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ORIGINAL PAPER

A longitudinal analysis of the impact of firm resources and industry characteristics on firm-specific profitability

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Abstract Using a dynamic heterogeneous panel data model, we examine the relationship between firm-specific resources (corporate management capabilities, employee value-added and technological competence) and firm-specific profitability and the potential moderating effects of industry characteristics on this relationship. We find that firm-specific resources enhance both accounting-based measures (return on assets and return on sales) and market-based measure (Tobin's q) of firm-specific performance. Moreover, industry characteristics moderate the relationship between firm-specific resources and firm-specific profitability. Managerial implications are discussed.

Keywords Resource-based view · Industrial organization · Evolutionary economics · Economic rent · Panel data analysis

1 Introduction

An important issue in research in the intersection between strategic management and industrial organization (IO) economics is to uncover the *raison d'être* for persistent profitability differences among firms. Since the emergence of the resource-based view (RBV), the RBV and IO economics are often perceived to offer two competing explanations for the variation in profitability across firms. This is not surprising since the branch of IO economics that was the first to make a significant impact on the study of strategic management is the structure-conduct-performance

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(S-C-P) paradigm (Porter 1980), which in the main traces profitability differences among firms to a different source than does the RBV. Specifically, the RBV looks to the internal resources of the firm for the explanation of its profitability relative to other firms in the same industry, while the S-C-P paradigm looks at the structural differences among industries and industry subgroups as the primary explanation as its principal concern is inter-industry differences in profitability. Perhaps because of this perceived competition between these two paradigms, few studies have explored their potential complementarity. The intent of this study is to explore both theoretically and empirically whether and how firm resources and industry conditions may interact to influence firm performance.

As Conner (1991) pointed out, the field of IO economics is far broader than the S-C-P paradigm, and some schools of thought within the field hold differing views from the S-C-P paradigm on the sources of supernormal profit. In particular, the S-C-P paradigm finds firm profitability to be related to the level of industry concentration and interprets the finding as evidence that supernormal profit is due to a lack of rivalry in concentrated industries with high barriers to entry (Bain 1956). The Chicago school of economics, on the other hand, gives a very different interpretation of the S-C-P paradigm's empirical findings and considers industry concentration to be a result of firm rivalry that allows more efficient firms to gain market share from less efficient ones (Demsetz 1973). The Schumpeterian theory of competition and growth (Schumpeter 1950), and the evolutionary theory (Nelson and Winter 1982) that is substantially rooted in the notion of Schumpeterian competition, take a more dynamic view of competition, market structure and firm profitability. Specifically, this school of thought regards industry structure and firm profitability as continually evolving in the cycles of innovation and growth. Even though all schools of IO economics focus their attention on the industry rather than the firm, the views of the Chicago and Schumpeterian schools on the sources of supernormal profitability are essentially compatible with, and potentially complementary to, the basic theoretical proposition of the RBV: In the absence of government-imposed restrictions on competition, a firm is unlikely to earn and sustain economic rents for an extended period of time unless it possesses resources and capabilities that are valuable, rare, difficult to imitate and imperfectly substitutable (Barney 1991; Peteraf 1993; Wernerfelt 1984).

Extant empirical examinations of the RBV can be categorized, at some risk of over-simplification, into one of two groups. The first group aims at ascertaining the importance of industry structure relative to firm resources in explaining the variance of profitability among firms (e.g., Brush et al. 1999; McGahan and Porter 1997; Powell 1996; Rumelt 1991). These variance decomposition studies do not actually model the impact of firm resources on firm profitability but partition total profitability into firm and industry components that are represented by latent or dummy variables (see Bowman and Helfat 2001 for a summary and assessment of these studies). The second group endeavors to verify the impact of firm resources on firm performance (e.g., Henderson and Cockburn 1994, 1996; Markides and Williamson 1994; Mehra 1996; Miller and Shamsie 1996; Yeoh and Roth 1999). Studies in this group in general do not examine how firm resources and capabilities might interact with industry characteristics in influencing firm profitability, although some of them do control for the effect of industry structure (e.g., Spanos and Lioukas 2001). This lack of attention to potential interactions between firm and industry factors is perhaps a reflection of the common perception that the RBV and IO economics offer competing explanations for profitability differences among firms and thus do not have much to complement each other. A closer inspection of the RBV and the more dynamic perspectives of IO economics, however, suggest that the compatibility of their constructs and propositions also allows them to complement each other in developing a theoretical basis for firm and industry factors to interact in influencing firm profitability.

It is our contention that an investigation of possible interactions between firm resources and industry characteristics can potentially provide a more precise test of the RBV. Although the RBV's theoretical constructs are powerful, it is difficult to test the theory empirically because some of its key constructs are unobservable (Godfrey and Hill 1995). Specifically, the proposition that rare, valuable and inimitable resources sustain supernormal profitability basically rules out the possibility that the detailed attributes of such resources can be readily observed. Otherwise, a competitor would be able to replicate these resources with relative ease and erode the original resource possessor's profit. As a result, extant empirical studies have relied on observable indicators of such resources' presence and strength to test the RBV's propositions (Levitas and Chi 2002). An inevitable weakness of this approach is the uncertain quality of the observable indicators used in the study. As explained in more detail later in this paper, we believe that one may be able to reduce the noise in the observable indicators by examining the effects of their interactions with observable indicators of industry conditions.

There is ample evidence that both firm resources and industry characteristics affect firm profitability, thus any study that tries to verify the effects of one set of factors needs to control effectively for those of the other set. The work of Waring (1996) points to a way to remove industry effects from a firm's profitability measure without adding a large number of industry dummies. Such a normalized measure, derived by standardizing firm profitability by the industry mean, can be called *firm-specific profitability*, which is an indicator of the firm's competitive advantage (Villalonga 2004). This method of controlling for industry effect is equivalent to using industry dummies (Green 2000, pp. 560–561).

Furthermore, both the RBV and the more dynamic perspectives of IO economics contain a time dimension. The relationship that the RBV conceives between resources and profitability is expected to hold not only across firms but also over time, involving both firm-specific and time-specific components. As highlighted by Bowen and Wiersema (1999), the coexistence of these components in an empirical model gives rise to the possibility of parameter instability across firms and across time, making cross-sectional analysis prone to estimation biases. This potential problem is further magnified in view of the Schumpeterian notion that industry structure and firm profitability are both outcomes from the same stochastic process of innovation and growth (Nelson and Winter 1982). The vast majority of extant empirical studies on the impact of firm resources, however, have relied on cross-sectional data (Bowen and Wiersema 1999). Those that did collect data from multiple years generally cover a very short time span (5 years or less), limiting their ability to incorporate the time effects (e.g., Russo and Fouts 1997; Schroeder et al. 2002; Spanos and Lioukas 2001; Yeoh and Roth 1999). We believe that this is an area of RBV research where methodological improvement is called for.

The purpose of this study is to fill the above-mentioned gaps in the empirical research on the RBV by examining how indicators of firm resources and their *interactions* with industry characteristics influence *firm-specific profit*. The study extends RBV research both substantively and methodologically. By scrutinizing both the main effects of firm resources and the effects of their interactions with industry characteristics, it can potentially gain a more complete and more precise understanding of their influences on firm profitability. In addition, the study introduces methodological improvements by constructing measures of firm resources and firm profits in the form of deviations from the industry mean and by estimating the impacts of the firm and industry factors on a panel data that span 13 years. With few exceptions (e.g., Acquaah 2003; Villalonga 2004), extant empirical studies either relied on cross-sectional data or a very short time series, or used performance measures subject to confounding by industry effects. The combination of these two methodological improvements in this study enables it to achieve a cleaner control of industry effects and verify the effects of firm resources and capabilities in a more rigorous fashion.

The rest of the study is structured as follows. The section that follows this introduction presents our theoretical framework and derives our hypotheses. The next section explains our data and statistical methods. A further section presents the results. The last section discusses our findings and concludes the study.

2 Theory and hypotheses

Our theoretical framework derives from augmenting the basic proposition of the RBV with the Schumpeterian evolutionary perspective of IO economics on industry structure. The RBV postulates that firms in less than perfectly competitive industries are heterogeneous in terms of their resources and capabilities (Lippman and Rumelt 1982; Wernerfelt 1984). The basic proposition that follows from this postulate is that those firms that are able to earn supernormal profit on a sustained basis must possess resources and capabilities that are valuable, rare, difficult to imitate, imperfectly substitutable, and organized to be exploited (Barney 1991). Although the attributes of value and rareness may be sufficient for a resource to generate a temporary profit, the earning of supernormal profit on a sustained basis entails conditions that make it difficult for existing or potential competitors to catch up via *imitation* or leapfrog via *innovation*.

RBV theorists have identified a number of conditions that can form barriers to imitation, including causal ambiguity (Lippman and Rumelt 1982), complexity and tacitness (Reed and DeFillippi 1990), and co-specialization (Teece 1986). These conditions also make the resources immobile (Peteraf 1993) in the sense that there is no competitive strategic factor market where they can be readily traded (Barney 1986). It should be noted that leapfrogging via innovation can be traced to a lack of rarity, successful imitation or successful substitution in the RBV framework. For instance, the development of a new technology that is similar but superior to the old entails essentially the same type of resources as those used to develop the old; so, the competing innovator must have also possessed or been successful in replicating those resources. The development of a new technology that is fundamentally different from the old, on the other hand, involves a search for substitutes that in general entails the use of substantially different resources and capabilities.

As noted earlier, such resource attributes as rarity, inimitability and non-substitutability are very difficult to measure directly, and hence empirical researchers have in general had to rely on rather coarse measures that are likely to contain considerable noise. We believe that one may be able to reduce such noise by examining how indicators of firm resources interact with indicators of industry conditions based on insights from both the RBV and IO economics. Specifically, the theoretical propositions of evolutionary economics on the relations of industry conditions to activities of innovation and imitation suggest that certain observable conditions of an industry may indicate the relative ease of innovation and imitation in the industry.

Using a discrete stochastic model, Nelson and Winter (1982, pp. 206–233) examined the relationship of industry growth and concentration with the intensity of innovation and imitation activities. Two of their results are particularly interesting from the perspective of the current study. The first is the positive association between the rate of industry growth and the frequency and magnitude of innovation. Industry growth can result from either endogenous or exogenous factors. Product and process innovation is the fundamental endogenous driver of growth in the long run. Innovation raises productivity in terms of output quality or production efficiency, which in turn gives rise to growth in market demand and sales (Nelson and Winter focused their model on the relationship between innovation and growth of total factor productivity that ultimately drives the growth of sales, and for simplicity did not include the demand side in the model). Hence, this result of their model suggests that industry growth can provide an indication about the conditions of innovation in the industry. As discussed earlier, a low intensity of innovation activities in an industry likely reflects either a scarcity of the requisite resources for innovation, or a high level of difficulty in replicating or finding substitutes for the existing resources. Based on the RBV, these are all conditions that tend to reduce the level and sustainability of supernormal profit. Exogenous factors that also influence an industry's rate of growth include business cycles, changes in population size, and expansion or contraction in upstream and downstream industries. Extant literature in general considers higher growth or munificence to make it easier for firms to remain competitive (Hofer 1975; Dess and Beard 1984; McArthur and Nystrom 1991). Based in this postulate, higher industry growth can be expected to exert an equalizing effect on performance in the industry, weakening the effect of firm resources on performance; so, exogenous growth can be expected to moderate the performance effect of firm resources the same way as endogenous growth.

The other result of Nelson and Winter's (1982) model that is also very interesting from the perspective of the present study is the negative association between the concentration of an industry and the intensity of innovation and imitation activities in the industry. The regression analysis of their simulation outcomes shows that the factor that contributes by far the most, and most significantly, to the buildup of industry concentration is the lack of imitation. The intensity of imitation, in their model, is defined as the frequency with which firms in an industry are able to develop technologies similar to those of their competitors. This result suggests that the level of and change in industry concentration can provide an indication about the nature of imitation and innovation activities in an industry. As we discussed in the preceding paragraphs, a high (low) intensity of imitation and innovation activities implies low (high) barriers to imitation and substitution, which in turn is expected to reduce (enhance) the level and sustainability of supernormal profit in the industry. Hence, the level of and change in industry concentration are another type of industry characteristics that can be expected to condition the effect of firms resources on firm performance.[1]

The above analysis forms the basis for the following propositions about the relationship between firm performance and firm resources and the role of industry conditions in moderating the relationship.

Proposition 1 A firm's relative performance to that of its rivals is positively related to the relative strength of its resources and capabilities that are neither abundant nor easily replicable nor easily substitutable.

Proposition 2 The effect of a firm's resources on its relative performance is more positive as the conditions of the industry offer its participants more limited opportunities to imitate or leapfrog one another.

Proposition 1 focuses on the relationship between firm performance and the *value* attribute of resources and capabilities and treats the other attributes as given. Proposition 2 incorporates the impact of the *rarity*, *imitability* and *non-substitutability* attributes by linking the impact of the *value* attribute to industry conditions. We will in the rest of this section derive a number of hypotheses to test these two propositions. The hypotheses involve three variables that represent the strength of a firm's resources and capabilities, and three variables that reflect the conditions of the given industry. The three resource variables are *Corporate Management Capabilities*, *Employee Value-Added*, and *Technological Competence*. The three variables representing industry conditions are *Industry Growth*, *Industry Concentration*, and *Change in Industry Concentration*. The response variable in all the hypotheses is *Firm-Specific Profitability*, defined as the deviation of a firm's profitability from the industry average to remove effects that are common to the industry.

[1] This is also consistent with the Chicago school of economics that views industry structure as the outcome of industry competition that is based the relative strengths of its participants (e.g., Demsetz 1973). The S-C-P paradigm, however, views industry concentration as a condition that is conducive to collusion and monopoly rent (Bain 1956). A theoretical model that Makadok (2004) recently developed suggests that collusion can actually hurt firms that possess significantly superior resources to those of their competitors in the industry. If industry concentration is taken as an indicator of collusion, then his model would suggest that concentration negatively conditions the performance impact of firm resources in disagreement with our proposition. The question, then, is whether concentration reflects primarily the outcome of competition (as envisaged by the Schumpeterian and Chicago schools of IO economic) or the ease and likelihood of collusion (as envisaged by the S-C-P paradigm).

2.1 Corporate management and firm-specific profitability

As pointed out by Mahoney (1995), a crucial insight of Penrose's (1959) theory on the growth of the firm is that the ability of any firm to create and maintain a competitive advantage depends on how well that firm's resources are managed. Drawing on Penrose's insight, the RBV conceives the firm as a bundle of idiosyncratic resources embedded in its various organizational units (Wernerfelt 1984). Although a unique resource residing in only one part of the firm can give it an advantage over its competitors, truly sustainable advantage accrues from the presence of valuable, unique and co-specialized resources in many parts of the firm (Chi 1994; Grant 1996). This kind of complex resource configuration can potentially create not only greater value through synergy but also higher barriers to imitation (Castanias and Helfat 1991; Mahoney 1995; Miller and Shamsie 1996). In the meantime, the creation and regeneration of such a valuable and imitation-resistant resource bundle necessitates creative management and effective coordination, posing an exceedingly challenging task for the firm's management team. So a firm's *corporate management capabilities*, which we define as the ability of the firm's management team to creatively link and effectively coordinate resources and competencies at the product, business or the multidivisional level, are central to its capacity to earn supernormal profit on a sustained basis. Such capabilities can be reflected in innovative leadership (Aaker 1989; Petrick et al. 1999); capacity to develop and execute a clear strategic vision; ability to attract, develop and retain high-quality employees (Ireland and Hitt 1999); institution of superior compensation and reward systems (Mehra 1996); and aptitude in judicious management of the firm's financial and physical resources (Foil 1991). As articulated by Teece et al. (1997), these capabilities are fundamentally dynamic as they enable the firm to respond effectively to changes in the internal and external environments in the effort of generating and maintaining its competitive advantage. Hence, we have the following hypothesis about the effect of corporate management capabilities on a firm's performance relative to that of its rivals:

Hypothesis 1 Corporate management capabilities enhance firm-specific profitability ceteris paribus.

2.2 Relative employee value-added and firm-specific profitability

Researchers have long recognized that creative utilization and efficient management of skills embedded in a firm's employees boost the productivity of the firm and can serve as a source of sustainable competitive advantage (Leibenstein 1976). Henderson and Cockburn (1994) classify the expertise imbedded in a firm's employees into component competence and architectural competence. C*omponent competence* refers to the local abilities and knowledge possessed by the firm's employees that are fundamental to the activities of the firm, while *architectural competence* refers to the ability to integrate the knowledge and skills within the firm and to develop new ones as they are required. The latter type of competence resides not only in individuals but more importantly in teams and larger groups such as functional departments in an organization. While the knowledge and skills embedded in individual employees yield rents for the employees, those embedded in groups, teams or functional units generate rents for the firm. The possession of such embedded organizational knowledge and expertise raises the collective productivity of the firm's employees to a level the employees are unable to achieve based on their individual knowledge and skills, thus yielding rents primarily for the firm. This type of organizational knowledge and expertise is also more imitation-resistant because of its embeddedness and path dependence.

It is obviously difficult to measure directly a firm's architectural competence that is embedded in its employees and organization routines. Several studies suggested, however, that the productivity of a firm's labor force can capture both the individual skills of its employees and the positive interactions among the skilled employees in the firm's activities of value creation (Haltiwanger et al. 1999; Nickell 1996; Oulton 1998). Such complementary interactions among the employees reflect what Henderson and Cockburn (1994) refer to as a firm's architectural competence. Firms from different industries tend to hire employees from different labor pools that exhibit varying skill types and levels, but firms in the same industry can be expected to have much greater homogeneity in the composition of their employees. So, productivity differences across firms in the same industry are likely to capture more of the differences in their architectural competences as compared to productivity differences across industries.[2] Therefore, we hypothesize the following relationship between performance and relative employee value-added, which is defined as the deviation of a firm's employee value-added from industry average:

Hypothesis 2 Relative employee value-added enhances firm-specific profitability ceteris paribus.

2.3 Technological competence and firm-specific profitability

In many industries, competitive advantage depends on a firm's ability to accumulate knowledge and expertise rapidly through its innovative activities, entailing persistent investment in knowledge creation through R&D spending. Many studies have documented a positive linkage between a firm's R&D intensity and the stock market's valuation of its equity (e.g., Austin 1993; Ben-Zion 1984; Connolly et al. 1986; Cockburn and Griliches 1988; Shane and Klock 1997). Does this empirical

[2] Higher employee productivity can result from either of three conditions: (i) more intensive use of other production factors than labor such as capital; (ii) high employee skills that are not specific to the firm; (iii) high employee skills that are substantially specific to the firm and thus exhibit positive interactions to create value. Theoretically, only higher employee productivity under condition (iii), which falls under rubric of the architectural competence, can be expected to yield rent for the firm. Under condition (i), the economic gain from the higher employee productivity must be used to pay for the services of the more intensively used other production factors. Under condition (ii), the employees are expected to reap the economic benefit from their higher productivity because they can easily threaten to leave the firm and get the market value of their skills elsewhere. We thank an anonymous referee whose comment helped us clarify our thinking about this question.

relationship represent evidence for the position of the S-C-P paradigm that high R&D spending signifies high entry barriers or evidence for the position of the Chicago and Schumpeterian schools that the high R&D spenders tend to be superior innovators? The RBV, while in agreement with the Chicago and Schumpeterian schools on this question, provides a more precise exposition of the mechanisms that cause intra-industry heterogeneity in technological competence to persist. These mechanisms include causal ambiguity, complexity, tacitness and co-specialization (Reed and DeFillippi 1990). It should be noted that in an industry where competitive advantage depends on continued innovation, firms are likely to have greater opportunities to imitate and leapfrog one anther. So, in such industries, the truly rare, inimitable and imperfectly substitutable resources are unlikely to be the outcomes of individual innovations but rather firm-specific skills of employees and organization routines that enable the firm to generate faster and better innovations. In other words, they have to meet the criteria for dynamic capabilities (Teece et al. 1997). Because of the afore-mentioned difficulty in measuring directly any dynamic capabilities of this nature, it often becomes necessary to find indirect indicators of their strength.

The robust empirical finding that the stock market tends to place a higher value on a more R&D-intensive firm suggests that a firm's R&D intensity can serve as an indicator of the firm's technological competence embedded in difficult-to-imitate firm-specific skills and organization routines. Given that a firm's R&D intensity can reflect both industry conditions and firm-specific factors, the possible influence of industry conditions would make the indicator noisy. Such noise, in view of the divergent interpretations concerning the role of R&D spending in IO economics (i.e., entry barrier or efficiency), could reduce its reliability when used as a variable in a test of the RBV. Following the same rationale for our definition of firm-specific profitability, one can also remove this type of noise in the variable by redefining it as the deviation of a firm's R&D intensity from the industry's average. We refer to this redefined variable as *technological competence.* Based on the above discussion, we hypothesize:

Hypothesis 3 Technological competence enhances firm-specific profitability ceteris paribus.

2.4 Moderating effects of industry characteristics

Nelson and Winter's (1982) evolutionary theory considers such observable industry characteristics as growth and concentration to be fundamentally driven by such difficult-to-gauge technology dynamics of the industry as intensity of innovation and imitation. Drawing on the results of their simulation model, we argued earlier in this section that industry growth, concentration and change in concentration provide indications about the opportunities for the firms in an industry to imitate or leapfrog one another. In other words, these variables reflect how easily competitive advantages in the industry can be eroded by what the RBV refers to as imitation and substitution. In the rest of this section, we will examine how these variables may moderate the relationship between firm resources and firm performance.

2.4.1 Industry growth

Nelson and Winter's evolutionary model suggests that an industry's growth is fundamentally driven by the frequency and magnitude of innovation in the industry. As a lower frequency of innovation implies greater barriers to innovation, slower industry growth can be taken as an indication of more limited opportunities for firms to improve on the current "state of the art". When the industry conditions are such that improvements are more difficult, the competitive advantages that incumbents hold are less likely to be eroded. Part of the reason is perhaps that slower-growing industries tend to be more mature, offering fewer opportunities for significant product innovation and thus motivating firms to focus instead on process innovation that tends to be more difficult for rivals to replicate and provide more sustainable competitive advantage (Klepper 2002). Therefore, we expect a firm's resources to have a more positive impact on performance in industries that exhibit slower growth.

Without the theoretical insight from evolutionary economics, the idea that firm resources have a more positive impact on performance in slower-growing industries may appear counterintuitive at a first glance. It is not difficult to imagine that there could be greater resource heterogeneity in a more rapidly growing industry since high growth might allow highly profitable innovators and marginal laggards to coexist. Such a scenario is certainly plausible, and may have occurred in some industries at various times. Since there are also likely more abundant opportunities for and more intense competition in innovation in a rapidly growing industry, the forces that erode the advantages of an innovator are also stronger, possibly compelling all firms to spend heavily on R&D and consequently report lower profitability. Hence, the stronger theoretical justification provided by evolutionary economics prompts us to hypothesize the following:

Hypothesis 4 Firm resources have a more positive impact on firm-specific profitability when an industry is characterized by slower growth ceteris paribus.

2.4.2 Industry concentration and change in industry concentration

Nelson and Winter's (1982) model also indicates that the factor contributing by far the most to the buildup of industry concentration is the lack of opportunities in the industry for firms to imitate one another. A less important, but still significant, contributor in their model is the lack of opportunities to innovate. As both factors make it difficult for firms to emulate or improve on the current "state of the art", we can take high or increasing industry concentration as an indication that competitive advantage in the industry is likely to sustain. The rationale for this relationship can also be seen by taking a closer look at the antecedents for changes in industry concentration. Increasing concentration is likely prompted by an industry's movement toward maturity, with stronger firms establishing more sustainable advantageous positions in the market and gaining market share from their weaker rivals (Demsetz 1973; Malerba and Orsenigo 2002). Decreasing concentration, on the other hand, can reflect either of two different trends that both reduce heterogeneity in firm performance (Breschi et al. 2000). One is that the superior know-how of the previously dominant firms is being increasingly imitated due to dissemination (e.g., after the expiration of patent protection). The other is that recent technological changes have created new opportunities for incumbents or new entrants to innovate and leapfrog the previously dominant firms. These arguments lead to the following hypothesis:

Hypothesis 5 Firm resources have a more positive impact on firm-specific profitability when an industry is characterized by higher or increasing concentration ceteris paribus.

3 Methods

3.1 Sample and data

We use data gathered from *Fortune* magazine's America's Most Admired Companies (AMAC) dataset and Standard & Poor's Compustat database to test our hypotheses. The AMAC dataset provides information that can be used to construct a measure for the capabilities of a firm's corporate management. In the survey published in March 1998, *Fortune* argues that the key factor that makes a company admirable is its corporate leadership capabilities in managing the value creation process (Stewart 1998). The article contends that such capabilities include the abilities to (1) establish a clear vision; (2) align employees interests with the broader ideas of what the company should be; (3) create conditions that energize and inspire employees to go beyond the call of duty; and (4) strategically allocate capital towards high yielding uses.

Fortune has conducted surveys on large American firms since 1982 and published the results each year since 1983. It administers the surveys to over 8,000 top executives, outside directors and securities analysts and asks them to rate a subset of the firms that fall in their areas of expertise. This arrangement makes sure that each expert only rates those firms on which they have gained in-depth knowledge from their professional experience. The surveys ask the industry experts to evaluate the firms on eight attributes: (1) quality of management; (2) quality of products or services; (3) innovativeness; (4) ability to attract, develop and keep talented people; (5) wise use of corporate assets; (6) responsibility to the community and environment; (7) soundness of financial position; and (8) value as a long-term investment. Even though the survey is called "America's Most Admired Companies", the companies chosen for the survey consist of the 4–11 (typically 10) largest firms in each of the industries from the *Fortune* 1000 list for the year prior to the year of the survey. *Fortune* assigns industry groups to the companies on the basis of their largest source of revenue. A more detailed description of the survey's methodology can be found in Roberts and Dowling (2002). It should be noted that the survey's data collection procedure produces a sample that has considerable variability across firms in the rating scores as well as in performance. Even though the survey contains ratings of every company in the sample on each of the eight attributes, the magazine only publishes data on the highest- and lowest-rated companies (i.e., top 3 and bottom 3) in an industry on each attribute. The AMAC data for our study was obtained from the *America's Most Admired Corporations Databook* compiled by the Occam Research Corporation, which contained the full dataset as opposed to the top 3 and bottom 3 companies in each industry from 1983 to 1997.

The AMAC dataset was chosen to measure the capabilities of corporate management for several reasons. First, the first six of the eight attributes likely represent embedded competencies that are difficult for competitors to imitate and thus yield rents for the firm. Second, the surveys offer assessments by a diverse group of industry experts who have access to proprietary firm and industry information about the firms' resources and capabilities. According to Hammond and Slocum (1996, p. 161), "the quality of respondents is comparable to those that could be obtained elsewhere since respondents only rate firms with which they are familiar." Moreover, it has been argued that the assessment of a firm's intangible resources and capabilities should not be an internal affair, but should be done by external constituents who can examine what the firm does better than its competitors (Collis and Montgomery 1995). Third, they provide comparable longitudinal data over an extended period of time that can help capture the intertemporal effects of the use and development of firm-specific corporate management capabilities. Fourth, in an exploratory study, Chen et al. (1993) provide support for the reliability and accuracy of information offered by top executives and security analysts. Reflecting the wide acceptance of its validity, the AMAC data have been used extensively in business research (e.g., Roberts and Dowling 2002; Staw and Epstein 2000).

We established the following criteria for a firm to be included in the sample: (1) the firm's primary SIC code falls in a manufacturing industry, (2) the firm was included in the survey in each of the 13 years 1985–1997, and (3) the firm's financial and industry data are available from the Compustat database for each of the 13 years. The second criterion allowed us to obtain a balanced panel covering the entire period of the AMAC dataset that we acquired. It should be noted that using a balanced panel data has the potential of creating a survivorship bias. However, Wiggins and Ruefli (2002) argue that it is important to have a longitudinal dataset spanning 10 years or more to assess reliably the impact of resources and capabilities on the *sustainability* of performance. Moreover, Jimenez-Martin (1998) showed that a balanced panel tends to yield more reliable estimates in panel data analysis. Using the above criteria, we obtained a sample of 1118 firm-year observations on 86 manufacturing firms for the study.

To check for sample selection bias, we examined the complete AMAC dataset file from 1985 to 1997, which contained 4194 firm-year observations. The survey did not include the same firms in every year, and some firms did not appear in the dataset for more than two consecutive years. Because we used a two-year lag to create the *Corporate Management Capabilities* variable and thus needed at least three consecutive years of data on each firm, the full dataset that we used to check for sample selection bias did not include every firm either. All the manufacturing firms that were rated for at least three consecutive years yielded 2893 firm-year observations. A *t*-test was conducted to compare the mean of the pooled data in our manufacturing sample (1118 firm-year observations) with the mean of those manufacturing firms excluded from the sample (1775 firm-year observations) on assets, sales, R&D intensity, number of employees and capital intensity. The test results indicate that the two samples are not significantly different ($p > 0.10$ for all the variables). Moreover, a *t*-test was also conducted to compare the mean of the pooled data in our manufacturing sample with the mean of all firms both manufacturing and service excluded from the sample (3076 firm-year observations) on assets, sales, number of employees and capital intensity. The test results again indicate that the two samples are not significantly different ($p > 0.10$ for all the variables).

3.2 Dependent variables

The dependent variable, *Firm-Specific Profitability* $f_{i,t}$, is a normalized measure of relative firm performance. It is calculated as the percentage deviation of a firm's accounting or market return from the industry average,

$$f_{i,t} = [(\Pi_{i,j,t} - I_{j,t})/I_{j,t}] \times 100 \tag{1}$$

where $\Pi_{i,j,t}$ is the performance measure for firm i in industry j at time t, and $I_{j,t}$ is the asset-weighted average performance of firms in industry j at time t based on four-digit SIC codes. The weighted average measure of industry profitability is calculated as $I_{j,t} = \sum(P_{i,j,t} \times \Pi_{i,j,t},)$ where $P_{i,j,t}$ is the proportion of firm i's assets in industry j at time t (cf. Waring 1996; Roberts 1999; Villalonga 2004).

Three alternative measures of firm performance are used: return on assets (*ROA*), return on sales (*ROS*) and Tobin's q. *ROA* and *ROS* have been standard measures of performance in strategic management and IO economics. In this study, these two profitability measures are calculated as income before extraordinary items available to common shareholders divided by total assets and total sales, respectively. However, as accounting measures of performance, both *ROA* and *ROS* have been criticized for not taking into consideration differences in systematic risks, capital structures and accounting conventions. Furthermore, they do not take into account the future stream of profits and the risk involved in obtaining those profits. In addition, these measures are not sensitive to the time lags necessary for realizing the potential profits from capital (including human capital) investment (e.g., Bharadwaj et al. 1999).

Based on these considerations, financial market-based measures that take into account a firm's future profit potential have been proposed in the financial management and economics literature. In this study, we chose Tobin's q, which is defined as the ratio of a firm's market value to the replacement cost of its assets, because it represents the capital market's valuation of the return on additional investment that the firm faces. Following Chung and Pruitt (1994), whose model for calculating Tobin's q explains at least 96% of the variability in the measure of

Tobin's q obtained using the theoretically correct model of Lindinberg and Ross (1981), we measured Tobin's q as (see also Bharadwaj et al. 1999)

$$q_{i,t} = (MVE_{i,t} + PS_{i,t} + DEBT_{i,t})/TA_{i,t}, \tag{2}$$

where $MVE_{i,t}$ is the product of a firm's share price and the number of common stock shares outstanding, $PS_{i,t}$ is the liquidating value of the firm's preferred shares outstanding, $DEBT_{i,t}$ is the value of the firm's short-term liabilities net of its short-term assets plus the book value of the firm's long-term debt, and $TA_{i,t}$ is the book value of the firm's total assets, all at time t.

3.3 Independent variables

3.3.1 Corporate management capabilities

Corporate management capabilities ($CMC_{i,t}$) is measured using the first six of the eight attributes from the AMAC survey explained above: (1) quality of management; (2) quality of products or services; (3) innovativeness; (4) ability to attract, develop and keep talented people; (5) wise use of corporate assets; and (6) responsibility to the community and environment. These attributes apply to the corporate management of every firm (Bowman and Helfat 2001, Mehra 1996; Russo and Fouts 1997; Vergin and Qoronfleh 1998). We omitted the last two attributes, sound financial performance and value as long-term investment, because they are themselves perceptive measures of a firm's economic performance as opposed to the capabilities of its corporate management (Vergin and Qoronfleh 1998). The ratings are on a scale from 0 (poor) to 10 (excellent). The response rate has averaged about 50% for each year of the survey.

Despite the extensive use of the AMAC database for research purposes (e.g., Brown 1998; Fombrun and Shanley 1990; Staw and Epstein 2000; Roberts and Dowling 2002; Vergin and Qoronfleh 1998), some researchers have argued that the ratings are highly influenced by the previous financial performance of the firms due to a "halo" effect (Fombrun and Shanley 1990; Fryxell and Wang 1994). To address this concern, we adopted Brown and Perry's (1994) method for removing the "halo" from the ratings. The following regression equation was employed to generate a halo-removed rating for each of the six attributes for every firm in every year:

$$\begin{aligned} R_{i,t} = {} & b_0 + b_1 ROA_{i,t-1} + b_2 FGROW_{i,t-1} + b_3 DMR_{i,t-1} + b_4 LSALES_{i,t-1} \\ & + b_5 MBV_{i,t-1} + E_{i,t} \end{aligned} \tag{3}$$

where $R_{i,t}$ is the AMAC rating of each of the six attributes described above for firm i in year t from 1985 to 1997, and $E_{i,t}$ is the regression residual taken as the halo-removed rating of each attribute. The regressors are return on assets ($ROA_{i,t-1}$), percentage change in sales ($FGROW_{i,t-1}$), ratio of debt to market value ($DMR_{i,t-1}$), natural logarithm of sales ($LSALES_{i,t-1}$), and ratio of the market to the book value for firm *i* ($MBV_{i,t-1}$). The arithmetic average of the halo-removed ratings of the six attributes is used to operationalize the capabilities of corporate management for each firm. It has been shown repeatedly that the attributes measure a single underlying construct (e.g., Flanagan and O'Shaughnessy 2005; Fombrun and Shanley 1990).

Although we know that *current* managerial decisions influence *future* earnings (Nickell 1996), the exact lag structure is not known *a priori*. Following Amable and Verspagen (1995), the lag structure was limited to two years to maximize the length of the time series. The capabilities of a firm's corporate management are, therefore, measured as follows:

$$CMC_{i,t} = MGMT_{i,t-1} + MGMT_{i,t-2}(1 - \delta_m) \quad (4)$$

where $MGMT_{i,t-1}$ and $MGMT_{i,t-2}$ denote the average of the six halo-removed ratings at $t-1$ and $t-2$, and δ_m is the assumed rate at which knowledge-based capital loses its value over time. We apply a discount rate to the lagged component of this variable because management capabilities are subject to obsolescence if not renewed on a consistent basis. The rate of depreciation that has been used in the literature to discount knowledge-based capital typically ranges from 15 to 30% (Blundell et al. 1999; Henderson and Cockburn 1994, 1996). We experimented with rates ranging from 0 to 40% and found that higher rates of discount tend to enlarge the sizes of the regression coefficients without affecting their significance. The results reported in the next section were based on variables calculated at δ_m equal to 15%.

3.3.2 *Relative employee value-added*

Relative employee value-added ($REV_{i,t}$) is calculated as the percentage deviation of a firm's value added per employee from the industry average. The value-added for each firm is measured as the sum of depreciation, amortization, fixed charges, interest expense, labor and related expenses, pension and retirement expenses, net income before taxes, and rental expenses (Barney 2001). Value-added per employee measures the firm's labor productivity. A firm with a higher value-added per employee relative to the industry creates more value through the use of its employees' skills and expertise than other firms in the industry (Grant 2005). As discussed in the previous section, the variable is intended to capture what Henderson and Cockburn (1994) define as architectural competence that is rooted in firm-specific skills and organization routine and thus difficult for competitors to imitate. The formula that we used to calculate this measure is:

$$REV_{i,t} = [(FEV_{i,t} - IEV_{i,t})/(IEV_{i,t})] \times 100, \quad (5)$$

where $FEV_{i,t}$ denotes employee value-added for firm *i* and $IEV_{i,t}$ denotes the average of $FEV_{i,t}$ for the industry.

3.3.3 Technological competence

Technological competence ($TC_{i,t}$) is constructed similarly as a relative measure based on the firm's R&D intensity compared to the industry average. Because investment in R&D is likely subject to depreciation, the measure is also discounted. To construct this measure, we first calculated the R&D intensity (R&D expenditures/sales) for each firm in each year as well as the average of the industry. Then, their lagged values are used to obtain the lagged *Technological Competence* $TC_{i,t-1}$ and $TC_{i,t-2}$:

$$TC_{i,t-1} = (FRD_{i,t-1}/IRD_{j,t-1})(1-\delta_s), \quad \text{and}$$
$$TC_{i,t-2} = (FRD_{i,t-2}/IRD_{j,t-2})(1-2\delta_s),$$

where $FRD_{i,t-1}$ and $FRD_{i,t-2}$ are the lagged R&D intensity for firm i, $IRD_{j,t-1}$ and $IRD_{j,t-2}$ are the lagged industry averages, and δ_s is the rate of discount. We experimented with rates ranging from 0 to 30% and did not find them to affect the results qualitatively. As such, we just chose a discount rate of 20% (quite arbitrarily) for the results reported in the next section based on the rationale that technological knowledge is likely subject to a greater speed of obsolescence than managerial expertise. The final value of our *Technological Competence* measure is simply the sum of the lagged values,

$$TC_{i,t} = (TC_{i,t-1} + TC_{i,t-2}) \times 100. \tag{6}$$

It should be noted that R&D intensity has been used extensively in the literature to measure intangible technological resources and capabilities (e.g., Helfat 1994, 1997; Villalonga 2004; Yeoh and Roth 1999).

3.3.4 Industry growth

Industry growth is measured as the annual rate of sales growth for the four-digit SIC industry in percentage terms based on data from the *Compustat* database (Ferrier et al. 1999; Russo and Fouts 1997; Waring 1996).

3.3.5 Industry concentration and change in industry concentration

Industry concentration and change in industry concentration are measured as the four-firm concentration ratios and the year-to-year percentage change in the ratios, respectively (Bharadwaj et al. 1999; Blundell et al. 1999; Davies and Geroski 1997; Geroski 1990; Waring 1996). The industry concentration ratio is calculated as the proportion of sales in a firm's industry accounted for by the four largest firms using data from Compustat. This method has been frequently used to compute concentration ratio based on information from publicly available databases including Compustat (e.g., Blundell et al. 1999; Ferrier et al. 1999; Waring

1996). Our data include firms from 50 industries with distinct 4-digit SIC codes, and each of them showed at least a slight change in concentration in each of the 13 years.

3.3.6 Control variables

A number of control variables that prior theoretical and empirical studies suggest as potentially influential on firm profitability were included in the model. They include the lagged firm-specific profit $f_{i,t-1}$ to capture the effects of omitted variables (Green 2000), natural logarithm of the number of employees to reflect firm size (Bharadwaj et al. 1999; Nickell 1996), annual percentage rate of growth in the firm's sales (Silverman 1999), ratio of the firm's total assets to sales to reflect capital intensity (Porter 1980; Russo and Fouts 1997), non-normalized R&D intensity for each firm (Silverman 1999; Yeoh and Roth 1999), and extent of a firm's diversification. We used the entropy measure of firm diversification calculated as $\sum P_{i,k,t}$ [$\ln(1/P_{i,k,t})$], where $P_{i,k,t}$ is the annual percentage of the firm's sales in segment k in year t (Davies and Duhaime 1992). All these variables were obtained from the *Compustat* database.[3]

3.4 Model specification

A dynamic heterogeneous panel data regression model was used to capture the effects of firm resources and industry attributes on firm-specific profits over time. The method allows for the examination of the heterogeneity of firm-specific profits across firms over time (Greene 2000). Based on the assumption that each firm is unique in terms of resources and capabilities, this method allows us to control for such uniqueness through firm effects if this is statistically called for. The method has the advantage of requiring relatively few time-series observations to assess the dynamic impact of firm-specific resources and industry attributes on firm-specific profitability (Baltagi 1995). Furthermore, it allows for the control of not only individual firm effects but also time-specific effects in the sample. Cross-section and time-series studies cannot control for these effects and therefore run the risk of obtaining biased estimates (Baltagi 1995). Moreover, simply pooling the data and estimating by an OLS procedure can result in inefficiency as well as biases in the estimates due to the heterogeneity of coefficients across firms and time periods (Hsiao 1986). The following dynamic heterogeneous panel data model was estimated using the panel procedure in LIMDEP 7.0:

[3] We try to control for the effects of all commonly included variables in empirical studies of firm performance in order to be conservative in testing the effects of the normalized resource variables. It is worth noting that *Technological Competence* is measured as the normalized deviation of firm R&D intensity from industry average. So, the inclusion of non-normalized firm R&D intensity in the model as a control variable allows us to test whether the normalized resource measure captures anything beyond the non-normalized control variable. We also ran our analyses without the non-normalized firm R&D intensity variable, and the results remain qualitatively the same.

$$f_{i,t} = \alpha_i + \beta f_{i,t-1} + \tau W_{i,t} + \phi X_{j,t} + \delta Y_{i,t} + \gamma Z_{i,j,t} + U_{it}, \qquad (7)$$

where $i = 1,\ldots, M$; $j = 1,\ldots, N$; $t = 1,\ldots, T$; $f_{i,t}$ denotes firm-specific profitability; $W_{i,t}$ denotes the vector of control variables; $X_{j,t}$ denotes the vector of industry characteristic variables; $Y_{i,t}$ denotes the vector of firm-specific resource variables; $Z_{i,j,t}$ denotes the interaction terms between the firm-specific resource and the industry characteristic variables; and $U_{i,t}$ is the error term.

The generalized least squares (GLS) procedure was employed in the estimation using a two-way random-effect model. A Hausman (1978) test indicated that a random-effect model is more appropriate. The null hypothesis (random effects) could not be rejected at the 1% significance level. None of the computed *Hausman statistics*, which has a χ^2(distribution, exceeded 10.5. Furthermore, a likelihood ratio test indicated that both firm and time effects are important. A null hypothesis of no time effect was rejected at the 1% level of significance. All the *Likelihood ratio statistics*, which have a χ^2 distribution, were greater than 64.

The models were estimated in two stages because of the potential correlation between the lagged dependent variable and the error term in the model, which could give rise to inconsistent estimates. The two-stage procedure uses the method of instrumental variables to compute a proxy variable that is highly correlated with the original lagged dependent variable but uncorrelated with the error term (Greene 2000; Gujarati 2003). In the first stage, each of the lagged dependent variables (i.e., firm-specific *ROA*, firm-specific *ROS* and firm-specific Tobin's *q*) was regressed on firm size, firm sales growth, firm capital intensity, non-normalized firm R&D intensity, firm diversification, industry growth, industry concentration, percentage change in industry concentration, relative employee value-added, the two additive components of corporate management capabilities, and the two additive components of technological competence. The vector of predicted values of the lagged dependent variables obtained from the first-stage regression was used as the proxy for the original lagged dependent variable in the second stage (Greene 2000).

Table 1 presents the descriptive statistics and correlations among the variables in the sample. To minimize the potential problem of multicollinearity between the interaction terms and their constituent terms, we centered the firm-specific resource variables and the industry characteristics variables (Neter et al. 1996; Russo and Fouts 1997). Table 1 reveals that the correlations among the variables are generally low.

4 Results

The regression results are presented in Table 2. Models 1a, 1b and 1c and Models 2a, 2b and 2c are the baseline models that show, respectively, the effects of the control variables and the effects of the industry characteristic variables on firm-specific profitability. Models 3a, 3b and 3c introduce the firm-specific resource variables to test Hypotheses 1, 2 and 3. Models 4a, 4b and 4c represent the full models that further add the interaction terms to test Hypotheses 4 and 5. To reduce clutter and improve parsimoniousness and readability, we dropped the statistically

Table 1 Descriptive statistics and correlation matrix of variables

Variables	N [a]	Mean	SD	Correlation among variables 1	2	3	4	5	6	7	8	9	10	11	12	13
1. Firm-specific $ROA_{i,t}$	946	133.76	278.46													
2. Firm-specific $ROS_{i,t}$	946	121.32	370.54	0.30^{**}												
3. Firm-specific Tobin's $q_{i,t}$	814	8.49	50.96	0.15^{**}	0.15^{**}											
4. Corporate management $capabilities_{i,t}$	946	0.05	1.16	0.10^{*}	0.12^{**}	0.24^{**}										
5. Technological $competence_{I,t}$	946	139.80	78.92	0.07	0.14^{**}	0.16^{**}	0.34^{**}									
6. Relative employee value $added_{i,t}$	946	11.85	35.24	0.15^{**}	0.11^{*}	0.14^{**}	0.15^{**}	0.05								
7. Industry $growth_{j,t}$	946	18.57	23.84	0.03	0.01	-0.08^{*}	-0.02	-0.09^{*}	0.14^{**}							
8. Industry $concentration_{j,t}$	946	0.73	0.241	-0.03	0.03	0.11^{*}	0.13^{**}	0.08^{*}	-0.18^{**}	-0.32^{**}						
9. Change in industry $concentration_{j,t}$	946	0.05	5.32	0.01	0.01	0.06	0.05	0.02	0.10^{*}	-0.02	0.07					
10. Firm $size_{i,t}$	946	3.91	0.92	0.08^{*}	0.01	-0.07	0.07	0.22^{**}	-0.08	-0.01	-0.02	0.01				
11. Firm $growth_{i,t}$	946	5.98	4.43	0.07	0.04	0.23^{**}	0.05	0.12^{**}	0.18^{**}	0.08^{*}	-0.03	0.09^{*}	0.12^{**}			
12. Firm capital $intensity_{i,t}$	946	1.07	0.41	0.05	0.03	-0.15^{**}	0.19^{**}	0.09^{*}	0.09^{*}	0.01	0.01	-0.05	0.33^{**}	-0.23^{**}		
13. Firm R&D $intensity_{i,t}$	946	0.05	0.06	0.04	0.09^{*}	0.09^{*}	0.08^{*}	0.29^{**}	0.08^{*}	0.05	0.05	0.06	0.10^{*}	0.37^{**}	-0.03	
14. Firm $diversification_{i,t}$	946	0.91	0.62	0.10^{*}	0.09^{*}	0.01	0.11^{*}	0.05	0.11^{**}	-0.03	-0.04	0.05	0.19^{**}	0.01	0.11^{*}	0.13^{**}

For significance levels: $^{*}p < 0.05$; $^{**}p < 0.01$

[a] All correlations with Tobin's q are based on $N = 814$; the rest are based on $N = 946$

Table 2 Two-way random effects model of firm resources on firm-specific profitability

Variable	Firm-specific ROA ($FROA_{i,t}$)				Firm-specific ROS ($FROS_{i,t}$)				Firm-specific Tobin's q ($FTQ_{i,t}$)			
	1a	2a	3a	4a	1b	2b	3b	4b	1c	2c	3c	4c
• Constant	0.432 (0.502)	0.494 (0.555)	0.587 (0.665)	0.422 (0.577)	0.144 (0.650)	0.443 (0.862)	0.468 (0.845)	0.502 (0.806)	0.147 (0.102)	0.126 (0.127)	0.342^{**} (0.125)	0.324^{**} (0.127)
• Lagged firm-specific profits ($f_{i,t-1}$)	0.229^{**} (0.036)	0.238^{**} (0.036)	0.234^{**} (0.036)	0.236^{**} (0.036)	0.124^{**} (0.033)	0.121^{**} (0.033)	0.125^{**} (0.032)	0.120^{**} (0.033)	0.742^{**} (0.027)	0.752^{**} (0.026)	0.745^{**} (0.025)	0.745^{**} (0.025)
• Firm $size_{i,t}$	0.236^{*} (0.102)	0.223^{*} (0.104)	0.219^{*} (0.107)	0.229^{*} (0.109)	0.061 (0.148)	0.034 (0.155)	0.028 (0.155)	0.122 (0.151)	-0.026^{+} (0.015)	−0.025 (0.020)	-0.066^{**} (0.019)	-0.062^{**} (0.019)
• Firm $growth_{i,t}$	0.045^{*} (0.023)	0.041^{*} (0.020)	0.063^{**} (0.024)	0.114^{**} (0.023)	0.056^{*} (0.027)	0.067^{*} (0.032)	0.063^{*} (0.030)	0.092^{**} (0.034)	0.020^{**} (0.004)	0.020^{**} (0.004)	0.014^{**} (0.004)	0.014^{**} (0.004)
• Firm capital $intensity_{i,t}$	0.134 (0.239)	0.106 (0.234)	−0.128 (0.249)	−0.0004 (0.0018)	0.256 (0.320)	0.270 (0.326)	−0.006 (0.330)	−0.002 (0.002)	-0.089^{+} (0.055)	−0.030 (0.058)	−0.012 (0.056)	−0.007 (0.057)
• Firm R&D $intensity_{i,t}$	1.946 (1.621)	1.912 (1.592)	1.557 (1.677)	0.648 (1.267)	4.345^{*} (2.175)	4.313^{*} (2.122)	3.987^{+} (2.124)	3.821^{+} (2.124)	-0.627^{*} (0.322)	−0.481 (0.323)	-0.578^{+} (0.322)	-0.522^{+} (0.322)
• Firm $diversification_{i,t}$	0.325^{*} (0.149)	0.332^{*} (0.146)	0.251^{+} (0.146)	0.248^{+} (0.151)	0.378^{+} (0.213)	0.385^{+} (0.214)	0.365^{+} (0.214)	0.359^{+} (0.205)	0.037 (0.025)	0.034 (0.024)	0.018 (0.023)	0.016 (0.023)
• Industry $growth_{j,t}$		0.003 (0.004)	0.004 (0.004)	0.004 (0.004)		0.002 (0.005)	0.002 (0.005)	0.003 (0.005)		-0.004^{**} (0.0008)	-0.004^{**} (0.0007)	-0.004^{**} (0.0008)
• Industry $concentration_{j,t}$		−0.155 (0.389)	−0.213 (0.423)	−0.215 (0.422)		0.459 (0.561)	0.472 (0.569)	0.416 (0.572)		0.015 (0.076)	0.029 (0.079)	0.026 (0.079)
• Change in industry $concentration_{j,t}$		0.001 (0.017)	−0.008 (0.017)	−0.007 (0.017)		−0.004 (0.023)	−0.008 (0.023)	−0.006 (0.023)		0.009^{**} (0.003)	0.009^{**} (0.003)	0.009^{**} (0.003)
• Corporate management $capabilities_{i,t}$			0.204^{*} (0.081)	0.204^{**} (0.078)			0.214^{*} (0.103)	0.235^{*} (0.106)			0.162^{**} (0.024)	0.160^{**} (0.024)
• Relative employee value $added_{i,t}$			1.152^{**} (0.288)	0.965^{**} (0.288)			0.832^{*} (0.384)	0.886^{*} (0.383)			0.125^{**} (0.050)	0.125^{**} (0.050)

Table 2 continued

Variable	Firm-specific ROA ($FROA_{i,t}$)				Firm-specific ROS ($FROS_{i,t}$)				Firm-specific Tobin's q ($FTQ_{i,t}$)			
	1a	2a	3a	4a	1b	2b	3b	4b	1c	2c	3c	4c
• Technological competence$_{i,t}$			0.124 (0.133)	0.099 (0.130)			0.412^{**} (0.162)	0.441^{**} (0.178)			0.116^{**} (0.022)	0.115^{**} (0.022)
• Corporate management capabilities$_{i,t}$ × industry growth$_{j,t}$								-0.242^{*} (0.109)				
• Relative employee value added$_{i,t}$ × industry growth$_{j,t}$				-2.026^{**} (0.561)				-1.668^{*} (0.728)				-0.162^{**} (0.038)
• Relative employee value added$_{i,t}$ × change in industry concentration$_{j,t}$												0.258^{**} (0.089)
• Log-likelihood[a]	−2224.87	−2224.15	−2209.72	−2201.41	−2506.61	−2506.48	−2491.06	−2479.21	−459.21	−437.00	−374.19	−359.31
• Likelihood ratio test[b]		χ^2 (3) = 1.44	χ^2 (3) $= 28.86^{**}$	χ^2 (1) $= 16.62^{**}$		χ^2 (3) = 0.26	χ^2 (3) $= 30.84^{**}$	χ^2 (2) $= 23.70^{**}$		χ^2 (3) $= 44.42^{**}$	χ^2 (3) $= 125.62^{**}$	χ^2 (2) $= 29.76^{**}$

Standard errors are in parentheses. For significance levels: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{+}p < 0.10$

[a]Every equation is significant at $p < 0.01$

[b]For the Likelihood ratio test: Models 2a, 2b, and 2c are compared to Models 1a, 1b, and 1c respectively; Models 3a, 3b and 3c are compared to Models 2a, 2b and 2c respectively; Models 4a, 4b and 4c are compared to Models 3a, 3b and 3c respectively

insignificant interactions terms from the full models presented in Table 2. As indicated in the notes below the table, the log likelihood ratio statistics in the last row test the significance of each expanded model against the relevant baseline model.

4.1 Control variables

Among the control variables, only the lagged dependent variable and *Firm Growth* are consistently significant across all models. The lagged dependent variable is often used to capture the effects of omitted variables, including those that represent firm resources but are omitted from our study. Lagged dependent variables are used in time-series studies of firm performance to gauge the degree of persistence in performance (e.g., Jacobson 1988; Robert and Dowling 2002), as a larger coefficient (closer to 1) indicates greater persistence. The fact that the sizes of their coefficients in our models stay rather stable as new variables are added indicates that there is unexplained persistence. The larger coefficients in the Tobin's *q* models suggest that the stock market's valuation of a firm's performance tends to be more persistent, even though the stock market can be highly volatile itself. The consistently significant effect of *Firm Growth* may also represent certain underlying firm resources that are not captured by our resource variables.

It is interesting to observe that two of the control variables, *Firm Size* and *Firm R&D Intensity*, tend to affect the accounting-based profit measures positively but the stock market-based profit measure, *Firm-Specific Tobin's q*, negatively. The negative effect of *Firm Size* is consistent with other studies on the determinants of Tobin's *q* in the literature (e.g., Hirsch and Seaks 1993; Hall 1993). The negative effect of *Firm R&D Intensity*, however, differs from most previous findings. The difference is perhaps due to the measurement of the dependent variable as deviation from the industry average in the present study, and we will discuss this result in more detail when we examine the effect of *Technological Competence* later in this section.

4.2 Industry characteristics

As can be seen in Models 2a and 2b, none of the industry characteristic variables are significant in affecting the accounting-based profit measures. The likelihood ratio tests show that these three variables as a group do not make a statistically significant contribution to explaining either *Firm-Specific ROA* or *Firm-Specific ROS*. This result, of course, is expected on the basis of our theoretical framework. It is surprising, however, to see in Model 2c that two of them have statistically significant effects on the market-based performance measure *Firm-Specific Tobin's q*, with *Industry Growth* negatively and *Change in Industry Concentration* positively related to the dependent variable. This result suggests that the firms in our sample tended to have a higher Tobin's *q* relative to the industry average in industries that experienced a lower growth rate or a more positive change in

Table 3 Simple slopes (coefficients) of the resource variables and crossing point in interaction at high and low levels of industry growth and increasing and decreasing levels of change in concentration

Models	Industry growth[a]		Change in industry concentration[a]		Crossing point in interaction[b]
	High	Low	Increasing	Decreasing	
Model 4a: Firm-specific ROA					
Relative employee value-added (EVA)	−84.958*	11.642***			0.002
Model 4b: Firm-specific ROS					
Corporate management capabilities	−10.028*	1.510**			0.012
Relative employee value-added (EVA)	−69.854^{+}	9.676**			0.002
Model 4c: Firm-specific Tobin's q					
Relative employee value-added (EVA)	−2.215^{+}	2.910**	1.510***	−1.235	
Industry growth					−0.025
Change in industry concentration					−0.035

For significance levels: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; $^{+}p < 0.10$

[a] The simple slopes were computed using the values that were used to plot the interactions

[b] The values are determined by setting the equations for the models equal to one another at high and low levels of industry growth, and at increasing and decreasing levels of change in industry concentration

concentration. Note that the asset-weighted industry average is based on the performance of all the firms in the industry according to the Compustat database, including those firms that the AMAC surveys excluded and thus are left out of our sample. So, this finding is probably unique to the firms included in the AMAC surveys and may not be generalizable.

4.3 Firm resources

The three hypotheses on the impact of firm resources are tested in Models 3a, 3b and 3c. The likelihood ratio tests indicate that the inclusion of the firm-specific resource variables as a group significantly improves the fit of all these models ($p \leq 0.01$).

Hypothesis 1 predicts that expert ratings of a firm's *Corporate Management Capabilities* in the previous periods have a positive effect on its current-period *Firm-Specific Profitability*. The results of the three models provide support for all the performance measures ($p \leq 0.05$ for *Firm-Specific ROA* and *Firm-Specific ROS*, and $p \leq 0.01$ for *Firm-Specific Tobin's q*). To check the robustness and sensitivity of the results, we estimated the models using different discount rates in calculating the measure for *Corporate Management Capabilities*, ranging from 0 to 40%. Note that a discount rate δ_m greater than 0 assumes knowledge-based resources depreciate in value over time if they are not renewed. None of the coefficients changed sign or statistical significance with the variation in δ_m; the only systematic changes we observed are that the coefficient of the variable tends to grow in size as δ_m become larger.

Hypothesis 2 predicts a positive relationship between *Relative Employee Value-Added* and *Firm-Specific Profitability*. This hypothesis is also supported in all three models, no matter whether the profitability measure is accounting-based ($p \leq 0.01$ for *Firm-Specific ROA* and $p \leq 0.05$ for *Firm-Specific ROS*) or market-based ($p \leq 0.05$ for *Firm-Specific Tobin's q*).

Hypothesis 3 predicts a firm's *Technological Competence* to have a positive effect on *Firm-Specific Profitability*. The results show that the variable has a statistically significant positive effect on *Firm-Specific ROS* and *Firm-Specific Tobin's q* and an insignificant positive effect on *Firm-Specific ROA*. We also varied the discount rate δ_s that is used to calculate the measure for *Technological Competence* in order to check the robustness of the results. The variation in δ_s (from 0 to 30%) again did not yield any qualitative change in the results.

It is interesting to compare the effects of *Technological Competence* with those of *Firm R&D Intensity*. The only difference between the two variables is that the former is standardized by the industry average while the latter contains a component that varies from industry to industry. The effects of the two variables on the measures of the firm-specific performance, however, are markedly different. Specifically, the effect of *Technological Competence* is consistently positive and mostly significant, but the effect of *Firm R&D Intensity* seems rather unstable. This indicates that the presence of a common industry component in the measure for a firm's technology-based resources can yield inconsistent results when the common industry component in the measure for firm performance is already effectively removed. It points to the importance of controlling for industry effects in both the firm performance measure and the firm resource measures.

It worth noting that the main effects of the resource variables presented in Models 3a, 3b, and 3c all maintained their direction (positive) and significance levels in Models 4a, 4b and 4c. However, we estimated the conditional impact (simples slopes) of the *Corporate Management Capabilities* and *Relative Employee Value-Added* variables at high and low levels of *Industry Growth* (Models 4a, 4b and 4c) and at increasing and decreasing levels of industry concentration (Model 4c) using the methodology described in Aiken and West (1991, pp. 14–19). The values, shown in Table 3, indicate that most of the simple slopes are significantly different from zero at both high and low values of *Industry Growth* and both high and low values of *Change in Industry Concentration* confirming the main effects of the resource variables on *Firm-Specific Profitability* in Models 3a, 3b, and 3c.[4]

4.4 Moderating effects of industry characteristics

The moderating effects of the industry characteristic variables predicted in Hypotheses 4 and 5 are tested in Models 4a, 4b and 4c. As explained in the beginning of the section, most of the interaction terms were found to make no

[4] We thank an anonymous reviewer for suggesting that we estimate the simple slopes or conditional coefficients of the resource variables at the various levels of industry growth and change in industry concentration to fully explore the impact of the main effects of the resource variables of firm-specific profitability.

significant contributions either individually or as a group to the fit of the models. To avoid clutter and ensure parsimoniousness and readability, our models retained only those interaction terms that do make a statistically significant contribution, based on suggestions of Neter et al. (1996, p. 313–314). For instance, none of the interaction terms involving *Industry Concentration* is significantly related to *Firm-Specific Profitability*. So, we did not enter the variable in the full models reported in Table 2.

Hypothesis 4 predicts that firm-specific resources have a more positive impact on performance when the industry is characterized by slower growth. Support for this hypothesis is found in Models 4a, 4b and 4c. Specifically, *Corporate Management Capabilities* interacts negatively with *Industry Growth* in influencing *Firm-Specific ROS*, and *Relative Employee Value-Added* interacts negatively with *Industry Growth* in influencing all three measures of *Firm-Specific Profitability*. The statistical significance of these interaction terms all exceeds $p \leq 0.05$.

Hypothesis 5 predicts that firm-specific resources have a more positive impact on performance when industry is characterized by higher or increasing concentration. As mentioned above, we did not find any interaction terms involving *Industry Concentration* to have a significant effect. Support for Hypothesis 5 is found only in Model 4c, which shows a positive interaction between *Relative Employee Value-Added* and *Change in Industry Concentration* ($p \leq 0.01$). This result suggests that the possession of architectural competence rooted in firm-specific skills and organization routines may be especially important to a firm's competitive advantage when the industry is in a period of consolidation and increasing concentration.

The insignificance of *Industry Concentration* in moderating the effect of firm resources is perhaps due to a form of complexity that the theory of evolutionary economics did not anticipate. For instance, even though firms in lowly concentrated industries are unlikely to exhibit much heterogeneity in either resources or performance, firms in highly concentrated industries may also have reduced heterogeneity due to incentives to rely more on monopoly power to maintain profit. If this is the case, the effect of *Industry Concentration* would be much more complex than our model could detect.

The plots presented in Fig. 1 graphically illustrate the interaction effects postulated in Hypotheses 4 and 5 to shed more light on the results.[5] As depicted in the graphs, in congruence with our hypotheses, the effects of the resource variables become more positive as industry growth is slower or industry concentration is increasing. The reader may find it intriguing that the slopes of the resource variables are negative under high industry growth or decreasing industry concentration. Given that existing theories do not predict this kind of divergence in the effects of firm

[5] We thank an anonymous reviewer for suggesting that we plot the interaction effects and explore their implications. To create the plots, we followed the procedure suggested by Aiken and West (1991). We constrained all variables except *Relative Employee Value-Added* (Models 4a and 4c), and *Corporate Management Capabilities and Relative Employee Value-Added* (Model 4b) in Table 2 to their mean values. *Corporate Management Capabilities* and *Relative Employee Value-Added* then took the values of one standard deviation below the mean (low), the mean (medium), and one standard deviation above the mean (high) at different levels (one standard deviation below the mean, the mean, and one standard deviation above the mean) of *Industry Growth* and *Change in Industry Concentration*. Since the plots assume the other variables to be constant, the value of the dependent variable is meaningful only in a relative sense.

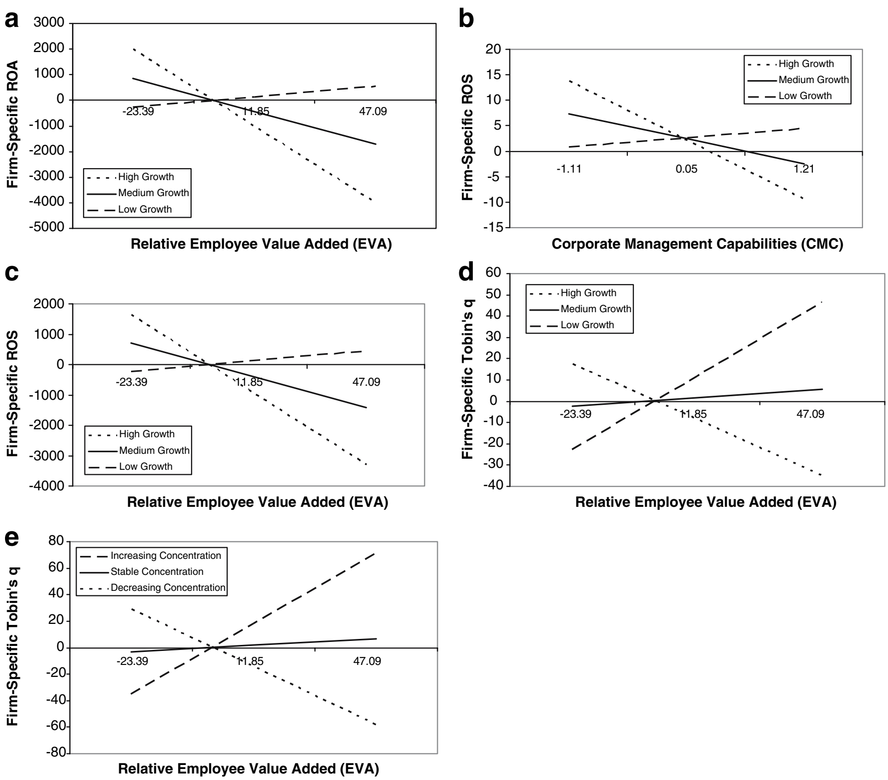

Fig. 1 Plots of interaction effects. (**a**) Relationship between EVA and firm-specific ROA under low, medium and high industry growth, (**b**) relationship between CMC and firm-specific ROS under low, medium and high industry growth, (**c**) relationship between EVA and firm-specific ROS under low, medium and high industry growth, (**d**) relationship between EVA and firm-specific Tobin's *q* under low, medium and high industry growth, and(**e**) relationship between EVA and firm-specific Tobin's *q* under differing dynamics of industry concentration

resources, any ad hoc explanation one can offer is bound to be speculative. One possibility is that industries with high growth or decreasing concentration may be witnessing strong competition from new firms that rely on breakthrough technologies and skilled labor-intensive production processes for their competitive advantage. Such new firms are likely rated low in the *Fortune* survey when their competitive advantage is rooted in strength on a single rather than multiple dimensions, and their use of skilled labor-intensive rather than capital-intensive production processes can also cause them to exhibit relative low employee value-added.

The points at which the plots of the various models for high and low levels of *Industry Growth*, or increasing and decreasing levels of *Change in Industry Concentration* cross are also presented in Table 3. As shown in Table 3, firms in industries with slow growth or increasing concentration tend to benefit more from *Relative Employee Value-Added* than their counterparts in industries with fast growth or decreasing concentration. Moreover, firms in industries with slow growth also tend to benefit more from *Corporate Management Capabilities* than their counterparts in industries with fast growth. It is worth noting that the simple slopes of the resource variables are either insignificant or barely significant at conventional statistical confidence levels when their values are estimated to be negative in industries with fast growth or decreasing concentration.[6]

5 Discussion

This study introduced a number of innovations in the empirical investigation of the determinants of firm performance, contributing to the study of the RBV both substantively and methodologically. The findings of the study shed new light on the relationship between firm resources and firm performance as well as industry conditions that moderate the relationship. These findings have a number of implications for researchers and practitioners, and also raise new questions for future research.

5.1 Firm resources and industry characteristics

The main contribution of our study to RBV research is that it decouples the question about the heterogeneity of firm resources from the question about the value of firm resources both in its theoretical formulation and in its empirical design. The economic value of a resource, just as the economic value of any other good that provides some utility, ultimately depends on scarcity (i.e., supply vs. demand). By introducing industry conditions (e.g., growth and level of and change in concentration) as proxies for resource heterogeneity that moderate the effect of firm resources on performance, the study helps to clarify the point that the heterogeneity of resources interacts with the utility value of the resources because heterogeneity reflects the presence and extent of scarcity.[7]

The findings of our panel data analysis clearly indicate a strong relationship between firm resources and firm performance. First, the variable *Corporate Management Capabilities* reflects the assessments by industry experts of a firm's ability to manage its resources at the product, business, and multidivisional level. Even though the assessments are arguably the best available from outside experts, we still used a regression procedure to remove what some suspect to be a "halo" effect in the ratings. The robust effect of the halo-removed variable on performance across the models confirms the importance of such capabilities in enhancing performance. Second, the variable *Relative Employee Value-Added* was developed to capture what Henderson and Cockburn (1994) call architectural competence that is rooted in co-specialized employee skills and organization routines. Our regression

[6] We thank an anonymous reviewer for suggesting that we estimate the points at which the simple slopes cross one another.

[7] We thank an anonymous reviewer whose comment helped us to sharpen this point.

results also confirm the importance of such competence to performance. Finally, the variable *Technological Competence* measures intra-industry variation in technology-related capabilities across firms. This type of resources is found to have a significant impact on two of our three measures for performance. In short, the main effects of our resource variables provide clear support for the central proposition of the RBV.

Our resource variables were developed primarily to reflect the strength or value of firm resources and can be justified as exhibiting also barriers to imitation and substitution. Given the serious difficulty in measuring such barriers directly, it would seem reasonable just to provide a set of well articulated justifications. We realized, however, that one could find indicators for the height of such barriers indirectly by examining the conditions of the industry. By augmenting the RBV with insights from evolutionary economics, we explicated a theoretical basis for industry characteristics to indicate the height of imitation and substitution barriers in a given industry and derived hypotheses to test the effects of interaction between firm and industry factors. Although many of the potential interactions between our firm resource and industry characteristic variables turned out to be insignificant, our analysis did uncover evidence consistent with our theoretical framework. Specifically, slower industry growth and increasing concentration, both of which can reflect higher barriers to imitation and substitution based on Nelson and Winter's (1982) model, are found in our analysis to moderate the effects of resource variables on firm performance. In short, the results suggest that, when opportunities to imitate or leapfrog competitors are more limited in an industry, firms that already possess competitive advantages tend to achieve higher profitability, presumably due to slower dissipation of rent in the face of higher barriers to imitation and substitution. Our results are consistent with those of Villalonga (2004), who studied interaction between firm resources and industry conditions using industry dummies, rather than variables that reflect an industry's structural characteristics.

5.2 Measuring and modeling issues in RBV research

The methodological innovations adopted in this study include the measurement of the key variables and the modeling methodology employed. By measuring both firm resource variables and firm performance variables as deviations from industry averages and by applying the panel study method, our empirical analysis better isolates the effects of firm-specific resources from those of industry conditions on performance over time. A major debate that arose with the emergence of the RBV concerns whether profitability differences among firms are primarily explained by firm factors or industry conditions. The RBV looks at the internal resources of the firm as the primary explanation (e.g., Mehra 1996; Miller and Shamsie 1996), while the S-C-P paradigm of IO economics looks at the structural differences across industries and industry subgroups as the primary explanation (e.g., McGahan and Porter 1997). Given that both camps now acknowledge that firm and industry factors both affect firm performance, it is important for empirical studies aiming at verifying the effects of firm factors to have effective control for the effects of industry factors.

In this study, measures in the form of deviation from the industry average are used not only for the performance indicators but also for the firm resource indicators. The benefit from normalizing the profitability measures is an arguably clean control for the industry effects in regression analyses. The AMAC ratings, from which our measure for *Corporate Management Capabilities* is derived, are based on intra-industry comparisons and thus largely free of biases from inter-industry comparisons. The normalization of the other two resource variables also removes potential confounding of industry effects and yields more accurate measures for the strength of firm resources. Specifically, since firms in the same industry tend to hire from the same labor pools, the standardization of employee value-added by the industry mean controls for interfirm variation in *component competence* in the form of generic individual skills, hence enabling the variable to better reflect *architectural competence* rooted in co-specialized skills and organization routines. Similarly, normalizing the R&D intensity measure by the industry mean removes ambiguity about the nature of the measure, given that R&D intensity has been considered to reflect both industry-wide entry barriers and firm-specific capabilities. The more precise measurement of these constructs serves to improve the rigor of our test of the propositions derived from the RBV and IO economics.

The use of a dataset spanning 13 years and the panel data methods in our analyses also overcomes what has been seen as a major weakness in the empirical tests of the RBV, i.e., a reliance on cross-sectional data (Bowen and Wiersema 1999). The long time series and panel data analysis avoids the potential estimation biases arising from cross-sectional or time-series analysis in the presence of both firm-specific and time-specific elements in the RBV's propositions.

5.3 Managerial implications

Our findings provide a number of managerial insights, particularly, for firms in industries that are experiencing low growth and rising concentration. First, the negative interaction between *Corporate Management Capabilities* and *Industry Growth* in influencing *Firm-Specific ROS* suggests that competitive advantage in slow-growing industries likely requires competence in a wide range of areas and that strength in one area alone (e.g., technology) is likely insufficient. Second, the negative interaction between *Relative Employee Value-Added* and *Industry Growth* suggests that the development of architectural competence that boosts the collective productivity of employees becomes important in a mature or maturing industry. Third, the positive interaction between *Relative Employee Value-Added* and *Change in Concentration* in influencing *Firm-Specific Tobin*'s *q* suggests that the stock market tends to place a particularly high value on the attainment of high employee productivity when the industry is in a period of consolidation and rising concentration.

5.4 Suggestions for future research

This paper certainly has its share of limitations or shortcomings. First, our measure of technological competence derived from a firm's R&D intensity measures only the investment in the generation of new knowledge rather than the outcome from such investment. Because of this, some researchers have argued that patents offer richer information about a firm's technological competence than R&D intensity (e.g., Lanjouwet al. 1998; Silverman 1999). Patent data, however, have their limitations, too. All the technological knowledge of a firm is not patented, and patents do not always lead to commercializable innovations (Blundell et al. 1999). Furthermore, studies have shown that knowledge acquired through R&D activities is highly correlated with patent counts (Amable and Verspagen 1995; Audretsch et al. 2002; Fagerberg 1988). To the extent that the relative R&D intensity measure does not accurately reflect a firm's technological competence, the coefficients for the technological competence variable are biased downward, making them less likely to be significant than they would otherwise be (Los and Verspagen 2000). Nevertheless, an alternative measure of technological competence such as weighted patent counts could be used in future studies to triangulate and thereby arrive at a more robust conclusion about the impact of technological competence on firm-specific profitability.

Second, our sample is comprised of large US firms whose performance, as measured by ROA and ROS, are on the average higher than their industry rivals (see Table 1). The sample is also limited to a small number of manufacturing firms with an average of 1.72 firms per industry. This places limitations on the generalizability of our results since they may be confined to these relatively large manufacturing firms. However, due to the nature of the research and some of the key variables, especially the quality of corporate management, it would have been difficult if not impossible to obtain data if we had broadened our sample to include small and medium-sized firms. Meanwhile, other aspects of firm-specific resources (e.g., marketing resources, and intangible resources as reflected in goodwill valuation on a firm's balance sheet) that could be obtained from archival data on small and medium-sized firms could be used to test how they influence firm-specific profits over time. The results may also be subject to firm survivorship bias because of the sample selection procedure we adopted. The procedure limited our sample to firms with availability of data for the period 1985–1997. However, as we explained in the methods section, firms that were not included in the study were not significantly different from those included in the study in the characteristics that we examined.

Finally, the intriguing results revealed by the plots of the interaction effects suggest that some of our resource variables (i.e., *Corporate Management Capabilities* and *Relative Employee Value-Added*) may reflect the capabilities of mature firms with strengths in multiple dimensions better than those of emerging firms with strength primarily along a single dimension. It should be noted, however, the technological competence variable that we also included in our study does measure a type of resource in which emerging firms are typically strong. As discussed above, future research may be able to gauge a firm's technology resources more completely by including patent citation measures.

Despite its limitations, this study has taken a number of steps to improve the precision in testing the RBV's propositions through methodological innovation and incorporation of insights from complementary perspectives. The effects of the firm-specific resource variables on firm-specific performance are found to be strong and consistent. Even though only a small number of the moderating effects of the industry characteristic variables are statistically significant, those that do make a significant contributions to the fit of the model seem consistent and robust, given that no qualitative changes were detected when the model and the measures for the key variables are varied.

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