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Intangible resources, Tobin's *q*, and sustainability of performance differences

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Abstract

This paper tests empirically the hypothesis that the greater the intangibility of a firm's resources, the greater the sustainability of its competitive advantage. Resource intangibility is measured by: (1) Tobin's q and (2) the predicted value from a hedonic regression of q on several accounting measures of intangibles. Sustainability is measured by the persistence of firm-specific profits. Using a dynamic panel data regression model, I find that intangibles play an effective role in sustaining a firm's competitive advantage, as predicted by the resource-based view of the firm. However, the results suggest that intangibles can also lock firms into persistent disadvantages.

JEL classification: G31; M21

Keywords: Intangibles; Sustainability; Tobin's *q*; Resources; Hedonic

1. Introduction

A fundamental question in corporate strategy and industrial organization is why profit differences exist across firms and industries. Research on profit persistence suggests that the question of why these differences *persist* is equally fundamental (Mueller, 1977, 1986; McGahan and Porter, 1999, 2003). This question has received much less attention than the former. Yet, profit existence and profit persistence may not be driven by the same factors (Jacobsen, 1988; Cubbin and Geroski, 1987).[1] Cubbin and Geroski find that persistence arises primarily from the firm-specific component of profits rather than from the industry

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[1] Jacobsen finds that vertical integration, market share, and marketing expenditure intensity are all positively related to both profit levels and profit persistence. On the other hand, Cubbin and Geroski find that conventional market structure variables cannot explain much of the observed variation in profit persistence.

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component.[2] Waring (1996) analyzes in detail industry determinants of firm-specific profit (FSP) persistence. However, the firm-specific component remains under-explored.

In this study, I empirically investigate the theory that most directly addresses the question of what firm characteristics determine firm-specific profit persistence. According to the *resource-based view of the firm* (RBV), a firm's endowment of resources is what makes its competitive advantage sustainable in time (Wernerfelt, 1984; Rumelt, 1984; Barney, 1996; Dierickx and Cool, 1989; Amit and Schoemaker, 1993; Peteraf, 1993). RBV stresses the importance of intangible resources as the key to sustainability. As Itami observes:

> . . . 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. (1987, p. 1)

I test the association between intangibles and sustainability predicted by RBV in a large sample of public US corporations. I use the estimated persistence of firm-specific profits to measure sustainability, and Tobin's q to measure resource intangibility. For the latter, I use both raw q, and the predicted value from a hedonic regression of q on several accounting measures of intangibles. The results lend support for the resource-based prediction that intangibles contribute to sustain a firm's competitive advantage. However, intangibles can also lock firms into persistent disadvantages.

By testing a key theory about what makes firm-specific profits persist, this study brings together RBV and persistence-of-profits research, and contributes to fill a gap in both literatures. This is a particularly important contribution to RBV, which is widely regarded as the strategy paradigm since the mid-1980s but has been subject to much criticism due to the difficulties inherent in its operationalization. In addition, the study offers new insights about the benefits and costs of intangible investment, by showing how these investments affect the sustainability of competitive positions.

2. Operationalizing the resource-based view's key prediction

2.1. Theory and hypotheses

2.1.1. Intangible resources and sustainability

RBV points to intangible resources as the main drivers of the sustainability of performance differences across firms. Different contributors to the RBV literature have used different terms, such as "capabilities", "core competences", or "knowledge", to refer to these resources, and a variety of definitions have been offered. Because it is not clear whether this abundance of terms adds precision or just noise to RBV, in this study I will only use the term "intangible resources" to refer indistinctly to all these concepts—excluding, of course, resources that are clearly tangible such as physical or financial assets.

[2] McGahan and Porter (2003) find exactly the opposite with respect to the persistence of *shocks* to profitability. While this may seem paradoxical, it must be noted that the behaviors of the fixed and incremental components of profitability are actually independent of each other. For reasons explained later, this study is concerned with the systematic component, and not with the incremental one.

Intangible resources are typically tacit and hard to codify (Kogut and Zander, 1992; Conner and Prahalad, 1996). They are also likely to trade in imperfect factor markets (Barney, 1996); and exhibit complementarities (Milgrom et al., 1991; Athey and Stern, 1998; Rivkin, 2000). As a result, intangibles are difficult to acquire or develop, and to replicate and accumulate within the firm (Itami, 1987; Winter, 1987). For the same reasons, they are also difficult to be understood and imitated by others (Rumelt, 1984; Dierickx and Cool, 1989; Nelson, 1991). This uncertain imitability is what makes them valuable and prone to be the basis of a sustainable competitive advantage for a firm (Lippman and Rumelt, 1982; Hall, 1993b).

RBV's prediction about the role of intangibles in sustaining superior firm performance might be formalized by saying that *the more intangible resources a firm has, the greater the sustainability of its competitive advantage*. However, stating the prediction in such a way does not lead to a very powerful test of the underlying theory. For instance, such proposition could be true as a result of industry-related size effects that have nothing to do with the arguments mentioned above about what makes intangibles so crucial under RBV. Thus, a statement about the absolute importance of intangibles in the aggregate may not capture the gist of RBV.

Rather, what RBV arguments seem to suggest is a test of the importance of intangibles *relative* to tangibles, i.e. of the degree of intangibility of a firm's resources. For instance, from a resource-based perspective, the tacitness of the firm's knowledge base, the complexity of a firm's activities and the complementarities among them, or the firm's dependence on imperfect factor markets, are all characteristics that can be expected to translate into a greater degree of intangibility of the firm's resource endowment. The difficulty to trade, substitute, or imitate this highly intangible resource endowment arises from such characteristics and is in turn responsible for the greater sustainability expected under RBV.

Ghemawat proposes a specific vehicle through which the characteristics of intangible resources translate into sustainability of competitive advantages for firms. In his view, intangible assets, because of their lower tradability and higher stickiness, are particularly prone to be a source of commitment, which he defines as the tendency of strategies to persist over time. Commitment, in turn, is "the only general explanation for sustained differences in the performance of organizations" (1991, p. 25).

If intangibles help sustain performance differences across firms by enhancing the sustainability of competitive advantage, competitive disadvantages must either stay constant or also persist in time. Some RBV studies indicate that the latter is in fact the case. Henderson and Clark (1990) argue that radical innovation destroys the usefulness of firms existing capabilities or "architectural knowledge". Leonard-Barton (1992) coins the term "core rigidities" to refer to the innovation-inhibiting downside of core capabilities. Christensen (1993) describes how the know-how and customer base that gave certain hard disk drive manufacturers a competitive advantage, eventually became liabilities that led them to be displaced by newer generation firms.

In summary, the following hypothesis can be taken as a key testable implication of RBV:

Hypothesis 1. The greater the degree of intangibility of a firm's resources, the greater the sustainability of its competitive advantage or disadvantage.

2.1.2. Industry effects in the impact of intangibles on sustainability

The impact of intangible resources on the sustainability of performance differences across firms is likely to vary systematically by industry, for two reasons. First, some of the intangible resources that can be a source of advantage are likely to be of a different nature in different industries and sectors. For instance, a firm's technological knowledge base built through research and development is more likely to be a source of competitive advantage in the manufacturing sector than it is in the lodging and entertainment industries. Amit and Schoemaker use the term "strategic industry factors" to refer to the set of resources that has become the prime determinant of economic rents for industry incumbents. They note that the capacity of a firm's resources for creating and protecting the firm's competitive advantage depends not just on their unique characteristics but also on the extent to which they overlap with industry-determined strategic industry factors.

Second, the efficacy of different mechanisms for ensuring the appropriation by firms of the value generated by intangible resources is also likely to vary across industries. Intangible resources may exist at different levels within the firm: human resources, teams, functions, processes, projects, or the organization as a whole (Nelson and Winter, 1982; Grant, 1991). RBV recognizes this, but focuses on the firm as the main level of analysis. RBV makes no prediction about the existence or persistence of performance differences across sub-units of a firm; only about differences across firms (Nelson, 1991; Rumelt, 1991). It is therefore important to note that, in order for those intangible resources to be a source of superior performance for firms, the owners of the firm must be able to appropriate at least some of their value (Ghemawat, 1991; Peteraf, 1993). Levin et al. (1989) provide evidence that the efficacy of different mechanisms for ensuring the appropriation by firms of returns to R&D varies significantly across industries. Accordingly, I hypothesize:

Hypothesis 2. The impact of resource intangibility on the sustainability of a firm's competitive advantage will differ significantly across industries.

2.2. Operationalizing sustainability: persistence of firm-specific profits

A firm's competitive advantage (disadvantage) is the degree to which it outperforms (underperforms) its competitors. If performance is measured by profitability, the difference between a firm's profitability and the average profitability of its industry is thus a direct indicator of its competitive advantage. Hereafter, I will refer to this indicator as *firm-specific profits*. Because many firms are diversified, the average profitability of an industry is the average for all segments in the industry—including both single-segment firms and segments of diversified firms. In turn, firm-specific profits of diversified firms are a weighted average of their *segment-specific profits* (the difference between a segment's profitability and the average of the industry).

Similarly, the *sustainability* of competitive advantage can be defined as the degree to which firm-specific profits persist. Jacobsen (1988) and Schohl (1990) show that firm-specific profits over time tend to follow a first-order autoregresive process or AR(1).[3] Thus, the

[3] Although profit persistence is likely to be affected by whether profits are distributed to shareholders or reinvested, the AR(1) model seems robust to different dividend policies across firms and over time.

persistence of firm-specific profits can be formally measured by the β coefficient in the following auto-regressive process or AR(1):

$$\mathrm{FSP}_{it} = \alpha_i + \beta^* \mathrm{FSP}_{it-1} + \varepsilon_{it}, \quad (1)$$

where FSP_{it} are the firm-specific profits of firm i in period t, defined as above.

The β coefficient in Eq. (1) indicates the percentage of firm-specific profits in any period before period t that remains in period t. An alternative definition of persistence that has been used in the literature is the percentage of the *incremental component* of firm-specific profits in any period before t that remains in period t. This narrower definition, which excludes fixed effects, was first introduced by Mueller (1986) to prevent the persistence estimates from being overly influenced by the arbitrary initial starting point. It has also been used by Waring, and by McGahan and Porter (2003). However, as the latter note,

> because persistence applies only to incremental components, the statistical approach generates results that must be interpreted carefully. For example, a high persistence rate may be associated with a small average incremental component to profitability. Thus, the persistence of the incremental component may be largely irrelevant to the tendency of profits to last between periods ... The consequence is a mistaken inference about the importance of a persistent effect to the continuing performance of a firm. (2003, p. 85)

Therefore, the fixed-effects approach would preclude the interpretation of firm-specific profit persistence as sustainability of competitive advantage. Because such an interpretation is central to the empirical test in this paper, I use the former definition of persistence, or the percentage of *total* firm-specific profits in any period before period t that remains in period t. As explained in more detail in the Section 3, I use a generalized method of moments (GMM) estimator to correct asymptotically for the bias that led earlier researchers to adopt the latter definition despite its interpretive caveats.

2.3. Operationalizing resource intangibility: Tobin's q

The hypotheses stated above refer to the degree of intangibility of a firm's resources, or *resource intangibility*. This term refers to the value of a firm's intangibles relative to its tangible resources. The fair value of a firm's tangible assets is the replacement cost of such assets—the current cost of purchasing an asset of equivalent productive ability, and can be estimated by appropriately adjusting accounting data. The value of a firm's intangible resources can be estimated as the difference between a firm's market value and the replacement cost of its tangible assets (Andersen, 1992). Firm resources include the managerial capability for deploying both tangible and intangible assets. When markets are efficient, capital market securities prices provide the best estimates of the value of a firm's resources, i.e. of the present discounted value of the future stream of cash flows generated by those resources (Fama, 1970; Ross, 1983). If markets are assumed to be efficient in the aggregate, there is no reason to expect any systematic bias from this calculation in large cross-sectional samples.

Following earlier research, I use Tobin's q to measure resource intangibility.[4] From an empirical point of view, it is well known that Tobin's q proxies for the intangible assets of firms as a result of the accounting treatment of intangibles (Lev, 2001). Tangible assets are capitalized, i.e. recognized as assets and reported on firms' balance sheets. In contrast, intangibles are expensed, i.e. written off in the income statement along with regular expenses such as wages, rents, and interests. As a result, the book value of assets does not reflect the stock of intangibles that results from cumulative investment, but market value does. The empirical association between q and intangibility is evident from studies such as Lindenberg and Ross (1981), which reveal that the q's of firms in R&D or advertising-intensive industries are abnormally high. In fact, it is a fairly common practice in studies that use Tobin's q as a measure of corporate performance to "correct" the denominator of q for the presence of such intangibles.

Several studies have used q to measure specific intangible assets, by taking the predicted value from a regression of Tobin's q on accounting or survey measures of the intangible asset of interest. Examples include knowledge capital (Hall, 1993a; Megna and Klock, 1993; Sougiannis, 1994; Hall et al., 2000; Lev, 2001), brand equity (Simon and Sullivan, 1993), or *customer asset* (Ittner and Larcker, 1998). The approach, then, is a corporate version of the *hedonic* price regressions used in other contexts to value intangible goods such as car quality (Court, 1939; Griliches, 1961), clean air (Harrison and Rubinfeld, 1978), or other product differentiation attributes (Rosen, 1974; Epple, 1987).

From a theoretical point of view, there are also various precedents for using q as a measure of intangibility at the firm level. In the particular context of the resource-based view that this study seeks to test, Teece et al. (1994, p. 19) have suggested that q may be used as an indicator of either technical or organizational competences. Note that this interpretation of q in fact assumes that the ratio not only captures those competences or intangible resources in themselves, but also the different isolating mechanisms through which the rents they generate are effectively protected and appropriated by the firm (Rumelt, 1984).[5]

[4] Denoting the market value of all assets owned by the firm by MV and the replacement value of book assets by A, so that tangibles $= A$ and intangibles $= (\text{MV} - A)$, several possible ratios can be computed to measure the relative value of the two sets of resources for any given firm. Each of those ratios, in turn, can also be expressed as a function of Tobin's q—the ratio of a firm's market value to the replacement cost of its assets.

(1) intangibles to tangibles: $(\text{MV} - A)/A = q - 1$;

(2) tangibles to intangibles: $A/(\text{MV} - A) = 1/(q - 1)$;

(3) intangibles to total assets: $(\text{MV} - A)/\text{MV} = 1 - 1/q$;

(4) tangibles to total assets: $A/\text{MV} = 1/q$;

(5) total assets to tangibles: $\text{MV}/A = q$; and

(6) total assets to intangibles: $\text{MV}/(\text{MV} - A) = 1/(1 - 1/q)$.

Ratios 1, 3, and 5 are all measures of the intangibility of a firm's resources, while ratios 2, 4, and 6 are measures of tangibility. Although ratios 1 or 3 might be seen as more direct measures of intangibility than q (ratio no. 5), a large literature justifies the use of q for this purpose.

[5] Otherwise, it is not clear why the returns to the intangible assets that make them valuable would accrue to the firm instead of to the providers of those resources (e.g. employees), or to competitors who may benefit from technological spillovers or late-mover advantages (Teece, 1986). In support of this interpretation, Cockburn and Griliches (1988) include the Yale survey (Levin et al., 1989) measures of appropriability in a hedonic regression

The interpretation of Tobin's q as a measure of intangibles is also closely related to Lindenberg and Ross's pioneering study of the significance of q for industrial organization. In their view, the ratio is "the valuation of ... all the intangible factors on which the firm earns rents, ... [which include two categories: One,] those special factors which the firm possesses which lower its costs relative to those of a competitive or marginally competitive firm ... For example, a firm might have special access to a river ... [Two,] those special factors of production which the firm possesses which act as barriers to the entry of competitors ... for example, patents or scale economies" (1981, pp. 3–4). Therefore, q is the capitalized value of the "aggregate Ricardian and monopoly rents" (p. 9) that accrue to the firm's current assets.[6] The resource-based view admits either type of rents as necessary conditions for a firm to sustain its competitive advantage (Peteraf, 1993). Under this view, then, a relationship between q and the persistence of firm-specific profits indicates that the firms that are more able to sustain their competitive advantage over time are those that have a more valuable endowment of intangible assets, regardless of the source of those assets.

2.4. Alternative interpretation of the hypothesized relationship

Hypothesis 1, if empirically supported, may be subject to the alternative interpretation that q is simply capturing investor expectations of a greater persistence of corporate profits. Furthermore, if this is the reason for the association, the causal direction of it might be the reverse of that implicit in my hypothesis. This need not be true, because the investor expectations reflected in market values are expectations of the future stream of cash flows and not of their persistence. In addition, market values presumably take into account the firm's overall profits, which are not the same as firm-specific (or "excess") profits.

I nonetheless address the possibility of an alternative interpretation in two different ways. First, I follow a hedonic approach like those described. I restrict my measure of resource intangibility from Tobin's q to the predicted value from the regression of q on several accounting measures of intangibles. I refer to this measure as *hedonic q*. Under this approach, any factor affecting investors' expectations other than the specific intangible assets considered will be left in the disturbance of the hedonic regression, and out of the main equation.

Second, Hypothesis 1 allows me to test explicitly the two competing explanations against each other. RBV implies that, among firms performing below the average of their industry, we should also expect those with a greater resource intangibility to exhibit a greater persistence. On the other hand, the alternative view would predict the opposite relationship for firms with a competitive disadvantage: q and the persistence of firm-specific losses should

of q, and provide evidence of an interaction between those measures and the market's valuation of a firm's R&D and patenting.

[6] The meaning of q in industrial organization has been the subject of debate between some researchers, essentially as a derivation of the Harvard (collusion) versus Chicago (efficiency) debate: Smirlock et al. (1984, 1986), on the efficiency side, and Shepherd (1986) and Stevens (1990), on the collusion side. But in fact, for all these authors, as for Lindenberg and Ross, q is *jointly* reflecting monopoly and/or Ricardian rents (which some equate to "efficiency"), and none of them has been able to effectively distinguish between the two. In contrast, McGahan and Porter (1999) show that the evidence about the persistence of shocks to profitability does shed light onto the Harvard vs. Chicago debate.

be negatively associated. Under the alternative view, if Hypothesis 1 were supported for disadvantaged firms, it would imply that a higher Tobin's *q* is capturing investor expectations of greater persistence of firm *losses*, which would be fundamentally inconsistent with this view.

3. Methods

3.1. Sample and data

The sample for this study is composed of 1641 US public corporations, between 1981 and 1997. The data come from Compustat annual company and industry segment files. These files contain information on both active and research companies (those that have been subsequently delisted from Compustat because of mergers, bankruptcies, or liquidations).[7] The Compustat company files during this period contain (as of April 2002) 183,628 firm-year observations. The Compustat active and research segment files for those years contain 154,719 segment-year observations. Several screening operations were performed on these two files. First, the following observations were excluded from the annual company files: (1) following previous research, those from companies whose assets are below US$ 50 million in all years between 1981 and 1997.[8] (2) Those with missing data for any of the key variables of this study, which are: market value, accounting profits, or SIC code. (3) Those with a market value of zero. These three exclusion operations result in a subset of the Compustat company files containing 74,224 firm-year observations.

Second, the following observations were excluded from the segment files: (1) Following McGahan (1999), those with SIC codes between 6000 and 6999 (financial institutions), between 9100 and 9199 ("government, excluding finance"), between 9900 and 9999 ("non classifiable establishments"), or ending in 9 (miscellaneous classifications).[9] (2) Following

[7] The sample starts in 1981 because that is when most companies began reporting segment data on a systematic basis. The sample ends in 1997 because in 1998 a new segment reporting standard was implemented (the Financial Accounting Standards Board's (FASB) Statement (SFAS) 131, superceding SFAS 14). Under the new standard, firms no longer have to report industry and geographic segment information separately. Instead, they are supposed to report one set of segment data corresponding to how they organize themselves internally for purposes of performance evaluation. As a result, post-1997 segment data are difficult to reconcile with prior segment data.

[8] Two important studies using Tobin's *q* and Compustat data, Lang and Stulz (1994) and McGahan (1999), exclude companies with less than US$ 100 and 50 million in assets, respectively, "because the market value of these small corporations may be distorted by infrequent trading" (McGahan, 1999, p. 8). I adopt McGahan's more conservative threshold for the same reason. However, my procedure differs from hers in that, if a firm's assets are greater than US$ 50 million in *any* year between 1981 and 1997, I keep in my sample *all* the observations that are available from Compustat for that period (as opposed to just those above the US$ 50 million threshold). This is done in order to: (1) have as long a time series as possible for each of the firms in the sample, and (2) ensure the continuity of the series.

[9] The SIC-code related screens are performed at the segment level because screening at the corporate level would introduce a bias in the analysis. First, it would exclude companies that may have significant operations in businesses that we would not want to exclude. Second, by excluding those firms and their segments, a bias would be introduced in the estimates of the industry averages (and therefore on the firm-specific profits that are crucial to the study). Note that screening on the segment file does not affect the estimation of the firm-specific profits because these are weighted averages within each firm, so the weights are adjusted to reflect the elimination of some segments within the firm whenever this happens. However, there is one caveat to screening on the segment

both Waring and McGahan, those that represent the single firms in an SIC category in any given year, for which firm-specific profits are indistinguishable from industry profits. These two exclusion operations result in a subset of the Compustat segment files containing 121,369 segment-year observations.

Third, the resulting company and segment data sets are merged into a temporary data set with 62,520 segment-year observations from 41,773 firm-years that are present in both the company and the segment databases (from 5682 firms). Following Berger and Ofek (1995), I eliminate from this merged database all firm-years in which the sum of the segment assets represents less than 75 percent of the firm's assets. This leaves 50,720 segment-years from 5325 firms. The purpose of this temporary dataset is to compute 'adjusted firm-specific profits' correctly for diversified firms, as described below. Once the 'adjusted firm-specific profits' have been computed, segment-level observations are deleted and I go back to a firm-level dataset with 35,802 firm-year observations.

Fourth, observations from companies for which the continuous time series available is shorter than 3 years are eliminated from the previous dataset, because persistence cannot be estimated otherwise. This operation leaves 18,237 firm-years from 1641 different firms, for which the time series length ranges between 3 and 16 years, with an average value of 11 years. The statistical analyses that follow are run on the unbalanced panel to use all information available. Pre-1981 data for these firms, which are necessary for calculating Tobin's q and measures of R&D and advertising stock, are obtained by temporarily appending to the former data set the relevant information from the Compustat company files.

This is the data set that is finally used for estimation purposes. In addition, to test Hypothesis 1 separately for competitive advantages and disadvantages, I extract two subsamples from of this data set. The "advantaged firms" are defined as those that exhibit positive firm-specific profits during all the years in which they appear in the sample. This subsample includes 3877 observations from 423 firms. The "disadvantaged firms" are those that exhibit negative firm-specific profits (i.e. firm-specific losses) during all the years in which they appear in the sample. This subsample includes 778 observations from 101 firms. The smaller sample size for disadvantaged relative to advantaged firms indicates that the persistence of firm-specific losses is much lower than that of firm-specific profits. This justifies the separation of the two in subsequent statistical analyses.

The advantaged and disadvantaged firms subsamples are stable in that no firm is included in both subsamples for different periods of time. This is also true if the subsamples are defined less restrictively by decades, e.g. "advantaged firms in the 1990s". That is, no firms fall into the advantaged group for one decade and into the disadvantaged group for the other decade. This fact is consistent with the evidence on corporate turnarounds presented by Furman and McGahan (2002). In contrast, 144 out of the 423 advantaged firms are in that subsample for both decades; and 40 out of 101 firms are disadvantaged for both decades.

Table 1 shows the distribution of the full sample and each of the two subsamples by sector. The table shows that the aggregate counts in each column are similar. There are relatively

file instead of on the corporate file: because there are no market values at the segment level, Tobin's q has to be calculated as a ratio over the firm's total assets (including the assets of the segments that have been eliminated). Effectively, this amounts to assuming that segment market values are apportioned within each firm in proportion to the segment's assets. This assumption does not affect the interpretation of the main results of this paper.

Table 1
Distribution of sample and subsamples by sector

SIC 1st digit	Description of sector	Full sample				Advantaged				Disadvantaged			
		Number of firm-years		Number of firms		Number of firm-years		Number of firms		Number of firm-years		Number of firms	
0	Agriculture	53	(0.3%)	9	(0.4%)	22	(0.6%)	3	(0.6%)	10	(1.3%)	1	(0.9%)
1	Mining & construction	809	(4.4%)	80	(4%)	116	(3%)	14	(2.7%)	6	(0.8%)	0	(0%)
2	Food, textiles & chemicals	3,517	(19%)	371	(19%)	698	(18%)	94	(18%)	170	(22%)	21	(19%)
3	Manufacturing	7,645	(41.9%)	812	(41%)	1,602	(41%)	215	(41%)	282	(36%)	40	(36%)
4	Transportation	798	(4.4%)	90	(4.5%)	135	(3.5%)	21	(4%)	51	(6.6%)	11	(10%)
5	Wholesale & retail trade	3,383	(19%)	365	(18%)	853	(22%)	103	(19%)	204	(26%)	30	(27%)
7	Lodging & entertainment	1,699	(9%)	219	(11%)	402	(10%)	68	(13%)	42	(5.4%)	7	(6.3%)
8	Services	335	(1.8%)	46	(2.3%)	49	(1.3%)	11	(2.1%)	13	(1.7%)	2	(1.8%)
	All sectors	18,237	(100%)	1,992	(100%)	3,877	(100%)	529	(100%)	778	(100%)	112	(100%)

more disadvantaged firms in agriculture, transportation, and wholesale and retail trade, and relatively fewer in mining and construction, manufacturing, and lodging and entertainment.

3.2. Variables and measures

3.2.1. Firm-specific profits

Firm-specific profits have been defined as the difference between the firm's profitability and the average profitability of the industry in any given year. Profitability is measured by operating return on assets (ROA)—the ratio of operating income to identifiable assets. Industry averages are computed from the data before the final (fourth) screening operation is performed.

If the firm is diversified in any given year, firm-specific profits are computed as the weighted average, across its segments, of the *segment-specific profits*:

$$\mathrm{FSP}_{it} = \sum_{j=1}^{Jit} (\omega_{jt} \mathrm{SSP}_{ijt}), \qquad \forall i = 1, \dots, I_{jt}, \quad t = 1, \dots, T_i, \tag{2}$$

where FSP_{it} are the firm-specific profits of firm i in year t. SSP_{ijt} are the segment-specific profits of firm i's segment in industry j in year t:

$$\mathrm{SSP}_{ijt} = \mathrm{ROA}_{ijt} - \left(\sum_{i=1}^{Ijt} \frac{\mathrm{ROA}_{ijt}}{I_{jt}} \right), \qquad \forall j = 1, \dots, J_{it}, \quad t = 1, \dots, T_i, \tag{3}$$

$$\omega_{jt} = \frac{\mathrm{assets}_{jt}}{\sum_{j=1}^{Jit} (\mathrm{assets}_{jt})}, \tag{4}$$

I_{jt} is the number of firms with operations in industry j in year t, J_{it} the number of segments within firm i in year t, T_i the number of years in sample for firm i, and ROA_{ijt} the observed return on assets of firm i's operations in industry j in year t.

If the firm is not diversified, firm-specific profits are simply computed as:

$$\mathrm{FSP}_{it} = \mathrm{ROA}_{it} - \left(\sum_{i=1}^{Ijt} \frac{\mathrm{ROA}_{ijt}}{I_{jt}} \right), \qquad \forall i = 1, \dots, I_{jt}, \quad t = 1, \dots, T_i, \tag{5}$$

where ROA_{it} is the observed return on assets of firm i in year t, as reported in Compustat segment-level files.

3.2.2. Tobin's q

Tobin's q is calculated following the procedure in Lang and Stulz (1994) and McGahan (1999), which does not require out-of-Compustat data.[10] The numerator—the firm's market

[10] ... but is sophisticated enough to allow us all to call it Tobin's q, which sounds so much more scientific than 'market-to-book ratio'. Chung and Pruitt (1994) find that a simple market-to-book ratio explains *at least* 96.6% of the variability of Tobin's q—calculated as in Lindenberg and Ross, which is generally acknowledged as the most accurate procedure. Perfect and Wiles (1994) compare empirically five alternative constructions of Tobin's q, and find that results are method-sensitive for *levels* of q, but not for changes. In my sample, the correlation between q and the market-to-book ratio is 0.97.

Table 2
Means, standard deviations, and correlations

	Variables	Mean	S.D.	Correlations						
				1	2	3	4	5	6	7
1	Firm-specific profits	0.09	0.28	1						
2	Tobin's q	1.37	1.91	0.196	1					
3	Hedonic q	0.99	0.88	0.097	0.205	1				
4	R&D stock/assets	0.17	0.39	0.016	0.197	0.614	1			
5	Advertising stock/assets	0.05	0.11	−0.027	−0.001	0.026	−0.030	1		
6	Intangibles stock/assets	0.05	0.09	0.023	−0.045	−0.059	−0.084	0.003	1	
7	Assets	1,614	6,490	0.036	−0.043	−0.040	−0.040	−0.036	0.038	1

$N = 18{,}237$ for all variables.

value—is computed as the sum of the year-end market value of common stock, and the book value of preferred stock and debt. The denominator—the replacement cost of the firm's (tangible) assets—equals the sum of the replacement values of inventories and property, plant and equipment (PPE), and the book value of all other assets. The value of inventories is calculated as in Lindenberg and Ross—adjusting book values for inflation when the inventory valuation method used by the firm is LIFO, average cost or retail cost (a different adjustment is made for each of these). PPE is valued setting up an acquisition schedule and adjusting for price level and depreciation. Specifically, the following adaptation of Lindenberg and Ross's recursion is used: the replacement cost of a firm's PPE is assumed to equal its book value in 1970 or in the first year thereafter in which the firm begins to appear in Compustat. Each year, the (replacement) value from the previous is reduced by a 5 percent of assumed depreciation, adjusted to the new price level according to the GDP deflator for private non-residential fixed assets, and added to the change in book value during that year. As in Smirlock et al. (1984), the technological change parameter is assumed to be zero. The average q in my sample is 1.37, as reported in Table 2.

3.2.3. Hedonic q

This measure of resource intangibility is the predicted value obtained from the regression of Tobin's q on three accounting measures of intangible assets: R&D stock, advertising stock, and intangibles-in-books. I am therefore attempting to capture the joint value of a firm's knowledge capital, brand name reputation, and other intangible resources such as customer lists, franchises, licenses, or intellectual property rights. These "other intangible resources" are assumed to be reflected, however imperfectly, in the accounting item "intangibles" (which also includes goodwill, when available).

Previous hedonic approaches to intangibles valuation based on R&D and advertising measures have included either stock or flow (expenditures) measures, or both. Because having the two within the same regression introduces multicollinearity due to double-counting (Schankerman, 1981), I use only stock measures (which include current period expenditures). These are constructed, for both R&D and advertising, using the recursion:

$$K_t = (1 - \delta)K_{t-1} + I_t, \tag{6}$$

Table 3
Mean firm-specific profits, Tobin's *q*, and *hedonic q* by subsample

	Full sample	Advantaged	Disadvantaged	Diversified	Focused	Diversified in some years
1980s						
Firm-specific profits	−0.003	0.09	−0.09	−0.003	0.01	−0.01
Tobin's *q* (*q*)	1.08	1.96	0.55	1.29	0.69	0.87
Hedonic q (*hq*)	0.92	1.07	0.78	0.98	0.81	0.87
Difference $q - hq$	0.16***	0.89***	−0.23***	0.31***	−0.12***	−0.002
Number of observations	6,180	773	274	3,537	1,118	1,525
1990s						
Firm-specific profits	0.13	0.27	−0.13	0.15	0.11	0.10
Tobin's *q* (*q*)	1.53	2.20	0.97	1.77	0.94	1.16
Hedonic q (*hq*)	1.02	1.12	0.83	1.10	0.80	0.92
Difference $q - hq$	0.51***	1.09***	0.15	0.67***	0.14***	0.23***
Number of observations	12,057	3,104	504	7,877	1,761	2,419
All years						
Firm-specific profits	0.09	0.23	−0.12	0.10	0.07	0.06
Tobin's *q* (*q*)	1.37	2.15	0.82	1.62	0.84	1.05
Hedonic q (*hq*)	0.99	1.11	0.81	1.06	0.80	0.90
Difference $q - hq$	0.38***	1.05***	0.02	0.56***	0.04***	0.14***
Number of observations	18,237	3,877	778	11,414	2,879	3,944

*** Difference in means is statistically significant at the 1% level.

where K_t is the accumulated stock of R&D or advertising and I_t is the current period investment. Annual depreciation rates δ are assumed to be 15 percent for R&D (following Griliches, 1981; Hall, 1990; Hall et al., 2000), and 45 percent for advertising (following approximately Hirschey and Weygand, 1985). Based on the fact that estimates of the average duration of R&D effects on profits and/or market value range between 5 and 10 years (Hirschey and Weygand, 1985; Lev and Sougiannis, 1996), and those of the advertising effects on market value between 1 and 5 years (Broadbent, 1993; Hirschey and Weygand, 1985), I estimate the initial stock for each firm in my sample by starting the recursions as early as 1974 for R&D, 1979 for advertising. The procedure I use for dealing with missing data is described in the Appendix A.

Table 2 provides means, standard deviations, and correlations for all variables. Table 3 reports mean firm-specific profits, Tobin's *q*, and *hedonic q* by subsample. In addition to the advantaged/disadvantaged breakdown, the sample is also split according to firm diversification. Diversified firms are defined as those that have two or more segments in all the years in which they appear in the sample. Focused firms are those that have only one segment in all the years in which they are in the sample. "Diversified in some years" are those firms that switch diversification status during the time they are in the sample. Consistent with the notion that Tobin's *q* measures a much broader range of intangible assets than those represented by accounting measures of those assets, Table 3 shows that the *hedonic q* measure is significantly different from Tobin's *q*. This suggests that each measure of intangibles is valid as a measure for estimating the impact of resource intangibility on the sustainability of competitive advantage.

3.3. Econometric models

Two different econometric models are estimated: the hedonic regression of Tobin's q, and a dynamic panel data model of the relationship between q and the persistence of firm-specific profits. The hedonic equation is specified as:

$$\ln(q_{it}) = \alpha_j + \beta_{1j}^{*}\text{RDSTOCK}_{it} + \beta_{2j}^{*}\text{ADSTOCK}_{it} + \beta_{3j}^{*}\text{OTHERINTANG}_{it} + \varepsilon_{it}, \quad (7)$$

where q is Tobin's q, RDSTOCK is R&D stock divided by assets, ADSTOCK is advertising stock divided by assets, and OTHERINTANG is intangibles-in-books divided by assets.

Following Hall (1993a), the natural logarithm of q is taken because a linear formulation would imply unlimited constant returns to scale in intangible investment, which is unlikely to be the case. The j subscripts in all coefficients are used to indicate that this model is estimated separately for each of the 52 different two-digit SIC industries in the sample. This allows for the fact that the specific intangible assets included in this equation may to be more relevant in some industries than in others. The model is estimated through OLS.

The *hedonic q* estimates for each firm-year are the antilogs of the predicted values of q from the regression of Eq. (7). These values are then related to the persistence of firm-specific profits through the following fixed-effects model:[11]

$$\text{FSP}_{it} = \alpha_i + \beta_0^{*}\text{FSP}_{it-1} + \beta_1^{*}q_{it} + \sum_{j=1}^{J}\beta_{2j}^{*}\text{FSP}_{it-1}^{*}q_{it}^{*}D_j + \varepsilon_{it}, \quad (8)$$

where FSP_{it} are firm-specific profits, q is either Tobin's q or *hedonic q*, and D_j are sector (one digit) dummies ($J = 8$). In this model, β_0 is the persistence of the firm-specific profits coefficient after controlling for the other regressors; β_1 is capturing the effect of resource intangibility on the *level* of FSP; and β_{2j} the effect of resource intangibility on the persistence of FSP *for each sector*. The β_{2j} are the coefficients of interest for testing the hypotheses in this paper. These coefficients capture the effect of resource intangibility on the persistence of FSP (to test Hypothesis 1), interacted with sector dummies (to test Hypothesis 2). Sector dummies are used to facilitate the presentation, but results are similar if two-digit dummies are used instead.

Eq. (8) is a dynamic state-dependence panel data model (Anderson and Hsiao, 1982). A fixed effects approach is taken to allow for the potential correlation of the regressor q, with the firm-specific component of the error term. This component includes all the intangible resources that are not explicit in the hedonic regression (such as managerial ability, organizational culture, etc.).

OLS estimates of Eq. (2) are biased due to the correlation of the lagged dependent variable with the disturbance (see Nickell (1981) for the proof of this bias). Three main solutions have

[11] Note that this two-stage approach is equivalent to doing an instrumental variables estimation of Eq. (8) using Tobin's q as opposed to *hedonic q*, where the regressors in Eq. (7) would be the instruments for q.

been employed in previous research. First, Waring and McGahan and Porter take deviations from firm means, and correct the OLS estimates by adding back the bias, using Nickell's formula. Second, the standard solution in the econometrics literature (Anderson and Hsiao, 1982) is to eliminate the intercept through first-differencing, and use the lagged exogenous regressors (ΔX_{t-1}, $\Delta X_{t-2}, \ldots$) and predetermined variables ($\Delta y_{t-2}, \ldots$, or $y_{t-2}, \ldots$) as instruments for the lagged dependent variable (Δy_{t-1}). Third, Arellano and Bond (1991) and Arellano and Bover (1995) have developed a generalized method of moments (GMM) estimator that is superior in efficiency to the other procedures.

Blundell et al. (1992) compare the GMM estimator to others in a Tobin's q model of investment that is similar to the specification in this paper. They conclude it provides the most appropriate estimation strategy for panel data q models. In addition, because the main purpose of this paper is to test a hypothesis (about the β_{2j} coefficients), efficiency considerations are crucial. For these reasons, I estimate Eq. (8) using the GMM method, as implemented within the *DPD98* (*dynamic panel data*) program for GAUSS developed by Arellano and Bond (1998).

4. Results and discussion

Table 4 summarizes the results from the estimation of the 52 hedonic regressions specified in (7)—one for each two-digit SIC code represented in the sample. The figures reported are averages of the true regression coefficients. There is substantial variance across industries in the value-relevance of the intangible assets included, which justifies the calculation of *hedonic q* using industry-specific coefficients. The table also indicates that R&D stock is a valuable intangible asset in mining and construction, food, textiles, and chemicals, manufacturing, transportation, and services, but not in other industries. Advertising stock is valuable in most industries.[12] The book value of intangible assets is mostly irrelevant; in the actual regressions it is only statistically significant in 14 (out of 52) cases, mostly with a negative sign. The *hedonic q* values are very similar if the hedonic regressions are estimated without intangibles-in-books.

The average R^2 and adjusted R^2 are 0.19 and 0.15, respectively. These values are comparable to what previous studies using hedonic regressions of this type have attained (e.g. in Hall et al. (2000) R^2's range between 0.13 and 0.2). Nevertheless, this low explanatory power highlights the limitations of *hedonic q* as a measure of intangibles and provides additional evidence that Tobin's q captures a much broader range of intangible assets than those related to R&D and advertising.

Results from the GMM estimation of Eq. (8) appear in Tables 5–7 .[13] Table 5 contains the results of all hypothesis tests. Tables 6 and 7 contain sensitivity analyses on the main results

[12] Table 4 conceals many interesting exceptions at the two-digit SIC level, such as wholesale trade, or business, education, and management services (all positive and significant) or health services, which turns out to be negative and significant.

[13] The Arellano and Bond test statistics provide evidence of no residual serial autocorrelation (since the model has been transformed to first differences for estimation, first-order serial correlation is to be expected but not second-order), which guarantees the consistency of the GMM estimator employed. The Sargan tests of overidentifying restrictions confirm the null hypothesis of the validity of the instruments used.

Table 4
Summary of results from the 52 industry-wide hedonic regressions: averages across industries (two-digit SIC) within each sector

SIC 1st digit	Description of sector	Number of industries	Number of observations	Average q[a]	Average coefficients (average t-stats)[b]				R^2	Adjusted R^2
					Constant	R&D stock/assets	Advertising stock/assets	Intangibles stock/assets		
0	Agriculture	2	53	1.80	1.68 (3.09)	−31.49 (1.26)	9.43 (0.93)	−4.73 (−1.48)	0.51	0.37
1	Mining & construction	6	809	0.83	0.67 (12.3)	6.15 (2.06)	125 (−0.05)	−11.38 (−1.13)	0.26	0.20
2	Food, textiles & chemicals	10	3,517	1.58	0.98 (13.6)	1.82 (1.96)	1.62 (2.44)	0.09 (−0.08)	0.24	0.22
3	Manufacturing	10	7,645	1.36	0.98 (14.3)	0.64 (2.16)	0.30 (0.49)	0.88 (−0.05)	0.08	0.07
4	Transportation	6	798	0.97	0.91 (7.80)	0.59 (2.42)	2356 (1.36)	2.42 (0.77)	0.24	0.22
5	Wholesale & retail trade	10	3,383	1.07	1.26 (15.4)	−328 (−0.07)	−2.10 (−1.88)	−1.16 (−1.36)	0.10	0.09
7	Lodging & entertainment	6	1,699	2.05	1.25 (11.3)	−749 (−0.37)	−2.12 (−0.45)	0.05 (−0.55)	0.13	0.09
8	Services	2	335	1.46	1.42 (8.87)	2.07 (4.12)	10.46 (1.01)	−1.66 (−2.29)	0.18	0.17
	All sectors	52	18,237	1.37	1.07 (12.4)	−149 (1.43)	287 (0.34)	−1.31 (−0.53)	0.18	0.15

[a] Weighted.
[b] Unweighted.

Table 5
Influence of q on the persistence of firm-specific profits, 1981–1997[a]

	Full sample				Advantaged				Disadvantaged			
	Tobin's q		*Hedonic q*		Tobin's q		*Hedonic q*		Tobin's q		*Hedonic q*	
Intercept	0.004***	(0.001)	0.003***	(0.001)	0.011***	(0.001)	0.010***	(0.001)	−0.001	(0.002)	−0.001	(0.002)
Lagged FSP	0.284***	(0.015)	0.535***	(0.020)	0.268***	(0.036)	0.366***	(0.040)	0.234***	(0.080)	0.280***	(0.084)
q	0.043***	(0.004)	0.029*	(0.018)	0.060***	(0.011)	0.079*	(0.040)	0.031***	(0.009)	0.028	(0.025)
$q \times$ lagged FSP $\times$ D(agriculture)	−0.358	(0.329)	−1.761***	(0.813)	−0.523	(0.337)	−1.364*	(0.734)	0.248	(0.298)	−1.231	(1.805)
$q \times$ lagged FSP $\times$ D(mining & construction)	0.115***	(0.050)	1.547***	(0.126)	−0.412***	(0.183)	1.244***	(0.373)	0.161	(0.253)	−0.056	(0.352)
$q \times$ lagged FSP $\times$ D(food, textile & chemicals)	−0.256***	(0.019)	−0.694***	(0.041)	−0.286***	(0.033)	−0.991***	(0.091)	0.197**	(0.081)	0.115	(0.210)
$q \times$ lagged FSP $\times$ D(manufacturing)	0.109***	(0.019)	1.225***	(0.057)	−0.014	(0.038)	1.102***	(0.156)	0.114**	(0.046)	0.412***	(0.156)
$q \times$ lagged FSP $\times$ D(transportation)	0.280***	(0.087)	0.902***	(0.148)	0.103	(0.246)	2.215**	(0.895)	0.319***	(0.084)	1.611***	(0.541)
$q \times$ lagged FSP $\times$ D(wholesale & retail trade)	0.232***	(0.027)	0.945***	(0.062)	−0.015	(0.064)	0.519***	(0.175)	0.069	(0.058)	0.281**	(0.144)
$q \times$ lagged FSP $\times$ D(lodging & entertainment)	−0.360***	(0.021)	−1.112***	(0.040)	−0.335***	(0.037)	−0.799***	(0.076)	0.039	(0.088)	−0.585***	(0.189)
$q \times$ lagged FSP $\times$ D(services)	−0.207***	(0.066)	−0.226	(0.140)	−0.307***	(0.099)	2.139**	(0.890)	0.358***	(0.098)	−0.665***	(0.236)
Number of Observations	13,466		13,466		2,720		2,720		483		483	

[a] Generalized method of moments (GMM) estimation, in first differences. Dependent variable: firm-specific profits (FSP). D(sector) = sector dummies. Heteroskedasticity-consistent standard errors are in parentheses.

[*] Significant at the 10% level.

[**] Significant at the 5% level.

[***] Significant at the 1% level.

Table 6
Influence of *q* on the persistence of firm-specific profits during the 1980s and the 1990s[a]

	1980s				1990s			
	Tobin's *q*		*Hedonic q*		Tobin's *q*		*Hedonic q*	
Intercept	0.002***	(0.001)	−0.001	(0.001)	−0.004***	(0.001)	−0.003***	(0.001)
Lagged FSP	0.519***	(0.029)	0.690***	(0.035)	0.221***	(0.019)	0.505***	(0.026)
q	0.052***	(0.003)	0.038***	(0.016)	0.048***	(0.006)	0.027	(0.023)
q × lagged FSP × *D*(agriculture)	−2.966***	(1.340)	−3.621***	(1.624)	−0.262	(0.377)	−1.545	(0.960)
q × lagged FSP × *D*(mining & construction)	0.474***	(0.053)	1.730***	(0.162)	0.058	(0.062)	1.654***	(0.158)
q × lagged FSP × *D*(food, textiles & chemicals)	0.211***	(0.051)	0.225***	(0.113)	−0.254***	(0.024)	−0.662***	(0.050)
q × lagged FSP × *D*(manufacturing)	0.370***	(0.030)	0.816***	(0.087)	0.094***	(0.024)	1.407***	(0.071)
q × lagged FSP × *D*(transportation)	0.532***	(0.114)	0.783***	(0.147)	0.271***	(0.105)	0.920***	(0.189)
q × lagged FSP × *D*(wholesale & retail trade)	−0.045	(0.054)	1.009***	(0.099)	0.219***	(0.032)	0.937***	(0.075)
q × lagged FSP × *D*(lodging & entertainment)	−0.220***	(0.059)	−1.207***	(0.117)	−0.323***	(0.024)	−1.085***	(0.049)
q × lagged FSP × *D*(services)	0.284	(0.185)	−1.558	(0.987)	−0.229***	(0.079)	−0.104	(0.164)
Number of observations	3,859		3,859		7,937		7,937	

[a] Generalized method of moments (GMM) estimation, in first differences. Dependent variable: firm-specific profits (FSP). *D*(sector) = sector dummies. Heteroskedasticity-consistent standard errors are in parentheses.

*** Significant at the 1% level.

Table 7

Influence of q on the persistence of firm-specific profits for diversified and focused firms[a]

	Diversified		Focused		Diversified some years	
	Tobin's q	*Hedonic q*	Tobin's q	*Hedonic q*	Tobin's q	*Hedonic q*
Intercept	−3E−6 (0.002)	−0.003* (0.002)	0.007*** (0.001)	0.005*** (0.001)	−6E-5 (0.001)	0.001 (0.002)
Lagged FSP	0.271*** (0.039)	0.854*** (0.075)	0.285*** (0.020)	0.500*** (0.025)	0.296*** (0.032)	0.438*** (0.039)
q	0.012 (0.012)	−0.015 (0.035)	0.053*** (0.005)	0.030 (0.025)	0.024*** (0.009)	0.024 (0.030)
q × lagged FSP × D(agriculture)	0.772 (5.936)	0.612 (6.704)	0.272 (0.605)	−0.910 (1.422)	−0.628 (0.383)	−1.992** (0.933)
q × lagged FSP × D(mining & construction)	0.348*** (0.131)	2.193*** (0.241)	0.092 (0.069)	1.566*** (0.219)	0.071 (0.080)	1.090*** (0.190)
q × lagged FSP × D(food, textiles & chemicals)	−0.021 (0.066)	−1.009*** (0.146)	−0.299*** (0.023)	−0.697*** (0.047)	0.080 (0.066)	−0.145 (0.122)
q × lagged FSP × D(manufacturing)	0.078 (0.060)	1.794*** (0.171)	0.036 (0.024)	1.008*** (0.076)	0.261*** (0.040)	1.224*** (0.107)
q × lagged FSP × D(transportation)	0.511* (0.267)	1.027** (0.468)	0.242** (0.100)	0.820*** (0.175)	0.457* (0.247)	0.996*** (0.339)
q × lagged FSP × D(wholesale & retail trade)	0.427*** (0.104)	1.366*** (0.155)	0.174*** (0.035)	0.879*** (0.084)	0.306*** (0.049)	0.778*** (0.107)
q × lagged FSP × D(lodging & entertainmt)	0.337*** (0.111)	1.072*** (0.171)	−0.381*** (0.024)	−1.137*** (0.048)	−0.314*** (0.052)	−0.835*** (0.096)
q × lagged FSP × D(services)	0.410* (0.249)	2.102*** (0.756)	−0.336*** (0.081)	−0.249 (0.183)	0.151 (0.130)	−0.130 (0.214)
Number of observations	2,054	2,054	8,543	8,543	2,869	2,869

[a] Generalized method of moments (GMM) estimation, in first differences. Dependent variable: firm-specific profits (FSP). D(sector) = sector dummies. Heteroskedasticity-consistent standard errors are in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

presented in Table 5. As column (1) of Table 5 shows, the positive sign and significance of the β_{2j} coefficients (those of the interaction terms $q \times$ lagged FSP $\times$ sector dummies) confirms Hypothesis 1 for most sectors. In mining and construction, manufacturing, transportation, wholesale and retail trade, the greater a firm's Tobin's q, the greater the persistence of its firm-specific profits.

Column (2) of Table 5 shows that similar results are observed when *hedonic q* is used in lieu of Tobin's q to measure resource intangibility. This favors the interpretation of the main finding as evidence in support of Hypothesis 1. The greater the intangibility of a firm's resources, the greater is the sustainability of its competitive advantage. The value of using *hedonic q* is that it rules out the possibility of the results being driven by investors' expectations about the persistence of firm-specific profits other than any expectation that may be generated from the firm's intangible assets stock. The latter expectations, if they existed, would not be inconsistent with the primary interpretation given in this paper; however, they would suggest a different causal direction for the observed relationship.

The alternative interpretation of the results is also eliminated by the fact that the positive relationship between q and the sustainability of competitive advantage holds even more strongly for competitive disadvantage. Columns (5) and (6) of Table 5 show that the influence of Tobin's q or *hedonic q* on the persistence of firm-specific *losses* is positive and significant for most sectors. In fact, the influence of Tobin's q is positive for *all* sectors without exception. These results support the RBV interpretation over the alternative about investor expectations.

Table 5 also shows that, in support of Hypothesis 2, results differ significantly by sector. No sector exhibits a significantly negative effect of intangibility on sustainability consistently across all subsamples and measures of intangibility (i.e. in all columns of Table 5). Yet, some sectors do exhibit a negative effect for some subsamples and/or intangibility measures. For instance, in agriculture there is a significantly negative effect of *hedonic q* on sustainability of firm-specific profits, but the effect is not significant for losses. This suggests that R&D and advertising investments are unlikely sources of competitive advantage in agricultural businesses. In food, textiles, and chemicals, the negative relationship appears both for Tobin's q and *hedonic q*, but again only for firm-specific profits (columns 1–4). On firm-specific losses, the relationship turns positive and significant. A similar pattern is observed in lodging and entertainment. Overall, intangible investment seems a particularly risky strategy in certain industries, since it is associated with lower sustainability of competitive advantage but with a no lower (or a higher) sustainability of competitive disadvantage.

Table 5 also provides evidence of the average duration of competitive advantages and disadvantages of firms. The average persistence coefficient β_0 from Eq. (8) is 0.284 when the model is estimated using Tobin's q, or 0.535 when the model is estimated using *hedonic q*. The difference between the two coefficients is due to the different extent to which the effect of intangibility on persistence is controlled for under each measure.[14] A coefficient of 0.284

[14] These persistence coefficients cannot be compared to those in prior studies of profit persistence, for two reasons. First, the coefficients reported in this study indicate the percentage of firm-specific profits in any period before period t that remains in period t. In contrast, the persistence coefficients reported by Waring and McGahan and Porter refer only to the *incremental component* of firm-specific profits. Jacobsen's estimates do refer to both the

implies that it will take a firm's competitive advantage or disadvantage 1.8 years to dissipate up to a 90 percent of it, or 7.3 years to dissipate up to a 99.99 percent.[15] A coefficient of 0.535 implies that it will take a firm's competitive advantage or disadvantage 3.7 years to dissipate up to a 90 percent of it, or 14.7 years to dissipate up to a 99.99 percent (a value of 1, if achieved, would imply that the firm's competitive advantage lasts forever). The sample split into advantaged and disadvantaged firms reveals that the sustainability of competitive advantage is on average greater than the sustainability of competitive disadvantage under both the Tobin's q and the *hedonic* q specifications. The effect of resource intangibility on the *level* of firm-specific profits (β_1 in Eq. (8)) is positive and significant under all specifications, as expected.

Given how the measure of intangibility has been constructed, the interaction term coefficients β_{2j} can be used directly or be converted into duration intervals to quantify the importance of intangible assets relative to tangibles for the sustainability of competitive advantage. The estimated effect of q on persistence for each sector indicates by how much the persistence coefficient increases for each unit of increase in q. Consider for instance two manufacturing firms with equal level of firm-specific profits, one with as many intangible assets as the average firm in the sample (Tobin's q of 1.37), and another with twice as many intangibles as the average firm (Tobin's q of 1.74). The β_{23} coefficient of 0.109 indicates that the intangible-intensive firm would have a persistence coefficient 0.081 higher (0.109*0.37), or that it is able to sustain 99.99 percent of its competitive advantage for 2.9 more years than the low-intangibles firm. Because the 99.99 percent duration interval for the average manufacturing firm in the sample is 9.9 years, one could say that, on average, intangibles are 30 percent more important than tangibles in manufacturing. The same estimate obtains regardless of the percentage of the duration interval used.

Table 6 examines the robustness of the results to the sample period used by running separate analyses for the 1980s and 1990s decades. Again there are notable differences across sectors in the sign and significance of the main coefficients, as predicted by Hypothesis 2. Hypothesis 1 is supported consistently over the two decades in the same four sectors as before: mining and construction, manufacturing, transportation, and wholesale and retail trade. Breaking up the sample into the two decades throws additional light into the sectors for which Hypothesis 1 is not supported. The negative effect in agriculture, for instance, appears during the 1980s but not during the 1990s. Conversely, in food, textile, and chemicals there is a positive effect of intangibility on sustainability during the 1980s, but the effect is reversed in the 1990s. Only in the lodging and entertainment sector is the effect consistently negative during both decades. These exceptions notwithstanding, the results in Table 6 generally confirm the main result of this paper. They also show that, even if the persistence estimates are affected by the starting level of profits, the qualitative results of the hypothesis tests are not.

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fixed and incremental components, but of all of a firm's profits, not just of its firm-specific component. Second, like Jacobsen but unlike Waring and McGahan and Porter, the coefficients reported here result from a multivariate specification in which the influence of other variables (here, intangibility) in those persistence coefficients is controlled for. The fact that the persistence coefficient using *hedonic* q is twice as large as that using Tobin's q suggests that including control variables in the equation makes comparisons across different specifications difficult.

[15] If p is the percentage of a firm's competitive advantage whose sustainability is being considered, and ρ is its estimated persistence coefficient, the p% *duration interval* can be calculated as $\ln(1-p)/\ln(\rho)$ (Clarke, 1976).

Finally, Table 7 reports on the results of a sensitivity analysis where Eq. (8) is estimated separately for the subsamples of diversified and focused firms. This analysis provides further evidence of the robustness of the main results and shows that the strength of the results increases with firms' diversification status. In the subsample of diversified firms, the effect of Tobin's q on sustainability is significantly positive for five of the eight sectors and is not significantly negative for any. When *hedonic q* is used, the results are significantly positive for six of the eight sectors and only significantly negative for one (food, textiles, and chemicals). In contrast, in the subsample of focused firms, the significant coefficients are more equally split between positive and negative across sectors. The subsample of firms that are diversified in some years and focused in others is at an intermediate point between the other two subsamples with respect to the sign of the relevant coefficients. Altogether, the results in Table 7 suggest that diversified firms are better able to sustain their competitive advantages (or disadvantages), perhaps because they can smooth profits across divisions and over time.

5. Conclusion

This study shows that resource intangibility is positively related to the persistence of firm-specific profits or losses. Resource intangibility is measured in two different but related ways: (1) Tobin's q, and (2) the predicted value from a hedonic regression of Tobin's q on several accounting measures of intangibles. The results support the interpretation that intangible assets play an important role in sustaining a firm's competitive advantage, as predicted by the resource-based view of the firm. They also suggest that intangible assets play nearly as important a role in sustaining a firm's competitive disadvantage. Intangibles appear to be a double-edged sword, as a result of their greater stickiness relative to tangible resources. This is consistent with Ghemawat's argument about intangibles-based commitment driving sustained performance differences. Because this double-edged effect is a key implication of the resource-based view of the firm, the finding provides further empirical support for this theory.

Several qualifications to these implications must be mentioned. First, there is an issue about the aggregation at the firm level of other levels of analysis. As noted before, the RBV implication that intangible resources are associated with a greater sustainability of a firm's competitive advantage hinges on the premise that the owners of the firm are able to appropriate at least part of the value created by those resources. Consistent with this premise, Tobin's q measures the value of intangibles that the firm is able to appropriate, relative to its tangibles. However, the data and analysis in this paper say nothing about the total value created by intangible investments for beneficiaries other than the firm, such as employees or teams on which part of the firm's knowledge is likely to reside, competitors who may benefit from technological spillovers, or alliance partners who may share the benefits from the firm's reputation and brand name. Access to data on human resources would be helpful for that purpose.

Second, the *hedonic q* measure, while useful for the analysis of the alternative interpretation of results, is limited in its value as a proxy for intangibles because of the fact that R&D and advertising expenditures data are missing for many firms and years. In this study I have addressed this problem by combining several solutions that have been used in prior research. However, none of these solutions account for the fact that, since the decision to report R&D and advertising expenditures is endogenous to the firm, there is a potential sample selection problem in those data.

Third, the definition of intangibles used in this paper is overly broad, and only imperfectly captured by Tobin's q. As a result, I am for instance unable to explain the differences across sectors in the effect of intangibles. Further research may throw some light on this finding by using more fine-grained measures of intangible resources as well as of the different mechanisms by which firms may appropriate the value generated by those resources.

Subject to these qualifications, this study can be seen as one of the few large-sample tests available of the resource-based view of the firm. It is also one of the first empirical contributions to explaining what makes inter-firm performance differences persist over time. In particular, this study is the first to confirm that intangible resources can lock a firm into a disadvantage as well as into an advantage. This finding is consistent with RBV and inconsistent with the alternative interpretation of results suggested in the paper. My findings also have important implications for managers; namely, investment in intangibles is a high-risk, high-return strategy for firms. Further research might help us determine whether some intangible resources offer a better risk-return trade-off than others, and why some firms have suffered the downside of intangible investment while others have greatly benefited from it.

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Appendix A. Dealing with missing data on R&D and advertising expenditures

A well-known problem in studies using R&D or advertising expenditures is the substantial amount of missing data for both of these variables from most company databases, and particularly from Compustat. Two main alternative solutions have been adopted by different researchers: (1) Limit the sample to those firms for which no data are missing (e.g. Jensen, 1993); (2) Assume they are equal to zero (e.g. Morck and Yeung (1991); Hall (1993a)—for advertising). A third solution that can complement either of the first two is to "fill in" the data by interpolation when there are only one or two missing values in an R&D or advertising series. This has been used for the construction of the R&D stock variable in the NBER Manufacturing Sector Master File (Hall, 1990), on which many subsequent studies are based.

Solution one is the most straightforward, but creates two additional problems: sample selection bias, and sample size reduction. In my case, the sample selection problem is a serious one, because I am interested in comparing firms with different degrees of resource intangibility—including zero intangibility. As for sample reduction, excluding the observations with missing data would leave, after the necessary elimination of companies with less than three consecutive observations, a sample of less than 100 firms. For these two reasons, I discard solution one. Solution two, which is based on the assumption that firms that do not report R&D or advertising expenditures do not engage in those activities, may be acceptable when data are missing for the full series. However, it is typically untenable when there are only one or two missing values in the series.[16]

For these reasons, I have opted for combining solutions two and three for the construction of both the R&D and advertising stock variables. When a data point is missing between two non-missing ones, I follow Hall's interpolation procedure. When the last data point of a series is missing, so that the interpolation cannot be performed, I assume it to be equal to the previous period expenditures, multiplied by the growth rate of the previous period (with respect to the one before), and adjusted for inflation using the wholesale price index for R&D, and the consumer price index for advertising. The reverse procedure is used when it is the first data point of a series that is missing.

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[16] For instance, in my sample, 3COM exhibits the following data (in US$ millions) for years 1992–1995: Advertising expenditures: 40, 53, (missing), (missing). With growing series for sales (617, 827, 1295, 1237), R&D expenditures (64, 76, 188, 285) and other variables, it seems hard to believe that the company has simply stopped advertising in 1994.

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