becomes a precondition for most benefits of size to be effective (Cohen and Kepler, 1996).

It can be argued that under high environmental dynamism, costs associated to transactions of technological assets may be significantly reduced. Dynamic industries are characterized among other factors by their innovative intensity; indeed, dynamic markets being defined in terms of rapid change, the rate of technological change is one of the constitutive dimensions of dynamism (Duncan, 1972; Dess and Beard, 1984). As already mentioned, one of the consequences of innovation within the firm is the development of its absorptive capacity. Its ability to incorporate new externally-developed technologies is enhanced. It has also been noted in the literature that firms operating in unstable environments will tend to focus on improving flexibility, organizational change and learning (D´Aveni, 1994; Volberda, 1996). Competitive success will increasingly depend on the so-called dynamic capabilities (Brown and Eisenhardt, 1997; Teece et al., 1997), firms becoming better fitted to change, including technological change.

We can thus conclude that, under conditions of high environmental dynamism, stickiness of R&D-based assets is likely to decrease, as firms become better suited for incorporating innovations generated by other companies. As a result, market transactions of technological assets become relatively more efficient, *ceteris paribus*, thus offering better opportunities for firms to partially overcome small size disadvantages.

Industry instability is also relevant to the 'organizational inertia' argument. Firms' resistance to change cannot, and certainly should not, be interpreted as isolated from the competitive environment. It is the inability to keep up with the pace of environmental change which reduces strategic fit and harms the firm's competitive position (Ansoff, 1965). This idea underlies the concept of 'relative inertia' (Hannan and Freeman, 1984).

Innovative success in rapidly changing industries calls for the organization to act creatively, as well as to continuously gather and process new information (Priem et al., 1995; Peteraf and Bergen, 2003). This way it can overcome the intrinsic uncertainty of decision making under changing competitive conditions (Duncan, 1972, Burgeois, 1985). These needs collide with process bureaucratization and greater complexity of information flows as firms grow bigger (Van de Ven et al., 1999), preventing the relevant knowledge to be gathered and spread right across the organization. Additionally, task standardization and specialization discourage the kind of creative thinking that leads to the 'exploratory learning' needed to develop substantially new organizational routines (March, 1991).

Altogether, this reduces the chances of large firms to create and sustain advantage from technological change when such change is rapid and profound. In other words, smaller firms provide organizational settings that are relatively better suited for innovating in dynamic environments.

There is also some scattered evidence, both quantitative and qualitative, that in scientific and knowledge intensive industries small firms and new entrants are particularly likely to introduce major innovations, compared to large incumbents. Results have also shown that the former usually adapt better to radical technological changes.

The conjunction of both economic (basically transaction-cost based) and organizational arguments leads to hypothesis 3.

Hypothesis 3: The dynamism of the environment has a negative moderating effect on the relationship between firm size and the economic productivity of R&D.

Hypotheses 1 to 3 are summarized in figure 4.1. They will be tested empirically using extensions of a standard production function model, which we develop in the next section.

3. THE MODEL

The standard approach in the literature to the estimation of the productivity of R&D activities from firm-level data is through a three-input Cobb-Douglas production function. This model suggests that, along with traditional inputs, labour and physical capital, firms also make use of their stock of technological capital for productive purposes (Griliches, 1979):

$$Q_{it} = A_i\, t^{\lambda}\, C_{it}^{\beta 1}\, L_{it}^{\beta 2}\, K_{it}^{\beta 3}\, e_{it} \qquad (1)$$

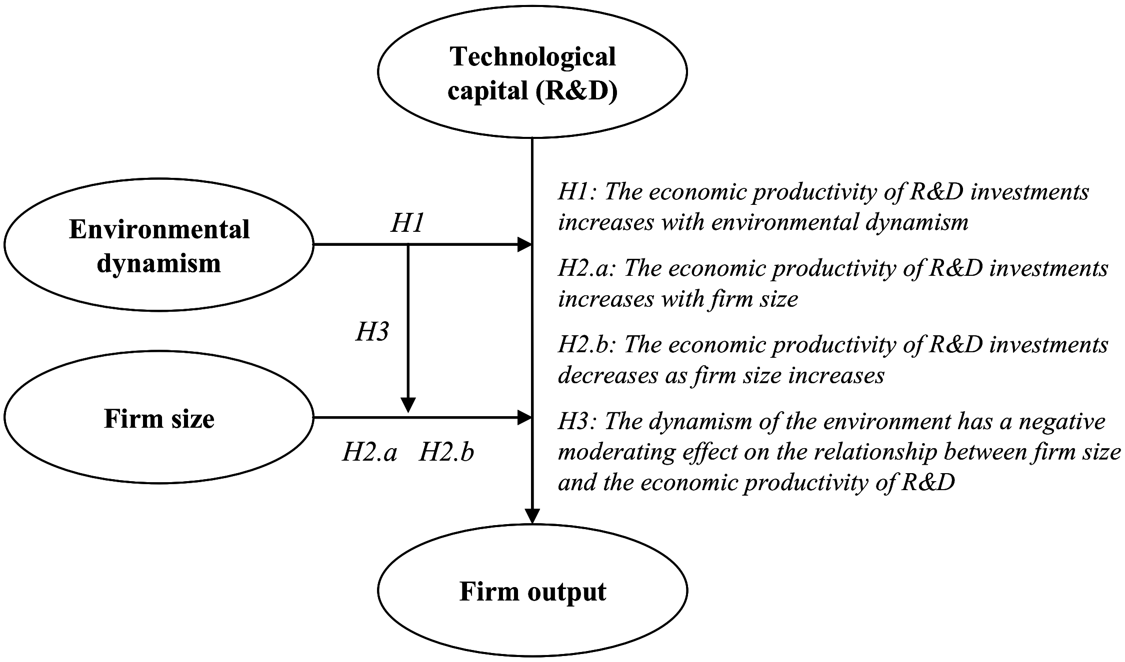
where Q_{it} represents output (i.e. revenue) of firm i in year t, C physical capital, L labour and K the firm's accumulated technological capital. In this model, λ accounts for productivity growth not associated with changes in the level of inputs. It is normally interpreted as the rate of disembodied technological change.

The function can be linearized taking logarithms of the original variables (represented here by lower-case letters).

$$q_{it} = a_i + \lambda t + \beta_1 c_{it} + \beta_2 l_{it} + \beta_3 k_{it} + e_{it} \qquad (2)$$

In expressions (1) and (2) above, technological capital accounts for the firm's '*accumulated know-how, technical expertise, trade secrets, patents, etc.*' (Hall and Hayashi, 1989: 2). These largely intangible and knowledge-based assets may accumulate in a number of ways, as organizational learning takes place in different fashions. However, it is commonly accepted that R&D investments are particularly well suited for creating and acquiring technological knowledge; the concept of technological or knowledge capital is thus normally reinterpreted as the more restrictive of R&D capital, which yields substantial operational benefits for empirical research.

FIGURE 4.1. Summary of research hypothesis



As mentioned above, most research on the topic has studied the effects of size on either innovative intensity (normally measured as R&D expenses as a percentage of sales or other analogous measures) or the technical productivity of R&D (e.g. 'patents per dollar'). Meanwhile, and following some previous works (Tsai and Wang, 2004; Tsai, 2005), we directly estimate the moderating effect of size by adding an interaction term of the form $c_{it}k_{it}$ to equation 2 above. Considering that the goal of the firm is maximizing economic profits and that patents are not an end on themselves but a means, the Cobb-Douglas approach has the distinctive advantage of providing direct estimates of the economic output of technological capital. Modelling size effects by an interaction term yields a continuous estimate, avoiding the intrinsic arbitrariness involved in choosing the cut-offs for subdividing the sample.

3.1. Econometric specification

Despite the extensive use of Cobb-Douglas-type functions in the literature during the last decades, most of the econometric concerns posed by Griliches's (1979) seminal work still lack a fully satisfactory response.

It has been noted repeatedly that the omission of unobserved effects may bias estimates and, under certain assumptions, lead to an overestimation of the elasticity of R&D. Some authors introduce industry dummies to account for industry effects[5]. An alternative approach is using fixed-effects or first-differencing estimators, so that permanent firm and industry effects are wiped out (Wooldridge, 2002).

A third option may come from the use of mixed-effects models[6], as they have proved an efficient technique for considering the multilevel structure of data in which observations are grouped in natural clusters (Snijders and Bosker, 1999); in this setting, they allow capturing industry-specific effects:

$$q_{it} = a_j + \lambda t + \beta_1 c_{it} + \beta_2 l_{it} + \beta_3 k_{it} + e_{it} \qquad (3)$$

$$a_j = a + v_{0j} \qquad v_{0i} \sim N\,(0,\sigma^2_{0j}) \qquad (3.a)$$

where a_j represents the industry-specific for firms in industry j. It is composed of a, the average intercept, and $v_{0j,}$ the later being a random variable corresponding to permanent industry effects.

Mixed-effects models yield three significant advantages (Snijders and Bosker, 1999).

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[5] Ideally, research should also control for unobserved firm-specific effects, but this is normally not feasible unless very long time series are available

[6] The term 'mixed effects' refers to models where the intercept and/or some of regression coefficients are assumed to be a mix of a fixed and a random component, the later accounting for unobserved differences across sampling units. Thus, it includes both the random-effects and random-coefficients models for panel data, as described by the Econometrics literature.

Firstly, they are more appropriate when the groups (i.e. industries) are sampled from a larger real or hypothetical population. Secondly, since not all variability is explained out by the random effects, as it is with group dummies, the effect of group-level variables can still be modelled and tested. This is particularly relevant for the research questions in the present paper, as we are interested in testing the effects of industry-level variables on our dependent variable. Lastly, the mixed-effects approach is much more efficient and allows obtaining group effects even when the number of groups is large and the observations per group limited[7].

Unfortunately, random-effects estimators only yield consistent results when the unobserved effects and the explanatory variables are assumed to be orthogonal[8] (Mundlak, 1978). Regarding model (3) above, firms operating in more productive factors are likely to invest more in production factors, and particularly in R&D (i.e. the random effect v_{0j} would be correlated with the independent variables), so that the orthogonality assumption seems implausible, and estimates may still be biased.

This would advocate for the use of a fixed-effects estimator; such an approach, however, also poses some serious problems of its own (see Mairesse and Sassenou, 1991). The 'technological capital' construct cannot be measured without error; well on the contrary, measurement error can arise from different sources. This will induce an alleviation bias for the β_3 coefficient in expression (3). Using a fixed-effects estimator in this context would exacerbate such alleviation bias, as corr (k_{it}, k_{it-1}) is expected to be

[7] Random effects models include the extra assumption that all group effects are identically distributed. In substantive terms, this implies assuming that group-specific effects are not totally independent, but share some common underlying processes. Such an assumption seems reasonable in this context, as there exist empirical regularities in the factors determining firm and industry profitability. Random effects for each group are thus based on specific information on units within that group, but also partially on information from the whole sample. In fixed-effects models coefficients for group dummies are estimated separately, therefore requiring more information.

[8] That is, it assumes $E(u_{0i}|X_i) = E(u_{0i}) = 0$

high (Hsiao, 2003), for technological capital at any point in time will be a function of past R&D investments[9].

As a result, fixed-effects estimator can also be severely (downward) biased, which, in turn, renders meaningless the results of specification tests for random effects, such as that proposed by Hausman (1978).

The econometric approach to model (3) thus becomes to a great extent a matter of choosing 'the lesser of two evils'. On the basis of preceding arguments, and considering the nature of the research questions posed in this paper, a random-effects model seems the most sensible choice.

As we have already suggested, model (3) above can be extended in order to account for the effects of size on R&D productivity by introducing a $c_{it}k_{it}$ interaction term (Tsai and Wang, 2004), where physical assets are taken as a proxy for firm size.

$$q_{it} = a_j + \lambda t + \beta_1 c_{it} + \beta_2 l_{it} + \beta_3 k_{it} + \beta_4 c_{it} k_{it} + e_{it} \qquad (4)$$

Research hypotheses stated in section 2 above also require a more complete specification of industry-level random effects

$$q_{it} = a_j + \lambda t + \beta_1 c_{it} + \beta_2 l_{it} + \beta_{3j} k_{it} + e_{it} \qquad (5)$$

$$\beta_{3j} = \beta_3 + v_{1j} \qquad v_{1j} \sim N(0, \sigma^2_{1j}) \qquad (5.a)$$

$$q_{it} = a_j + \lambda t + \beta_1 c_{it} + \beta_2 l_{it} + \beta_3 k_{it} + \beta_{4j} c_{it} k_{it} + e_{it} \qquad (6)$$

$$\beta_{5j} = \beta_5 + v_{2j} \qquad v_{2j} \sim N(0, \sigma^2_{2j}) \qquad (6.a)$$

Model (5) allows R&D elasticity to vary randomly across industries (v_{1j} term in

[9] This is obvious upon examination of the formula from which values for K are derived, as presented in section 4.

expression 5.a), whereas model (6) introduces industry-level variability to the linear effects of firm size on R&D productivity (v_{2j} term in expression 6.a). Finally, the effects of environmental dynamism can be introduced in the full model by adding two cross-level interaction terms, $k_{it}d_j$ (equation 7) and the three-way $c_{it}k_{it}d_j$ (equation 8), where d_j stands for environmental dynamism[10].

$$q_{it} = a_j + \lambda t + \beta_1 c_{it} + \beta_2 l_{it} + \beta_{3j} k_{it} + \beta_4 k_{it} d_j + e_{it} \quad (7)$$

$$q_{it} = a_j + \lambda t + \beta_1 c_{it} + \beta_2 l_{it} + \beta_{3j} k_{it} + \beta_{4j} c_{it} k_{it} + \beta_5 k_{it} d_j + \beta_6 c_{it} k_{it} d_j + e_{it} \quad (8)$$

4. METHODS AND SAMPLE

4.1. Concepts and measures

Measures of output, physical capital and labour are rather straightforward and well established in the literature. The main difficulties arise in the measurement of the technological capital and environmental dynamism constructs. Regarding firm output, production-function models normally use either total sales or added value as response variables. In the present case, total sales are used. Physical capital is measured by book value of fixed assets, and labour by the total number of man-hours (in 000's)[11].

4.1.1. Measuring Technological Capital

As mentioned in section 3 above, the technological capital construct refers to the idea of knowledge; in a strict sense, it is intrinsically intangible and unobservable. There is nevertheless academic consensus that past R&D investments constitute a reasonable proxy for the amount of technological knowledge accumulated by a firm. However, as

[10] It must be noted that, although dynamism is here represented by a single variable, this is a multidimensional concept and will be later operationalized using two different variables (see Section 4.5).

[11] In order to calculate man-hours, we multiply the number of equivalent full-time employees by the firm estimate of average hours worked by employee (considering overtime and lost working hours).

highlighted by evolutionary literature, organizational evolution is not simply a process of creating new knowledge, but also of discarding obsolete one (Burgelman, 1991); past R&D investments have to be depreciated in accordance with this obsolescence phenomenon. The standard approach to measuring technological capital is the perpetual inventory model, in which the stock of technological capital of firm i at time t is derived from the following expression

$$K_{it} = (1\text{-}d)K_{it\text{-}1} + R_{it\text{-}1}$$

where K_{it-1} represents the stock of technological capital in the previous year, R_{it-1} the R&D investments in t-1, and d the depreciation rate[12]. The initial stock of technological capital, accounting for all R&D expenditures prior to the sampled period, is sometimes estimated as $R_{i1}d^{-1}$ (e.g. Goel, 1990)[13]; this model can be extended in order to account for firm age as follows

$$K_{i1} = R_{i1}\, d^{-1}\, (1\text{-}(1\text{-}d)^{a\text{-}1})$$

where a represents the age of the company at the time of the first observation (Rodríguez, 2003).

An implicit and rather restrictive assumption of this model is that R&D investments are constant prior to the observed period; d^{-1} could also be substituted in the expression by $(d\text{-}g)^{-1}$, assuming a constant growth rate g of R&D investment prior to t=0 (Kwon and Inui, 2003); such assumption, however, can also be rather arbitrary if enough

[12] It is a well established fact that using R&D investments as an explanatory variable in a production function incurs in some double counting, as some R&D takes the form of capital or labour expenses (Schankerman, 1981). If such double counting is not corrected for (and the information to do so is rarely available), estimated elasticities must be interpreted cautiously. However, inter-firm and inter-industry comparisons, the main concern of this study, remain unaffected.

[13] This expression comes from the approximation to the sum of the following infinite geometric series

$$Rt = (1\text{- }d)R_{t\text{-}1} + (1\text{- }d)^2\, R_{t\text{-}2} + (1\text{- }d)^3\, R_{t\text{-}3} + \ldots$$

information is not available. Nonetheless, as R&D depreciates quickly, the impact on actual technological capital estimates of these and other assumptions regarding past investments is rather limited. Moreover, as the models of analysis in this paper are concerned with relative differences in R&D elasticity across firms and industries rather than with its absolute values, validity of results is unlikely to be affected.

The second question that needs to be sorted out is the value of d, the obsolescence rate of technological capital. Some efforts have been done to estimate firm-specific rates from empirical data, using either patent renewals (Bosworth, 1978; Pakes and Schankerman, 1984) or information from specific technology-oriented surveys (Goto and Suzuki, 1989). These approaches, however, may be problematic and rely on extensive information that is not generally available. Most researchers, on the other hand, have adopted a conventional and widely accepted 15% obsolescence rate (e.g. Griliches, 1979; Jaffe, 1988; McGahan and Silverman, 2003). A 15% depreciation rate is also assumed here.

4.1.2. Environmental Dynamism

Unlike other industry characteristics, empirical results have shown dynamism is a multidimensional concept, depending on the elements of the environment which are considered. A minimum of two dimensions can be identified: market (or demand) instability and technological dynamism (Tosi at al., 1973); such two dimensions are used in this study.

Following previous research (e.g. Dess and Beard, 1984), demand instability is measured by the relative dispersion over the regression line obtained when some relevant market variables are regressed on time over the 1991-2002 period; relative dispersion is operationalized as the standard deviation of the beta coefficient divided by the mean value of the variable. This approach controls for time trends, measuring just unsystematic and unpredictable changes. Four such dependent variables are considered here: total value of industry shipments, total employment, value added, and margin on sales. The results were further standardized, the aim being double: first, accounting for differences in the relative volatility of alternative indicators; second, enhancing interpretability of coefficients. Finally, standardized values for these four variables were averaged in order to obtain a composite measure of demand instability. Previous literature widely recognizes such a scale being reliable, which empirical results also confirm in this dataset: Cronbach's Alpha equals 0.778, well above the 0.70 cut-off value adopted as acceptable by convention (Nunnaly, 1978).

Technological dynamism, on the other hand, is operationalized by the relative innovative intensity (expenditures on innovation / total sales) of industry players, used as a proxy for the rate of technological change. Whereas most previous research focused exclusively on R&D expenditures or personnel as measures of innovative effort[14], this study benefits from recent developments in technology-oriented surveys and uses a more accurate and comprehensive measure of expenditures on innovation, including: both internal and external R&D, acquisition of new equipment and machinery, acquisition of other external knowledge (e.g. patent and software licences), design activities, changes in production and distribution needed to introduce innovations (as far as they are not already included under any other label), innovation-related personnel training, and efforts to commercialise innovations.

[14] Other authors used the proportion of scientists and engineers in the staff (Dess and Beard, 1984) or added capital investments to R&D expenditures (Lepak et al., 2003).

4.2. Data

Firm-level microdata were obtained from the Survey on Business Strategies, an annual panel survey conducted by *Fundación SEPI*, a Spanish publicly-owned foundation.

The survey collects a wide range of data on nearly 2,000 manufacturing companies per year, classified in twenty different industries. The sampling frame includes companies with 10 or more employees; micro-firms are thus not sampled. Two different techniques are combined to build the sample; complete enumeration is used for firms over 200 employees and stratified random sampling for firms between 10 and 200 employees. Average response rate is slightly over 90%[15].

An unbalanced panel for the 1991-2002 period was used for the analysis; observations without previous R&D activities (that is, with zero technological capital) were removed from the dataset[16]. The final set of data comprised 1,340 firms and 8,522 observations, yielding an average of 6.36 observations per firm.

In order to assure comparability across years, output data were deflated using the index of industrial prices published by the Spanish National Statistics Office (*Instituto Nacional de Estadística*), whereas physical capital was deflated using the deflator for capital goods. Regarding technological capital, there is no specific deflator for R&D, the question being troublesome and somewhat polemic in the literature; in this study the general GDP deflator was used. Descriptive statistics for the variables of interest are reported in table 4.1.

[15] It is worth noting, however, that once a firm has failed to provide information in any given year, it is removed from the panel in subsequent periods. Response rates, therefore, are calculated considering only firms which replied in previous years, as well as new entries to the sample. Consequently, the response rate provided can be significantly biased upwards and must be interpreted cautiously.
[16] The reason becomes obvious when considering that the variables included in the model are logarithms of the original values.

Industry-level information was collected from different sources, avoiding the pitfalls involved in using the same data for exploratory and confirmatory purposes. Demand dynamism was measured using National Accounts information for 1991-2002, whereas measures of technological dynamism were based on the Survey on Technological Innovation of Firms[17], conducted by the *Instituto Nacional de Estadística*[18]. Table 4.2 presents dynamism data for the industries on the sample.

TABLE 4.1. Sample and descriptive statistics

	n	N	N/n
1. Food, drinks and tobacco	168	986	5.87
2. Textile and clothing	98	666	6.80
3. Shoes and leather goods	28	205	7.32
4. Wood products	21	89	4.24
5. Paper manufacturing	34	228	6.71
6. Printing	41	208	5.07
7. Chemical products	140	1003	7.16
8. Rubber and plastic products	71	420	5.92
9. Non-metal mineral products	78	545	6.99
10. Metals	63	409	6.49
11. Metal products	114	623	5.46
12. Agricultural and industrial machinery	132	933	7.07
13. Office equipment, data processing, etc.	35	208	5.94
14. Electric equipment	129	812	6.29
15. Motor vehicles	87	554	6.37
16. Other transport material	33	215	6.52
17. Other manufacturing activities	68	418	6.15
Total	1340	5822	6.36

N: Number of observations **n: number of firms**

Descriptive statistics	**Ln (V)**	**Ln (C)**	**Ln (L)**	**Ln (K)**
Means	15.15	14.43	5.61	11.42
Standard deviations	1.88	2.23	1.45	2.61

We must note that industry classification was not exactly the same for the three different data sources; thus, in order to assure full comparability of data, we needed to merge

[17] The methodology of this Survey is based on the OECD Oslo Manual (OECD, 1997).
[18] Within the time span covered by this study, data from this survey were available for every two years between 1996 and 2002; the 'innovative intensity' measure was obtained averaging the values for the four observations that were available.

some industries, reducing our original set of 20 industries to a new total of 17.

TABLE 4.2. Measures of environmental dynamism

	NACE Codes	Technological dynamism	Market dynamism
1. Food, drinks and tobacco	151-160	0.91	-1.08
2. Textile and clothing	171-177 + 181-183	0.99	-0.51
3. Shoes and leather goods	191-193	0.49	1.10
4. Wood products	201-205	1.37	-0.37
5. Paper manufacturing	211-212	1.93	0.01
6. Printing	221-223	1.65	0.24
7. Chemical products	241-247	2.44	-0.34
8. Rubber and plastic products	251-252	1.38	-0.53
9. Non-metal mineral products	261-268	1.53	-0.62
10. Metals	271-275	1.24	1.81
11. Metal products	281-287	1.26	0.01
12. Agricultural and industrial machinery	291-297	1.96	-0.25
13. Office equipment, data processing, etc.	300 + 331-335	2.58	1.01
14. Electric equipment	310-316 + 321-323	3.13	-0.51
15. Motor vehicles	341-343	2.51	-0.16
16. Other transport material	351-355	7.04	0.38
17. Other manufacturing activities	361-366 + 371-372	1.24	-0.18

Source: INE

5. RESULTS AND DISCUSSION

The relevant estimates of the empirical models testing our research hypotheses are presented in table 4.3[19]. Results show a positive and significant contribution of R&D to total output, with an estimated elasticity ranging from 0.05 to 0.06, depending on the specification of the model; R^2 for the linear regression in column (1) is 0.89. It must be noted that the coefficient for technological capital decreased by 15% when industry random effects are considered (model 2 versus model 1), which suggests that ignoring such effects may indeed result in slight overestimation of R&D elasticity. These figures are consistent with results from other cross-sectional[20] estimates using Cobb-Douglas

[19] Results were obtained using the nlme package of R statistical software (an open-source application of S programming language also underlying the commercial package S-Plus); nlme is designed for fitting mixed-effects models using full and restricted maximum likelihood.

[20] Following Mairesse and Sassenou (1991), in this context 'cross sectional' refers to the use of variables in levels instead of first-differences. It does not exclude analysis of longitudinal data.

functions. However, comparability of results across studies must be taken cautiously as they may vary significantly depending on methodological issues.

TABLE 4.3. Empirical models on the economic productivity of R&D

Fixed effects	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Intercept	4.9804*** (0.0510)	5.0834*** (0.0644)	5.0536*** (0.1134)	6.1151*** (0.2107)	5.0205*** (0.1911)	5.0573*** (0.1118)	6.3111*** (0.2675)	6.1257*** (0.2096)
Time	0.0589*** (0.0021)	0.0625*** (0.0021)	0.0621*** (0.0020)	0.0608*** (0.0021)	0.0621*** (0.0020)	0.0620*** (0.0020)	0.0606*** (0.0020)	0.0608*** (0.0021)
Physical capital (c)	0.4357*** (0.0065)	0.4229*** (0.0067)	0.4266*** (0.0067)	0.3538*** (0.0138)	0.4266*** (0.0067)	0.4267*** (0.0067)	0.3461*** (0.01385)	0.3536*** (0.0137)
Labour	0.5108*** (0.0106)	0.5329*** (0.0104)	0.5285*** (0.0104)	0.5224*** (0.0104)	0.5286*** (0.0104)	0.5286*** (0.0104)	0.5226*** (0.0104)	0.5225*** (0.0105)
Technological capital (k)	0.0588*** (0.0038)	0.0504*** (0.0039)	0.0506*** (0.0094)	-0.0495** (0.0192)	0.0557*** (0.0161)	0.0502*** (0.0093)	-0.1083*** (0.0286)	-0.0511** (0.0193)
c*k				0.0070*** (0.0011)			0.0106*** (0.0014)	0.0071*** (0.0012)
Technological dynamism (td)					0.0160 (0.0772)		-0.0580* (0.0269)	
k*td					-0.0025 (0.6967)		0.0269* (0.0107)	
c*k*td							-0.0016*** (0.0003)	
Market dynamism (md)						0.1803 (0.1465)		0.2188 (0.1584)
k*md						-0.0137 (0.0126)		-0.0209 (0.0180)
c*k*md								0.0002 (0.0006)
Error structure								
σ_{v0}		0.1531	0.4028	0.4261	0.4167	0.3948	0.4418	0.4151
σ_{v1}			0.0341	0.0366	0.0352	0.0337	0.0361	0.0361
$corr_{v0v1}$			-0.923	-0.934	-0.925	-0.917	-0.926	-0.926
σ_e		0.5964	0.5917	0.5904	0.5917	0.5917	0.5905	0.5905
Adj. R-squared	0.8922							

P-values: *** < 0.001 ** < 0.01 * < 0.05 + < 0.1

Results in columns (2) and (3) differ in the specification of the random part of the model. Whereas (2) controls for constant industry effects, (3) also allows coefficients for technological capital differ across industries. That is, model (3) relaxes the assumption of productivity of R&D being the same for different industries. Likelihood ratio tests shows a significant improvement in model fit (p-value for the likelihood ratio being <0.0001). This provides strong formal evidence that industry effects do matter when it comes to average returns to R&D investments[21]. Moreover, such effects are relatively large, the standard deviation of the coefficient across industries being 0.0341 (σ_{v1} in table 4.3). Given an average coefficient for technological capital slightly over 0.05, this implies that R&D elasticity may vary by +/- 67% in the range of +/- 1 stdev.

As for testing of research hypothesis, empirical results consistently show a positive moderating effect of firm size on productivity of R&D; the coefficient for the interaction term c*k is positive and significant (p-value < 0.001) across the different model specifications. Hypothesis 2.a is thus confirmed. Findings are a bit more complex regarding environmental dynamism.

First, we have to establish a neat distinction between the two dimensions of the concept. As for market dynamism, it does not show any significant impact on total productivity, either direct or moderating the effects from any other variables. Technological dynamism, however, exercises the hypothesized moderating role on the relationship between size and R&D elasticity. The estimated coefficient for the two-way interaction c*k*td is indeed negative and significant. We can consequently conclude that the relative innovative advantage of large firms decreases as the competitive environment becomes more dynamic, verifying hypothesis 3. Model (7) also shows that technological dynamism improves overall productivity of R&D efforts (positive and significant coefficient for k*td); this last result, however, did not show up in the simpler

[21] Full output from the likelihood ratio test is as follows:

Model	d.f.	AIC	BIC	logLik	Test	L.Ratio	p-value
(2)	7	15483.54	15532.89	-7734.769			
(3)	9	15388.46	15451.91	-7685.229	(2) vs (3)	99.08143	< 0.0001

model (5), which does not include the interaction between technological capital, size, and dynamism. In other words, empirical results suggest technological dynamism gives rise to greater returns to R&D, but only when we control for its moderating role on the effects of firm size.

Overall, findings from models in table 4.3 provide strong evidence in favour of hypothesis 2, while partially supporting hypotheses 1.a and 3. Next we discuss in greater depth the implications of these results.

5.1. Discussion

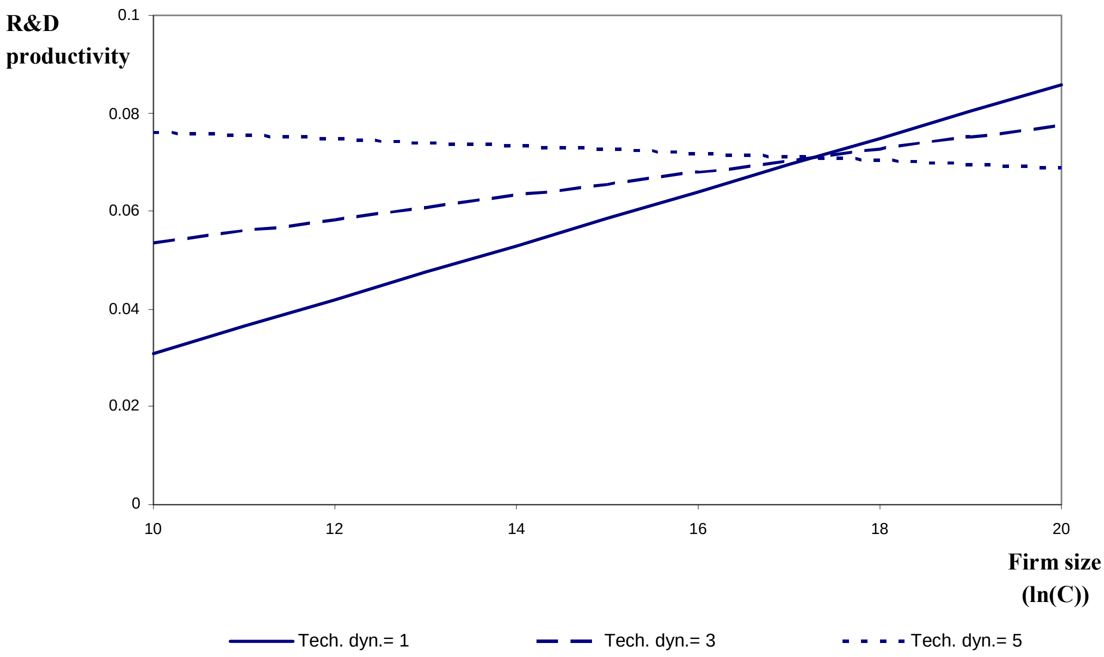
In the light of empirical findings, there is little doubt that the firm size has an overall positive effect on the economic productivity of technological capital. Our results are consistent with those from Kafouros (2003) and Kwon and Inui (2003), privileging those arguments pointing to a greater innovative efficiency of larger firms. This is not incompatible with previous evidence showing that technical productivity (i.e. generating innovations from R&D expenditures) decreases as firms grow (Cohen, 1995). If we put these two pieces of evidence together, we can suggest that major advantages of large firms lie in their greater ability to extract revenue from the innovations they develop. Larger sales bases and availability of complementary resources to fully exploit innovations in the market are plausible justifications. In this regard, McGrath et al. (1996) suggest that generating successful innovations does not suffice for creating extraordinary rents. Creating competitive advantages from innovation poses some far-from-trivial problems (Van de Ven, 1986; Brown and Eisenhard, 1995; McGrath et al., 1996). This would explain why technological leadership not always implies market leadership nor competitive advantage (Zahra et al., 1995). It appears from our results that such problems happen to be particularly hard to overcome for smaller firms.

It is important noting at this point that the relationship between size and innovative productivity, while holding on average, is far from deterministic. Certain organizational characteristics causing inertia are typically associated to larger firms, but they can be modified by management through deliberate action. Analogously, small firms can develop strategies to overcome their relative disadvantages, such as co-operation agreements. Management of innovation thus becomes to a great extent a matter of trying to combine small and large firms advantages (Vossen, 1998).

This interpretation is enhanced by our findings regarding the effects of (technological) environmental dynamism. We hypothesized that, under conditions of high dynamism, technological intensity would create more efficient markets for new technologies, bringing mechanisms for smaller firms to partially overcome their handicap. As a matter of fact, we found that size disadvantages become smaller, up to the point of eventually disappear, as technological dynamism grows bigger. Figure 4.2 shows the fitted output elasticities for technological capital as a function of firm size. We can observe that, whereas the slope is highly positive when dynamism equals 1, it gets progressively flatter and even becomes negative when technological dynamism = 5. This would imply that smaller firms may even enjoy some advantages when innovating in technology-based industries, which is consistent with some previous findings from Taiwanese electronic firms (Tsai and Wang, 2004). Overall, figure 4.2 suggests that technological dynamism not only has a significant impact on the effects of size on R&D, but also a rather important one in terms of magnitude.

It is a finding of particular interest that estimates for the effects of (technological) environmental dynamism on the elasticity of R&D were quite sensitive to changes in the specification of the model. This suggests that ‘naïve’ approaches comparing innovation across industries (not uncommon in the literature) may be misleading if not all the relevant effects are considered. In this study, the sampling technique used in the Survey on Business Strategies, described in section 4.2 above, may cause large firms to be to some extent over-represented. Many other researchers have also used samples of relatively large firms (e.g. publicly-traded companies), for which detailed information is more readily available.

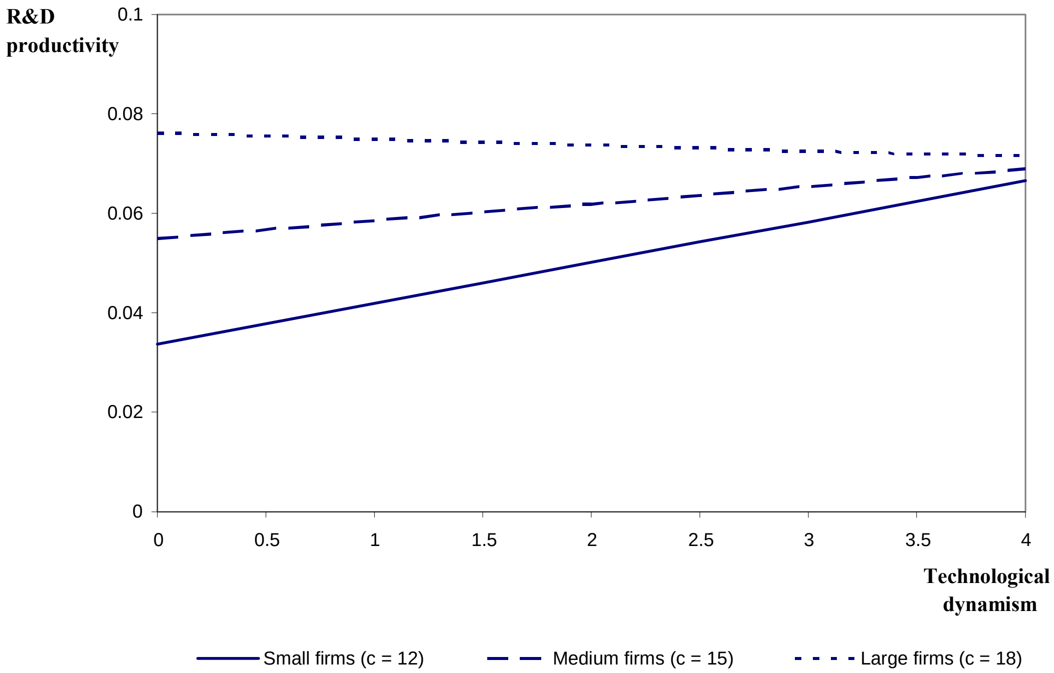
FIGURE 4.2: Productivity of R&D as a function of firm size: effects of technological dynamism



Unless full representativeness of sample can be convincingly defended, inter-industry comparisons need to consider relevant interactions between firm and industry variables. A graphical example is presented in figure 4.3, based on estimates from model (7). It shows that changes in environmental dynamism can affect productivity of firms' R&D efforts very differently according to their size. If such differences are not accounted for and large firms are over-represented in the sample, it is perfectly possible finding a non significant relationship between dynamism and R&D elasticity where there really is a positive and significant one.

This can explain lack of support to hypothesis 1 in simpler models (column 5 in table 4.3), in which the effects of size were overlooked. On the contrary, in fuller models the coefficient not only had the expected sign, but it was also significant, as far as we limit ourselves to technological dynamism.

FIGURE 4.3: Productivity of R&D as a function of industry technological dynamism: effects of firm size



Market dynamism, on the other hand, did not show any significant effect. This is unsurprising, as market instability (which we measured as year-to-year volatility of demand) is not so closely related to the R&D function of the firm. Indeed, according to innovation economists, it is overall trends in market demand, and not short-term shocks, which drive innovative efforts. Arguments we posed supporting our hypotheses on the effects of dynamism were closely related to the rate of technological change and innovative intensity in an industry, rather than to demand instability. Consequently, it does make full sense that we obtained significant effects for technological, and not for market, dynamism.

In summary, we obtained three major findings from our empirical analyses:

Firm size has a positive effect on the economic productivity of technological capital, larger firms being more productive when conducting R&D, mainly because of their greater ability to extract rents from innovations.

Such large-firm advantages, however, may be conditioned by industry characteristics, so that benefits of size decrease, or even disappear, under conditions of high technological dynamism.

Technological (but not market) dynamism also results in increased average returns to R&D investments, once we control for the effects of the size-dynamism interaction.

6. CONCLUSIONS, LIMITATIONS AND FURTHER RESEARCH.

In this chapter we have studied the effects of firm size and environmental dynamism on the economic productivity of research and development. The models for the empirical analysis were based on extensions of the Cobb-Douglas production function. Research hypotheses were tested on a panel of data from 1991 to 2002 for a sample of 1,380 Spanish manufacturing firms, grouped in 17 different industries.

The effects of firm size have been profusely studied in the literature, but there is neither theoretical nor empirical consensus. The present work contributes to build a corpus of evidence using Spanish data. This way, it adds to previous findings obtained from other countries. A major difference of this work from most previous research relating firm size and innovation has been the use of extended versions of a Cobb-Douglas function, firm revenue being the dependent variable. This approach has the distinctive advantage of providing direct estimates of the contribution of size to the economic, and not merely technical, output of R&D.

Regarding industry effects, previous works had mainly drawn on arguments from innovation economics. This study incorporates the concept of environmental dynamism, which the literature on management has shown to have relevant implications for strategy and organization.

We have also explored how certain conditions of the competitive environment may interact with firm characteristics when determining returns to R&D. In doing so, we have developed a number of arguments on the complex relationship between R&D, firm size, and environmental dynamism, which are essentially new to the literature on this topic.

Empirical results mostly confirmed research hypotheses, providing relevant evidence to the study of the factors influencing the productivity of R&D. We can conclude that our analyses have provided some degree of support for our arguments.

Overall, this study contributes to the literature on R&D and productivity both in terms of theoretical arguments and of building a corpus of empirical evidence. It is not free, however, from some significant limitations. The most relevant of them are now discussed, along with some suggestions for further research.

The classification of industries at (roughly) the two-digit level used by the Survey on Business Strategies is far from optimal. Many studies have used three- of four-digit classifications, allowing for a more fine-grained analysis of environmental influences. Variables measured for industries defined at two digits may sometimes provide a poor proxy for the actual environment some firms face. A more detailed classification of industries would also have yielded a greater number of level-three units, increasing the power of tests of random effects at the industry level. Moreover, our data did not allow for distinguishing the effects of size at the corporate and the business-unit levels, so that they had to be treated indistinctly.

This paper follows a standard approach in estimating technological capital. In this sense, the naïve assumption of a flat depreciation rate, however convenient and commonly accepted in the literature, is still not fully satisfactory. This is particularly so when inter-industry comparisons are involved, because different rates of technological dynamism can result in different rates of technological obsolescence. Apart from those already mentioned, some efforts are being made to improve estimation of R&D depreciation rates, based on models either of market demand and cost-benefit analysis (Nadiri and Prucha, 1997; Bernstein and Mamuneas, 2006) or of firm evolution (Rodriguez, 2003). Research on the effects of technological capital on productivity could largely benefit from further incorporating such developments.

Empirical findings in this paper provide evidence of the effects of industry dynamism on the relationship between size and R&D. Plausible theoretical arguments explaining and predicting such effects have also been proposed. It has to be noted, however, that the evidence provided is by no means direct proof of the arguments suggested. More concretely, we cannot disentangle organizational arguments from those relating to efficiency of technology markets when explaining the joint effects of firm size and industry technological dynamism. Alternative explanations of our findings surely can and probably should also be proposed. Empirical research explicitly testing the theoretical arguments developed here (e.g. effects of dynamism on imperfections in the markets for new technologies) would also be valuable.

We claimed that advantages of size would mainly come from rent-extraction (i.e. revenues obtained per innovation) than from innovation-development (i.e. innovations obtained per 'dollar' spent in R&D). Our argument is based on comparing our results to those from previous research on the 'technical' productivity of R&D. It would be of great interest if such arguments could be formally developed and tested in a model in which innovation mediates the relationship between R&D and revenues, and the effects of size can be tested in both sides of the relationship.

Finally, the framework proposed here could certainly be applied to studying the influence of other firm and industry variables on R&D and technological innovation.

In summary, the present study aims at contributing to the vast literature studying R&D and productivity, not only by providing reasonable answers to some interesting research questions, but also by giving rise to some others Pursuing answers to them is a task left to further research. Motivating such research would be not the least of the accomplishments of this work.

CHAPTER 5. CONCLUSIONS

We can identify two main research strategies when approaching the study of firm performance. First, we can exploit existing frameworks in order to analyze the incremental effects of a number of explanatory variables on profitability. Second, we can explore alternative frameworks and perspectives that, if proved useful, may yield significant new insights on the causality of firm success.

On this regard, Michael Porter (1991) encouraged researchers to explore the implications of the dynamic dimension of strategy for the analysis of the causality chain of business profitability. Stinchcombe (2000) suggests that, by ignoring such dynamic dimension, strategy research fails to provide a meaningful explanation of firm heterogeneity. This calls for the development of models attempting to explore the origins and dynamics of factors allegedly supporting superior performance (Cockburn et al. 2000). Whereas these claims have remained largely unaddressed, researchers have leveraged well-known strategic frameworks in order to build extensive empirical evidence on variables associated to profit differentials. As with organizational learning, there appears to be some tension between exploitation and exploration (March, 1991) when it comes to the development of academic knowledge.

Analogously, we can distinguish at least two different levels of analysis in this dissertation. On the one hand, we aim at making some contributions to the study of specific variables driving performance differentials (such as R&D investments and intangible assets); that is, we adopt an essentially static perspective in order to add evidence on the incremental effects that some factors have on profitability. On the other hand, we also try to obtain a more general perspective on causal antecedents of performance heterogeneity. Therefore, we move one step backward in our arguments, and develop some critical reflections on how strategy research can move further away along the causality chain behind differences in firm returns. Therefore, the tension between exploiting existing frameworks and exploring new ones is also present in this work.

There are some relevant difficulties and trade-offs involved in combining the two perspectives (or, as we have labelled them, 'research strategies') we have mentioned. Most saliently, our theoretical discussion sometimes reaches beyond what we can empirically verify, as we are interested in developing arguments on causal antecedents of firm performance that are not necessarily bounded by the constraints in our empirical analyses.

The first objective we set for the dissertation was contributing to the development of meaningful longitudinal approaches to the dynamics of firm performance. Such is the aim of the model we present and test in chapter two. We explain current variance in returns in terms of two main components. First, the enduring effects of some factors (e.g. valuable bundles of resources), resulting in persistent (i.e. not varying over time) inter-firm heterogeneity. We label such persistent factors as 'initial conditions', as they respond to the firm's competitive position at the beginning of the period covered by the study. Second, firms also differ in their efforts aiming at improving performance; some such efforts being more successful than others, this will result in further sources of profit differentials emerging over time. This we refer to as 'emergent heterogeneity'.

This distinction between persistent and emergent differentials is essentially new to the literature exploring dynamics of profitability. Previous research has just focused on persistence rates; that is, on how long it takes for 'abnormal' profits return to long-term equilibrium levels.

We test our model on a sample of Spanish manufacturing firms. Data on firm performance are obtained from the Survey on Business Strategies (*Encuesta de Estrategias Empresariales*) an annual rotating panel survey conducted by *Fundación SEPI*. This source of data has been extensively used in previous research. We analyze an unbalanced panel covering the period from 1991 to 2002; after cleaning up the data, we have 17,282 observations available, for a total of 1,868 firms, grouped in 20 different 2-digit industries. This sample is consistent, in terms of both firm breadth and time coverage, with those that have been used in previous research. We operationalize performance as return of assets, which we in turn measure as EBITDA / Average Total Assets.

Our results show that systematic profit dynamics can be meaningfully decomposed into the two effects we defined above. Moreover, they suggest that emergent heterogeneity plays a salient role in determining current profitability of firms. Firms exhibiting weak initial performance for the studied period, but being relatively successful in their performance-improving efforts, would ‘catch up’ with stronger competitors after a relatively short time.

This finding privileges explanations of superior performance drawing on evolutionary dynamics, rather than on sustainable advantages based on long-term market equilibrium. Competitive positions showing to be quite unstable, so that new ones are permanently built and old ones eroded, strategy research should move beyond the static dimension of competitive advantage in order to provide meaningful accounts on the dynamic processes by which firms build such advantage.

We also extend our model in order to add empirical evidence to the long-studied phenomenon of convergence in profit rates. Our distinction of initial vs. emergent heterogeneity allows us to disentangle convergence in the long-term dynamics of performance from convergence in the short-run deviations from such dynamics. This significantly extends previous research on the topic, which has been confined to the study of short-term shocks to profitability (McGahan and Porter, 1999, 2003), understood as deviations from firm averages. We found that initial profit differentials are effectively eroded by the effects of competition. Such erosion is quite fast for non-systematic shocks of profitability, which almost vanish after two or three years; this is unsurprising, as these differentials may largely account for year-specific factors. As for systematic differences in performance, they also tend do converge after a while, but they do rather more slowly. Our results suggest that existing research may have indeed confounded these two effects, which respond to rather different strategic logics, when studied erosion of profit differentials.

When commenting on these findings, we have to note that we do not assume markets approach any long-run equilibrium. Whereas initial performance differentials may be progressively eroded, new ones are permanently being created, as a result of emergent heterogeneity. There it therefore a noticeable difference in terms of assumptions and interpretation from most previous works, which heavily relied on neoclassical notions of equilibrium (Wiggins and Ruefli, 2002).

Our work extends existing research in a number of ways, and may add to the understanding of the dynamics of profit differentials. Nonetheless, it also has important limitations, particularly as to its ability to generate conclusions on causal mechanisms underlying such differentials.

The evolutionary patterns of firm performance provide useful but limited information on causal relationships driving superior returns. The model is neutral as to which firm and market-based factors may explain firm success. In the terms we have been using, it does not address the static dimension (i.e. the 'what') of performance. This is a relevant limitation, as the static and dynamic problems occupy correlative links in the same causality chain (Porter, 1991), and both of them are needed in order to provide a comprehensive account of firm profitability.

We have also highlighted the role of discretional managerial choice in shaping firm evolution. A dynamic approach to causality in strategic management should aim at understanding the roles of historical determinism, managerial discretionality, and chance in shaping strategy (Rond and Thietart, 2007). Our approach to the evolution of firm performance allows us to cast some inferences on this regard; whereas persistent heterogeneity (i.e. the effects of initial conditions) points to long-lasting determinism, emergent differentials can easily accommodate the effects of managerial choice.

However, we cannot really know why firms adopt different decisions or engage in different search routines; we are not able either to disentangle if successful managerial decisions come from truly superior insight or mere luck (Barney, 1986a; Stinchcombe, 2000; Rond and Thietart, 2007). Consequently, we are at risk of constructing *ex post* explanations to some phenomena that, if considered *ex ante*, are the result of mere chance (Cockburn et al., 2000; Stinchcombe, 2000). Indeed, our knowledge of initial organizational conditions and how they may influence subsequent changes in profitability is dramatically bounded (we are basically confined to the study of processes of convergence in return rates). We thus face severe limitations in our efforts to unveil the ultimate forces driving performance dynamics.

Whereas chapter two was devoted to the distinction between the static and dynamic dimensions of profitability (Porter, 1991), chapter three aims at making its contribution to a better understanding of heterogeneous performance by exploring interrelationships between two theoretical frameworks that provide different views on economic rents and firm profitability, namely the RBV and the Austrian (more concretely, neo-Austrian) school economics. In doing so, we also draw on some previous research that has claimed for integrating arguments from the resource-based and entrepreneurship literatures (Álvarez and Busenitz, 2001; Barney, 2001; Ireland et al., 2001; Alvarez and Barney, 2002; Janney and Dess, 2006; Foss and Ishikawa, 2007).

We claim that RBV and Austrian arguments on firm profitability, despite often being presented as separate, if not opposing (or at least alternative) views, are complementary, rather than mutually exclusive. They rely on different sources of rents that can all play a role in determining performance. Furthermore, integrating both views can yield a number of insights on causal mechanisms behind competitive success.

Having established that heterogeneous resource bundles drive competitive advantage, the next logic step for the RBV comes from explaining what drives resource heterogeneity. A number of scholars have developed insight on this matter, focusing on imperfections in factor markets (e.g. Barney, 1986a; Chi, 1994; Makadok and Barney, 2001). Austrian entrepreneurship theory can help in understanding both the origins of such imperfections and how firms can take advantage of them in order to build resource advantages. Austrians depict market as being inherently in disequilibrium, as players cannot guide their decisions by maximizing criteria; not existing optimal alternatives, managerial subjectivism and discretional action drive inter-firm heterogeneity. It is entrepreneurial discovery of previously unveiled opportunities what may give rise to superior combinations of resources and, consequently, to economic rents. On the other hand, we further argue that the relationship between entrepreneurship and resources is iterative and bidirectional, as heterogeneous assets and capabilities set the conditions for further entrepreneurial actions.

Unfortunately, differences in terms of research agenda and methodological approaches greatly difficult empirical comparisons between RBV and Austrian theories, in order to test our theoretical framework. In order to translate the arguments in our model into a number of testable research hypotheses, we focus on the relationship between firm resources and competitive dynamics as sources of inter-firm profit differentials. Austrian economics can be considered a theoretical antecedent of the literature on competitive dynamics (Jacobson, 1992; Smith et al., 1992; Young et al., 1996; Derfus, 2001; Quasney, 2003; Usero, 2003; Rountree, 2004). As a matter of fact, this research stream incorporates core concepts of Austrian theories into the study of strategy; we can highlight the idea that superior profitability arises from firms taking advantage of market disequilibrium by over-manoeuvring their competitors (Chet at al., 1992; Chen and MacMillan, 1992; Smith et al., 1992). We thus contend that the literature on competitive dynamics constitutes the strategy research stream that most precisely incorporates Austrian notions on disequilibrium, market process, entrepreneurial discovery and profitability.

More concretely, we argue that firms may gain entrepreneurial rents by engaging in new competitive moves; we thus hypothesize that competitive aggressiveness (i.e. number of competitive moves initiated by a firm) affects firm performance. Moreover, and following our theoretical considerations on the relationship between the RBV and Austrian-based arguments, we also formulate hypotheses on how intangible resources and competitive moves interact in determining firm profitability.

This involves a gap between our theoretical discussion (RBV – Austrian school) and the research hypothesis we can formulate and test (intangible assets – competitive moves), which results in significant limitations in our ability to empirically verify our theoretical arguments, given information available.

Again, we use data from de Survey on Business Strategies in order to test our model. This time, and given the nature of the variables, we rely on a complete panel from 1991 to 2002, which left 6,936 usable observations (578 firms). Previous research had largely relied on single-industry studies of profit dynamics; our sample being much wider and heterogeneous in terms of both industry and firm characteristics, this improves external validity of results.

Intangible resources show a positive long-term effect on profitability; moreover, such effect was very robust to inclusion of competitive aggressiveness in the model. We could not verify, however, that they also contribute to overall greater profit persistence, as previously found by Villalonga (2004). This could come explained by differences in our methodological approach. First, Villalonga uses Tobin's Q in order to measure intangible resources. Tobin's Q being based on market value, it incorporates market expectations on future profits, which could explain higher persistence rates. Meanwhile, we operationalize intangible resources in terms of their contribution to the firm's current profitability (a future-neutral measure). Secondly, autoregressive models, such as that used by Villalonga, capture sustainability only of the incremental components (i.e. deviations from firm long-term values) of profitability (McGahan and Porter, 1999, 2003). Villalonga's results refer to the consequences of invisible assets on the persistence, not of overall firm profits, but just of these incremental effects. Meanwhile, we explore persistence of overall firm performance; it makes full sense our results showed a less significant effect of intangibles.

Findings on the effects of competitive aggressiveness are mixed. Results from exploratory factor analysis show 'aggressiveness' to be a bi-dimensional construct. Therefore, and consistently with both our results and previous literature (Smith et al., 1991; Chen et al., 1992; Miller and Chen, 1994), we distinguish between strategic and tactical competitive aggressiveness; the first mainly includes technological innovations (either product or process) and changes in product lines, whereas the later relates to initiatives such as changes in prices and promotional activities. The number of strategic moves initiated by a firm exhibits a positive impact on performance, but such effect becomes partially diluted when controlling for intangible resources. Tactical moves, on the other hand, exhibit a negative or non significant influence. Finally, we could not verify that intangible assets have a positive moderating effect on the relationship between aggressiveness and performance.

Unlike most previous research, our approach combines resource-based and competitive-dynamics arguments for explaining firm performance. Overall, findings provide stronger support for RBV than for competitive dynamics predictions on the causes of firm performance. The results for aggressiveness were indeed very sensitive to the inclusion of intangible assets. This might suggest the existence of a potential bias (Huselid, 1995) in those results that do not control for resource endowments when studying outcomes from competitive dynamics.

Any conclusions we extract from chapter three, however, should consider how the measures we use may condition our empirical findings. Competitive dynamics research usually relies on very comprehensive and detailed information on competitive moves. Unfortunately, our data did not provide such information. As a consequence, we need to restrict ourselves to the most aggregate level of analysis in order to characterize competitive behaviour; additionally, not having a comprehensive action count available (Ferrier et al., 1999; Young et al., 1996), we had to proxy competitive aggressiveness by self-reported information on competitive behaviour of firms.

This is a significant shortcoming in our empirical work. Austrian economics suggests that entrepreneurial rents explain inter-firm performance differentials. We made use of the concept of competitive aggressiveness in order to test this argument. We must acknowledge that our proxy for aggressiveness yields limited information on firms creating and appropriating entrepreneurial profits.

Therefore, there is substantial room for future research to extend our analysis by making use of more detailed information. This would allow for corroborating our findings on aggressiveness, as well as incorporating other variables that have proved relevant to the analysis of competitive dynamics, such as simplicity and heterogeneity of competitive repertories, (He and Mahoney, 2006). Additionally, researchers may choose to make use of different strategy frameworks and variables in order to characterize the kind of firm behaviour depicted by Austrian entrepreneurship theory.

Results from chapters two and three, altogether, pose an interesting paradox. On the one hand, we show that dynamic effects play a salient role in explaining profit differentials, so that initial conditions (defined in terms of past profitability) seem to have a relatively short-lived effect, and can hardly suffice to sustaining long-term advantages. On the other hand, we find that initial endowments of valuable resources do have a persistent impact on performance; an impact we could not verify (at least, not so robustly) for the variable we used to characterize competitive dynamics. Whereas the former results call for dynamic arguments explaining how profits evolve over time, the later bring us back to classical equilibrium-based views on sustainable competitive advantage.

In elucidating this apparent paradox, we should consider the fact that strategy research offers well-developed equilibrium-based theoretical backgrounds and substantial empirical evidence as to the factors associated to persistent performance differentials. Meanwhile, 'we have no generally accepted theory —and certainly no systematic evidence— as to the origins or the dynamics of such differences in performance' (Cockburn et al. 2000: 1123). As a result, and despite dynamic effects may be more important than static ones in the long term, explanatory variables suggested by static frameworks may still show stronger effects in empirical models. More concretely, if intangible resources exhibited a greater and more robust impact in performance than competitive aggressiveness, it may well be not because the role of initial conditions is more relevant than that of dynamic behaviour by firms, but because resources captured initial differentials better than aggressiveness did with dynamic heterogeneity.

Our empirical findings can provide motivation for strategy scholars to explore, both theoretically and empirically, alternative frameworks that may contribute to identify factors influencing emergent heterogeneity in performance. We have showed there are substantial dynamic effects that remain to be properly explained.

On this regard, we believe that the model we propose in chapter two may give rise to a rich agenda for further research. The line of argumentation that we present in chapters two and three suggests that fully comprehending the causes of firm success requires answering, not only the 'what', but also the 'how' questions; we also claim that this calls for models that can properly capture the 'dynamic dimension' of firm performance. We have identified the main components of profit dynamics and studied how they contribute to current heterogeneity. As well as traditional strategy frameworks analyze profit in terms of different explanatory variables, the pathway towards more integrated studies, combining content and process considerations (Spanos and Lioukas, 2001), may come from finding relevant variables that help explaining, not just performance (i.e. profitability levels), but also its dynamic components.

Chapter four substantially differs from the previous ones in terms of both objectives and methodological approach. It is fully restricted to the study of the 'what' of heterogeneous performance; furthermore, it tackles a rather specific problem on the relationship between innovation and firm profitability. It closely relates, however, to some arguments we had presented in chapters two and three. First, we develop the idea that markets are permanently in disequilibrium (a core concept within an Austrian theory of entrepreneurship) and subject to frequent change. Such a conception of competition led us to analyzing the role of environmental dynamism. Second, we study innovation as a fundamental source of competitive advantage, as it follows from the Schumpeterian model of competition, which, in turn, can be included within evolutionary theories of economic change (Witt, 1992). Moreover, Schumpeter also paid great attention to firm size as a determinant of innovation. We approach this topic and explore how environmental dynamism and firm size interact in order to explain differences in economic returns to R&D.

Bigger firms enjoy certain economies not only when conducting research, but also when extracting profits from new technologies. On the other hand, smaller firms are likely to provide organizational settings that are better suited for innovative behaviour. There is also a vast (but inconclusive) body of empirical research relating firm size and innovation. Quite surprisingly, the overwhelming majority of such research has not explicitly analyzed economic output of innovative efforts; they have focused instead on the effects of size on either innovative intensity or technological productivity of R&D (*patents per dollar*). We address this research gap by estimating a Cobb-Douglas production function in which firm revenues are explained, among other factors, by technological capital (the stock of technological knowledge accumulated as a result of past R&D expenditures).

We also extend this model by considering how the environment, and more concretely the rate of environmental change (i.e. dynamism) may moderate the impact of size on innovation. This moderating effect is essentially new to existing literature on this topic. We develop our arguments in a double direction. First, we consider that dynamism may reduce inefficiencies in markets for new technologies, thus changing the ways firms can actually make profits from innovation. Secondly, we also claim that dynamic environments privilege smaller, more flexible organizations versus larger, more bureaucratic ones. Unfortunately, although we develop two different arguments on the dynamism-size relationship, our empirical analysis does not allow us to analyze them separately; this task remains to be accomplished by further research.

Finally, we also follow strategy scholars in suggesting that competitive success in rapidly changing markets is closely tied to innovation-related capabilities, so that the impact of technological capital on competitiveness is positively related to dynamism.

Again relying on data from the Survey on Business Strategies, we test our research hypotheses on a sample of 1,380 manufacturing firms engaging in R&D efforts. As for measures of environmental dynamism, we use aggregate data from National Accounts and the Survey on Technological Innovation of Firms (INE).

Conclusions from our empirical study show that bigger firms do enjoy, on average, greater returns to R&D. Advantages of size, however, are to a great extent contingent on the rate of environmental change; as hypothesized, smaller firms operating in highly dynamic industries greatly overcome any burdens stemming from smaller scale. Dynamism also shows a positive impact on productivity of technological capital, once we simultaneously control for the effects of firm size.

Chapter four yields some interesting conclusions, not only for researchers and practitioners, but also for regulatory authorities. Schumpeterian theory suggests that, whereas large firms operating in highly concentrated markets may reduce social utility in the short term, they may well result in greater long-term wealth if they actually are more efficient innovators (Schumpeter, 1942). Consequently, there may exist a trade-off between static and dynamic social efficiency; a trade-off that is dependent on empirical evidence confirming alleged greater innovative productivity of big firms. Our results suggest that the nature, intensity and even existence of such trade-off may well depend on characteristics of the industry (Mairesse and Sassenou, 1991; Griliches, 1995).

The study is not free from limitations. First, we only have information on industry variables at 2-digit classification level, which in some cases may provide a poor proxy for the actual environment that firms face. This is problematic, since our research interests focus on the interaction between firm and industry characteristics. Second, there are a number of relevant (and largely unsolved) methodological problems in estimating productivity from R&D investments: determining depreciation rates for technological capital, double-counting of R&D investments and econometric specification problems are among the most noteworthy of them (Griliches, 1995); our approach to such problems, being in line with existing literature, still does not provide fully satisfactory solutions to them. Third, and more importantly from a substantive standpoint, we present two different kinds of arguments supporting our hypothesis on the moderating effect of dynamism on the size – R&D relationship. Although our results seem to confirm such hypothesis, the evidence provided is by no means direct proof of the arguments suggested. More concretely, we cannot disentangle organizational arguments from those relating to efficiency of technology markets. Alternative lines of reasoning could and probably should also be proposed in order to explain our findings.

In summary, this dissertation aims at contributing to a better understanding of causal mechanisms underlying heterogeneous firm performance. Without rejecting the contributions from research frameworks exploring what factors are associated to profit differentials, our interest also comprehendeds the processes by which such differentials emerge and evolve. In doing so, we have distinguished two dimensions, namely static and dynamic, lying behind the study of firm profitability. This has involved considerable effort in order to combine different research objectives, perspectives, frameworks and methodologies into a consistent piece of research.

Contributions of this work are not limited to academia; we next discuss potential implications for practitioners. We have found that there seems to be substantial room for weaker competitors to catch up with stronger ones in relatively short periods of time. The key to persistent profitability does not lie only, nor even mainly, on leveraging stronger initial conditions. On the contrary, the origins of firm success seem to lie, to a great extent, in the recent past of the organization. Thus, if firms are to sustain superior performance, they should focus on continuously renewing their competitive advantage (or, at least, renewing barriers protecting the sources of such advantage), rather than relying on strong mechanisms isolating it from competition. Even if intangible resources seem to have a long-lived effect on profitability, such effect is not important enough as to sustain significantly superior performance in the long term. Moreover, our findings also suggest that firms also benefit from engaging in a greater number of competitive moves; particularly positive is the effect of strategic actions relating to technological innovations and changes in product lines. Finally, as to the effects of new technologies, managers should consider that improving productivity of innovative efforts requires a proper understanding of interactions between firm characteristics and environmental conditions. More concretely, the rate of change in the competitive environment appears to exert a significant effect on firm attributes associated to successful innovation.

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