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RESEARCH NOTE

Industry Implications of Value Creation and Appropriation Investment Decisions*

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ABSTRACT

Managers face a critical task in making firm investment decisions that are targeted toward creating and appropriating value. As managers weigh their resource investment decisions, we argue that these investments have a direct impact on the growth and volatility of the firm's industry. With data covering 377 industries across 16 years, we investigate relationships for aggregate firm investments on the growth and volatility of industry profit and sales. Results reveal important, complex relationships between investment in value creation and appropriation and different elements of the industry environment. Implications for management theory and practice are discussed.

Subject Areas: Decision-Making, Firm Environment, Industry Growth, Industry Volatility, and Resource Investment.

INTRODUCTION

Managers face a critical task in making resource investment decisions. In particular, resource investment comprises a nonrecoverable decision that requires knowledge of a firm's environment and of its rivals' capabilities (Bower & Gilbert, 2005). Understanding the environment is critical, because the level of growth, for example, can offer new opportunities and influence the reactive behavior of competing firms (e.g., Debruyne et al., 2002). As managers make resource investment decisions, they closely observe and consider investments by rival firms. Consequently, resource investments isolate similar firms in an industry that provides a point of reference for member firms (Peteraf & Shanley, 1997). In turn, a manager's resource investment decisions can have implications not only for the firm but also for its industry. Thus far, research on resource investment has predominantly focused

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at the firm-level without consideration for the industry (Priem & Butler, 2001; an exception is Lavie, 2007), leaving the industry-level effects from a firm's resource investment decisions largely unexplored (Bower & Gilbert, 2005). To fill this gap, our research offers insight by examining how firm investment decisions can shape the industry where firms compete.

As managers invest in different resources, they often have significant latitude in deciding between investments that affect the creation and the appropriation of economic value. Specifically, managers can choose to invest in resources with the aim of generating new value (e.g., investing in innovation), or with the aim of defending the firm against competition (e.g., enhancing brand perceptions, enabling price premiums). These investment decisions can be made independently, because managers can plan for value appropriation well before they actually create value (Coff, 2010), though several scholars argue that managers should make resource investment decisions that strive for a balance between value creation and appropriation (Mizik & Jacobson, 2003; Lavie, 2007). A manager's resource investments, however, can generate industry barriers against firms that do not make similar investments (Schmalensee, 1988). For example, resource investments can lead to new solutions, lower prices, and/or greater awareness that can affect all firms in the industry. Thus, because individual managers make specific resource investment decisions, their decisions have broad implications for the industry in which they compete.

In this research, we examine how aggregate firm-level in value creation and value appropriation influence industry growth and volatility. In our investigation, we follow extant research and focus on R&D investments as a primary means of creating new value and on advertising investments as a primary means of appropriating value (e.g., Mizik & Jacobson, 2003; Peterson & Jeong, 2010). Investments in these two types of resources are discretionary managerial activities that temporally precede critical outcomes (Peterson & Jeong, 2010). For example, in the case of R&D, investments by one firm can reduce the cost of rival firms' R&D (Knott, 2003) and allow imitators to capture profits. Hence, one firm's R&D investments can enhance the productivity of rival firms' R&D (Acs, Audretsch, & Feldman, 1994). Similarly, advertising investments for one brand may not only appropriate value for that brand but can also influence overall industry demand (Chakravarti & Janiszewski, 2003). Examining a lagged effect between investment and environmental change enables managers to assess current investment decisions in light of anticipated changes from observable prior, aggregate investment by firms in an industry. Moreover, our investigation of complex, curvilinear patterns between firm investments and the growth and volatility of industry sales and profit reveals asymmetries between R&D and advertising investments that offer new insight for resource allocation decisions. Overall, application of our findings can play a critical role in improving the efficacy of resource investment decisions by enabling managers to better anticipate investment outcomes.

INDUSTRY IMPLICATIONS OF RESOURCE INVESTMENT

Managers can invest in various resources to create and appropriate economic value, yet investments in R&D and advertising have been consistently linked to value creation and appropriation, respectively (e.g., Mizik & Jacobson, 2003; Peterson &

Jeong, 2010). Firms invest in R&D and build technological capabilities to generate superior products and processes (Gatignon & Xuereb, 1997). Hence, R&D is often considered a cornerstone of value creation (Mizik & Jacobson, 2003). Yet, the size of R&D investment may bear little relation to the commercial success of the product. Indeed, managers view other mechanisms, such as marketing activities, as helping to appropriate returns from innovation (Levin et al., 1987). Although R&D can help to create new products or improve existing products, it is advertising investments that help to communicate the product's availability, features, and benefits that cultivate favorable brand attitudes (Peterson & Jeong, 2010), differentiation, purchase behavior, and a comparative advantage (Erickson & Jacobson, 1992). If consumers are unaware of the distinguishing characteristics of a new product, or if this differentiation is not effectively communicated so as to influence purchasing behavior, a firm is unable to appropriate value. Consequently, advertising investments can act as an isolating mechanism that enables value appropriation. For example, Morton Salt is a commodity product that has used advertising to appropriate higher value when differentiation of a chemical compound (NaCl) from increased R&D is inherently limited.

These investment decisions, across all firms in an industry, are likely to affect key dimensions of the industry. Three dimensions are often recognized as foundational to an industry—munificence, dynamism, and complexity (Dess & Beard, 1984; Keats & Hitt, 1988). Indeed, extant research has established that firm investments influence industry complexity (Cockburn, Henderson, & Stern, 2000). In terms of the other two dimensions, munificence relates to the degree that the environment supports growth for firms within an industry, whereas dynamism corresponds to the level of environmental volatility or unpredictability within an industry (Dess & Beard, 1984). To understand how firm investments can shape the industry where firms compete, we examine the effects of aggregate firm-level resource investment in value creation (i.e., R&D investment) and value appropriation (e.g., advertising investment) on industry growth and volatility.

Resource Investment and Industry Growth

R&D investment

Investments in R&D build technological resources and facilitate value creation. Lower levels of aggregate R&D within an industry are likely to reflect decisions toward making small improvements in processes or enhanced features in products that can favorably affect sales within the industry. However, as aggregate R&D investment grows from low to moderate levels, two specific mechanisms are expected to generate a decline in industry sales growth. First, R&D investments often serve as an isolating mechanism (Schmalensee, 1988) due to the path dependent nature of resource development. As a result, applying technology successfully often depends on the experiences surrounding its development (Barney & Clark, 2007). Rival firms will need to make R&D investments to harness value created by other firms in the industry (Cohen & Levinthal, 1990). An implication is that R&D simply becomes a cost of doing business and does not enhance sales. Second, moderate levels of R&D investments insufficiently generate the technological improvements that would build or grow the industry. At moderate R&D levels, firms

tend to create innovations targeted toward offering parity toward rivals' products. This generates market share competition within the industry, as firms compete to retain or build their share, rather than increase the size of the industry.

However, increased sales growth can be expected for high levels of R&D in an industry. High R&D investments typically occur at times of technological ferment as old and new technologies compete for a market's attention. High levels of R&D investment suggest competition between alternate technologies, which can contribute to industry sales growth (Anderson & Tushman, 1990). Moreover, high R&D investments can help new technology realize its potential to meet market needs, with resulting radical innovation stimulating demand within the industry. As a result, we predict the following:

H1a: Aggregate R&D investment in an industry has a curvilinear, U-shaped effect on that industry's subsequent sales growth.

We also expect a curvilinear pattern between R&D investments and the level of profit growth in the industry. Jaruzelski, Dehoff, and Bordia (2005) lend support to this expectation. In particular, results from their examination of 1,000 global firms led them to caution firms to avoid ranking among the top or bottom of R&D spenders in an industry to stay profitable. Lower levels of R&D provide limited benefit in that they represent a cost of doing business, as information from rival firms is a basic technology input (Caballero & Jaffe, 1993) and a dollar for dollar reduction in profits. Increasing R&D investment to moderate levels typically directs attention toward improving the performance of existing technology or of internal processes—strategies that facilitate greater profit.

At high levels of R&D investment, the actual costs associated with investment decrease profitability as the path dependence of R&D inhibits use of the specialized knowledge. Consistent with this idea, Zhou and Wu (2010) revealed a concave relationship between R&D and exploration, where firms with higher levels of R&D became entrenched and less successful at assimilating new or different technology. Higher investments in R&D also involve a cost that does not guarantee profitability. For example, Nokia's recent investments in R&D were four times greater than Apple's, without a comparable level of market success (Broughton, 2010). Further, higher levels of R&D investment are consistent with attempts at radical innovation that sacrifice short-term profits. For example, Lev and Zarowin (1999) find that firms that increase their R&D investments experience lower earnings than firms with stable R&D investments. Therefore, we predict the following:

H1b: Aggregate R&D investment in an industry has a curvilinear, inverted U-shaped effect on that industry's subsequent profit growth.

Advertising investment

Investments in advertising activities can expand growth within the industry. Research shows a strong relationship between firms' increased advertising expenditures and market expansion (Erickson, 1985). Advertising can heighten customer awareness and preference for a firm's products and facilitate targeting specific customer segments (Moorman & Slotegraaf, 1999). Advertising investments also help to communicate the product's availability, features, and benefits that can cultivate

favorable brand attitudes (e.g., Peterson & Jeong, 2010). Moreover, advertising investments offer a means of attaining differentiation and a comparative advantage (Erickson & Jacobson, 1992). However, as the level of advertising investments increase, the benefits reach a point after which they negatively influence industry sales growth.

At high levels of advertising, competition for consumer attention can deter demand by generating clutter. Investment decisions among competitors also become interdependent. For example, in the late 1990s, Procter & Gamble attempted to influence consumer loyalty by substantially increasing its advertising investments and found that the action was met by competitors' increases in advertising investments (Ailawadi, Lehmann, & Neslin, 2001). This heightened level of advertising within the industry generates confusion among consumers and, in turn, weakens product choice (Malhotra, 1982). Research also shows that advertising can influence demand for rival products (Chakravarti & Janiszewski, 2003), implicitly indicating that higher levels of advertising expenditures may not grow an industry's sales aggregate. Therefore, we predict the following:

H2a: Aggregate advertising investment in an industry has a curvilinear, inverted U-shaped effect on that industry's subsequent sales growth.

With respect to industry profit growth, investments in advertising offer an isolating mechanism that influences profit returns (Mizik & Jacobson, 2003). New entrants are at a disadvantage relative to existing firms in that they must advertise more heavily and set prices lower to overcome loyalty to existing products. Thus, firm investments in advertising become a cost of doing business that will affect industry profitability. Although lower levels of advertising investment should exhibit higher industry-level profitability than at moderate levels (given the greater costs associated with moderate levels of investment), advertising investments at the low to moderate range may not reach the level of expenditure necessary to break through the clutter and capture attention.

In contrast, higher levels of advertising offer two key benefits even though the associated costs are greater. First, high advertising investments may be needed to avoid counterproductive rivalry that dissuades competitor moves and enables directing investments toward differentiating products and building brand loyalty. Second, high investments in advertising can help to enhance brand recognition, differentiate brands, and command price premiums (Erickson & Jacobson, 1992). Research also finds a significant, positive effect of advertising investments on the persistence of profits (Kessides, 1990). Therefore, we predict the following:

H2b: Aggregate advertising investment in an industry will have a curvilinear, U-shaped effect on that industry's subsequent profit growth.

Resource Investment and Industry Volatility

R&D investment

With innovation becoming a strategic imperative among firms facing dynamic environments (D'Aveni, 1994), investments in R&D are critical. R&D investments offer firms the ability to adapt to a changing environment. Yet, the R&D investments of all firms in an industry can also have a direct impact on the level of industry

uncertainty as firms experiment with ways to create value (Anderson & Tushman, 1990). At lower levels of R&D investments within the industry, greater sales volatility can result, as small R&D investments are more likely to focus on minor changes in product features that may or may not relate to customer needs. As R&D investments in an industry increase to moderate levels, industry demand volatility declines as R&D enables a better understanding of technological applications (Freeman & Soete, 1997) and facilitates greater market demand. Meanwhile, as the level of R&D investments increases to higher levels, stability in demand is offset by the degree of uncertainty produced by alternate technologies that threaten to displace existing technology. Often, several firms will offer alternate technological solutions that are based on different knowledge, experience, and development paths and only a couple of firms prevail (Hill & Rothaermel, 2003). The combined effect of firms building and updating path dependent knowledge on competing technologies will generate greater sales volatility at higher R&D investment levels within an industry. We therefore predict the following:

H3a: Aggregate R&D investment in an industry has a curvilinear, U-shaped effect on that industry's subsequent sales volatility.

From the standpoint of industry profit volatility, we expect the reverse pattern of effects. Within a technology cycle, low levels of R&D likely reflect incremental improvements that focus on improving the efficiency or effectiveness of technology, moderate levels may relate to establishing a dominant design, and high levels involve attempts to develop innovative alternate technology. Although low levels of R&D investment and incremental change coincide with less industry profit volatility, moderate levels of R&D are associated with greater variance in profitability. A majority of R&D spending results in products that fail (King, Slotegraaf, & Kesner, 2008), as the market selects a technology as the industry's new dominant design. Any secondary benefits of R&D, or applications beyond the initial purpose, may be partially captured at the industry level but in unpredictable ways.

It is the aspiration of high profitability that encourages firms' investments in R&D at the same time that it contributes to high variance in returns. Still, a point will likely be reached after which additional investments in R&D reduce industry profit volatility. In particular, high levels of R&D investment within an industry can focus on simply developing an understanding of a volatile situation. Alternatively, R&D investments aimed at furthering a promising technology may require higher investment. When advancing technology becomes a primary focus, then R&D investments will lessen industry profit volatility as the goal shifts from short-term profits to the potential for long-term rewards. Therefore, we predict the following:

H3b: Aggregate R&D investment in an industry has a curvilinear, inverted U-shaped effect on that industry's subsequent profit volatility.

Advertising investment

The level of advertising investment within an industry is also expected to influence the industry's volatility. In terms of sales volatility, we expect a positive relationship between advertising investments and industry sales volatility. In

particular, a lower level of advertising investment generally offers greater predictability, or less variation, by simply providing information about product offerings within a market. As the level of advertising investment within the industry increases, new consumer segments arise that create larger fluctuations in demand. Higher levels of advertising stress different product features and quality advantages to emphasize strategic points of difference (e.g., Stevenson & Swayne, 1984) generate a comparative advantage (e.g., Erickson & Jacobson, 1992), which induces brand switching. Advertising also aids new brands by generating awareness and attracting new users (Slotegraaf & Pauwels, 2008). As a result of reaching new customers and shifting demand preferences as awareness of advertised products increases, higher advertising levels have the potential to generate greater volatility in industry sales. Therefore, we predict the following:

H4a: Aggregate advertising investment in an industry increases that industry's subsequent sales volatility.

In contrast, we anticipate that increases in advertising investments will decrease profit fluctuations within the industry. Advertising investments offer a means of appropriating value by enhancing brand recognition (Erickson & Jacobson, 1992), reinforcing strategic points of differentiation (Mizik & Jacobson, 2003), and decreasing consumers' price sensitivity (Mela, Gupta, & Lehmann, 1997). The potential for brands to command a price premium should provide a stabilizing force where profitability becomes more predictable as advertising investments increase.

Further, the costs associated with investing in advertising may indirectly influence the profit volatility within an industry. Moreover, investments in advertising aimed at increasing the perceived value of a product may be interpreted by competitors as a less aggressive tactic, and thereby less likely to generate a profit-destroying competitive battle (Debruyne et al., 2002). Consequently, though higher advertising investments may generate new and potentially fragmented consumer segments within the industry that elevate the difficulty associated with predicting consumer demand, higher levels of advertising offer an economic advantage. As a result, we predict the following:

H4b: Aggregate advertising investment in an industry subsequently decreases that industry's profit volatility.

METHOD

Sample

With industry as the unit of analysis, we identified industry by the unique four-digit Standard Industrial Classification (SIC) code and sampled all public U.S. firms operating in these SIC industries between 1980 and 2000. Following Kahle and Walkling (1996), we used nonzero, four-digit SIC codes in our analysis. To arrive at our final sample we eliminated industries with fewer than 10 firms because low industry concentration may limit competitive market forces. After using five years of data to calculate industry measures, our resultant sample includes 377 industries with observations over 16 years.

Measures

We measure industry sales growth and volatility over a five-year span following Keats and Hitt (1988). Specifically, we first calculate industry sales performance for five years using Equation (1).

$$y_t = b_0 + b_1 t + u_t, \tag{1}$$

where y_t is a linear transformation (Log_e[Industry sales]) for year t, t refers to the year, and u is the residual term. We then use the regression slope coefficient from Equation (1) for each of the five years to calculate *industry sales growth* by estimating Equation (2).

$$\text{SG}_t = \text{In}(b_1) \tag{2}$$

where SG_t refers to industry sales growth and b_1 is the regression coefficient from Equation (1) to create a smoothed industry sales growth measure of the average growth rate over five years (Keats & Hitt, 1988). To calculate *industry sales volatility*, we use the standard error of the regression slope coefficient from Equation (1) for each of the five years (Keats & Hitt, 1988) and estimate Equation (3).

$$\text{SV}_t = \text{In}(se_{b1}) \tag{3}$$

where SV_t refers to industry sales volatility and se_{b1} refers to the standard error of the slope coefficient from Equation (1). Although both our growth and volatility are derived from the same data there is no reason to question their independence, as the result is comparable to a mean and standard deviation.

In terms of aggregate investments, we account for carryover effects from prior investments by lagging R&D (Pakes & Schankerman, 1984) and advertising (Leone, 1995) investment by one year. This approach is similar to that of Peterson and Jeong (2010), who found similar results across different time lags for R&D and advertising. Hence, we calculate the aggregate sum of prior-year expenditures-to-sales from firms operating in the industry, based on unique four-digit SIC code membership with data from COMPUSTAT [data codes 46 and 45] for each industry and year.

We also control for various extraneous factors. We control for capital investment, because it is a competing investment decision that is readily observable, using a one-year lag with data from COMPUSTAT [data code 30]. We also account for industry complexity to ensure that all three characteristics of an industry (munificence, dynamism, and complexity) are included. We calculate industry complexity using a market concentration measure recommended by Keats and Hitt (1988), where lower values signify higher levels of complexity. In addition, we control for industry return on sales for the prior year because it may influence potential growth and volatility. Given our focus on multiple years, we also control for year with the use of a series of dummy variables with 1989 serving as the reference year. Finally, because high-intensive industries exhibit different market behaviors (Ranft & Lord, 2000), we control for intensive industries by separately identifying R&D intensive and advertising intensive industries between 1980 and 2000. Specifically, we identified the top 1% of industries consistently making

these investments over time, and use separate categorical variables for intensive industries and use nonintensive industries as the reference group.

Preliminary Analysis

We conducted Granger (1969) causality tests to assess whether prior firm-level investments provide statistically significant information about industry growth (and volatility) in the presence of prior levels of industry growth (and volatility). An autoregressive specification of a bivariate vector autoregression parceled out potential causality effects across the different combinations of firm-level investments and industry characteristics. For a one-year lag, we tested 12 separate models for industry sales growth, profit growth, sales volatility, and profit volatility and found all tests to be significant at the .01 level. Resulting Granger bivariate causality tests were significant for aggregate firm-level R&D investments on industry sales growth ($F = 9{,}462.3$, $p < .01$), sales volatility ($F = 1{,}648.0$, $p < .01$), profit growth ($F = 5{,}121.7$, $p < .01$), and profit volatility ($F = 1{,}191.5$, $p < .01$); and for advertising investments on industry sales growth ($F = 1{,}827.4$, $p < .01$), sales volatility ($F = 10{,}858.1$, $p < .01$), profit growth ($F = 1{,}117.8$, $p < .01$), and profit volatility ($F = 1{,}667.3$, $p < .01$). Therefore, the prior year's level of aggregated firm-level investments in R&D and advertising predict industry growth and volatility. Descriptive statistics and Pearson correlations for our variables are in Table 1.

Analytical Technique

We used seemingly unrelated regression to account for possible correlation of errors (Zellner, 1962), and consequently produce more efficient estimates (Pindyck & Rubinfeld, 1998). We estimated two sets of two-equation models, one set for the sales and profit growth models and one set for the sales and profit volatility models. We also tested four separate ordinary least squares regression models to estimate the effects of aggregate investments on: (i) industry sales growth; (ii) industry profit growth; (iii) industry sales volatility; and (iv) industry profit volatility, and found similar results.

RESULTS

Industry Growth

Our analysis accounts for 38% of the variance in industry sales growth, 42% in industry profit growth, and 78% of the overall variance for the system of equations. Results show that industry complexity significantly influences both industry sales growth and industry profit growth, with less complex industries experiencing lower sales growth and higher profit growth. Although industry sales (profit) growth is a strong predictor of industry profit (sales) growth ($p < .01$), aggregate investment continues to play a significant role in shaping industry growth (Table 2).

In terms of our hypothesized effects, results show the linear effect of aggregate R&D investments on industry sales growth is negative ($p < .01$), whereas the quadratic effect is positive ($p < .01$), revealing a U-shaped effect and supporting H1a. Results further show that aggregate R&D investments have an inverted U-shaped effect on industry profit growth, revealing a positive linear effect ($p < .01$)

Table 1: Descriptive statistics and Pearson correlations.

Variable	Mean	*SD*	1	2	3	4	5	6	7	8	9
1. Sales growth	1.11	0.21	1.00								
2. Profit growth	1.15	0.45	0.57	1.00							
3. Sales volatility	1.04	0.06	0.27	0.20	1.00						
4. Profit volatility	1.08	0.13	0.18	0.37	0.59	1.00					
5. R&D investments	0.78	7.53	0.02	0.31	0.02	0.05	1.00				
6. Advertising investments	0.09	1.01	−0.03	0.01	0.08	−0.00	0.07	1.00			
7. Capital investments	0.59	5.74	0.03	0.04	0.00	0.01	0.17	0.03	1.00		
8. Industry complexity	1.02	1.83	−0.20	−0.11	0.10	0.13	−0.01	−0.01	−0.01	1.00	
9. Industry return-on-sales	−1.89	13.74	−0.02	−0.05	−0.00	−0.04	−0.09	−0.04	−0.08	0.00	1.00

Notes: Correlations >.04 are significant at the $p < .05$ level, and correlations >.08 are significant at the $p < .01$ level. $n = 321$.

Table 2: The effect of aggregate firm investments on industry growth.

	Industry Sales Growth	Industry Profit Growth
Predictor variables		
R&D investments	−0.36[a]	0.41[a]
(R&D investments)^2	0.09[a]	−0.10[a]
Advertising investments	0.17[a]	−0.19[a]
(Advertising investments)^2	−0.19[a]	0.21[a]
Control variables		
Capital investments	0.05[a]	−0.04[a]
Industry complexity	−0.09[a]	0.05[a]
Industry profit growth	0.90[a]	
Industry sales growth		0.84[a]
Industry return-on-sales	0.01	−0.02
1990	0.02	−0.01
1991	0.01	−0.01
1992	−0.01	0.01
1993	0.00	0.00
1994	−0.01	0.01
1995	0.02	−0.01
1996	0.03[c]	−0.02
1997	0.03[b]	−0.03
1998	0.05[a]	−0.04[b]
1999	0.04[b]	−0.04[b]
R&D intensive industries	0.03[b]	−0.03[b]
Advertising intensive industries	0.05[a]	−0.04[b]
Model fit		
R^2	0.38	0.42
System $R^2 = 0.78$		

[a]$p < .01$, [b]$p < .05$, [c]$p < .10$ (standardized estimates, two-tailed test).

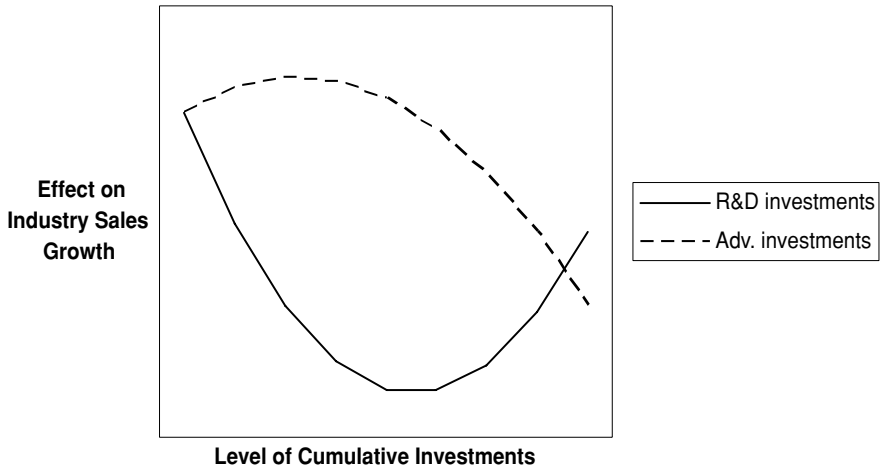
and negative quadratic effect ($p < .01$), thereby supporting H1b. To illustrate these patterns, we plotted the effects using the full range of aggregate R&D investments in our sample (Figures 1 and 2).

With respect to aggregate firm-level advertising investments, results show a significant positive linear effect ($p < .01$) and negative quadratic effect ($p < .01$) on industry sales growth, revealing an inverted U-shaped effect and supporting H2a. For industry profit growth, the effect of aggregate advertising investments shows a strong U-shaped effect, with a negative linear effect ($p < .01$) and a positive quadratic effect ($p < .01$), thereby supporting H2b. The effects are plotted to illustrate the patterns, using the full range of aggregate firm-level advertising investment (Figures 1 and 2). The opposing effects between the decision to invest in value creation (R&D) and appropriation (advertising) become clearly evident in these figures.

Industry Volatility

Our models explain 36% of the variance in industry sales volatility, 37% in industry profit volatility, and 77% of the overall variance for the system of equations.

Figure 1: The effect of aggregate firm investments on industry sales growth.



Although industry complexity does not significantly affect sales volatility ($p >$ .10), it does have a positive effect on profit volatility ($p <$ .05), indicating that less complex industries experience higher profit volatility. Although profit (sales) volatility plays a significant role in industry sales (profit) volatility ($p <$ .01), aggregate investments by firms in an industry also play an important role (Table 3). Specifically, results show the effect of aggregate R&D investment on industry sales volatility is U-shaped (i.e., the linear effect of R&D investments is negative ($p <$ .01), whereas the quadratic effect is positive ($p <$ .01)), supporting H3a. Results further indicate that aggregate R&D investment has a strong inverted U-shaped effect on industry profit volatility (the linear effect is positive ($p <$ .01)

Figure 2: The effect of aggregate firm investments on industry profit growth.

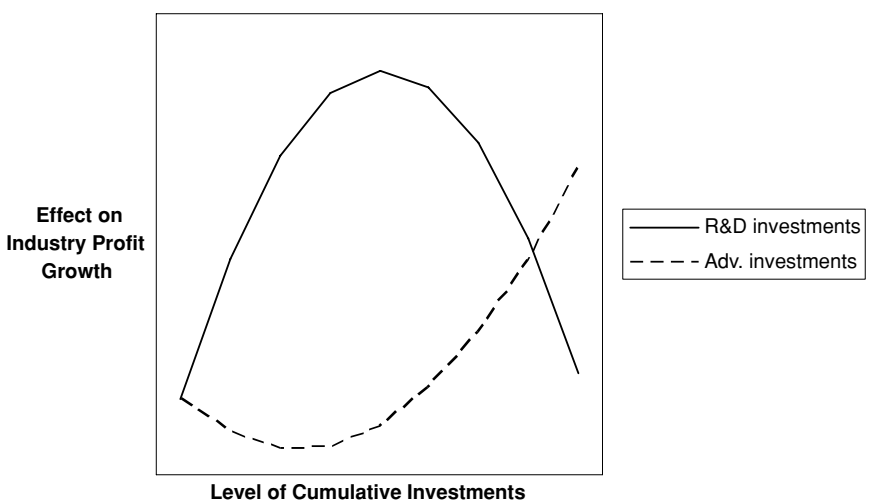


Table 3: The effect of aggregate firm investments on industry volatility.

	Industry Sales Volatility	Industry Profit Volatility
Predictor variables		
R&D investments	−0.11[a]	0.15[a]
(R&D investments)^2	0.10[a]	−0.12[a]
Advertising investments	0.09[a]	−0.08[a]
Control variables		
Capital investments	0.01	−0.01
Industry complexity	0.00	0.03[b]
Industry profit growth	0.88[a]	
Industry sales growth		0.87[a]
Industry return-on-sales	0.03[b]	−0.04[b]
1990	−0.01	0.01
1991	−0.01	0.01
1992	−0.01	0.01
1993	−0.03[c]	0.02
1994	−0.04[b]	0.03
1995	−0.01	0.00
1996	0.01	−0.03[c]
1997	0.02	−0.03[c]
1998	0.01	−0.03[c]
1999	0.01	−0.03
R&D intensive industries	0.01	0.01
Advertising intensive industries	0.00	−0.02
Model fit		
R^2	0.36	0.37
System $R^2 = 0.77$		

[a] $p < .01$, [b] $p < .05$, [c] $p < .10$ (standardized estimates, two-tailed test).

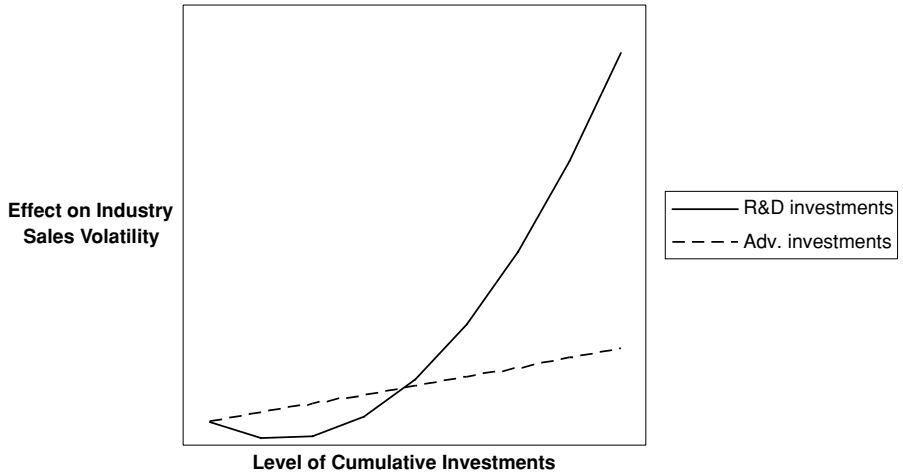
and the quadratic effect is negative ($p < .01$)), supporting H3b. A curvilinear relationship between R&D investment and industry volatility is clearly evident (Figures 3 and 4).

For aggregate advertising investment, results indicate that advertising investments have a positive linear effect on industry sales volatility ($p < .01$) and a negative, linear effect on industry profit volatility ($p < .01$), supporting H4a and H4b, respectively. These effects are shown in Figures 3 and 4. Supplemental analysis to test for potential curvilinear effects from advertising investments on industry sales volatility or profit volatility indicate that curvilinear effects are not present.

DISCUSSION

We outline how firm investment, captured at an aggregate level within an industry, can impact industry characteristics. In general, we find that the resource investments made by a firm and by other firms in its industry play a strong role in defining their industry's environment. Our findings also reveal stark differences across investments in value creation and value appropriation (observed in

Figure 3: The effect of aggregate firm investments on industry sales volatility.

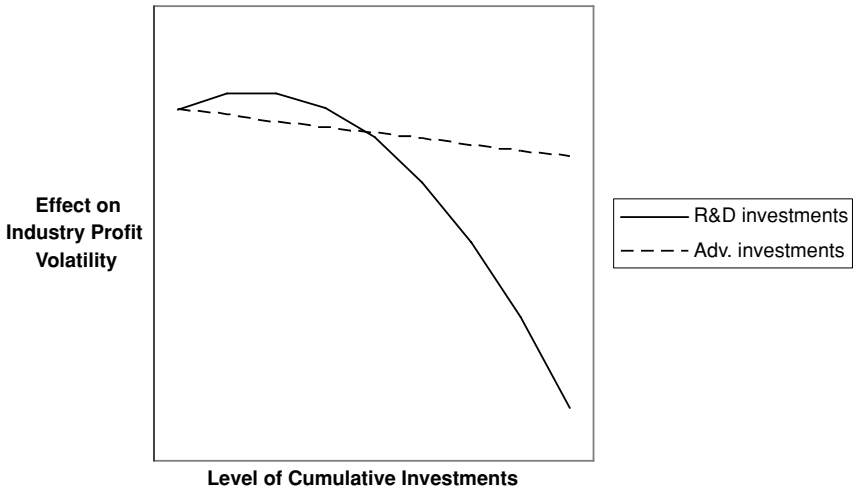


Figures 1–4). Priem and Butler (2001) observed that the value of resources varies across environments, and our results extend this insight to resource type. Importantly, knowledge of how investment decisions can influence the industry in which a firm operates enables managers to assess current investment decisions in light of anticipated industry changes.

Theoretical Implications

Foremost, our results indicate that, by making specific resource investments, firms can impact their competitive advantage both directly and indirectly. This advances

Figure 4: The effect of aggregate firm investments on industry profit volatility.



the resource-based view (Barney, 1991) by illustrating how the deployment of different resources extends beyond firm boundaries to a firm's industry. Further, our results reveal that investments in resources that stimulate value creation and appropriation are not substitutable, given their divergent effects on the growth and volatility of industry sales and volatility. Indeed, our research reveals that this relationship is complex, with firm investments illustrating differential effects on underlying industry factors. For example, R&D investments have an inverted U-shaped effect, whereas advertising investments have a U-shaped effect, on industry profit growth. This complexity is also evident for investments in the same type of resource. For example, investment in R&D has opposing curvilinear effects on industry sales volatility (U-shape) and industry profit volatility (inverted U-shape). Consequently, it is critical that these two types of resource investments are not considered in isolation, because the benefits of investing in one may balance the potential negative side effects of the other.

Our research also underscores the important distinction between growth and volatility (Castrogiovanni, 1991). Consequently, our results point to the importance of understanding the impact of different firm-level investments and the complex relationship between resource investment and industry environment. By focusing on the industry level, we are able to identify the impact of total investment on industry growth and volatility. Because results from both successful and unsuccessful firms are included, the impact of investments on profits and sales should avoid either over or under estimation. Another advantage of examining aggregate investment is that the secondary benefits or any spillover effects should be partially captured. Overall, our results highlight firm resource allocation decisions as an important research area, and call for future research to disaggregate type of resource investment when considering the impact of resource investment decisions. Identifying mechanisms to limit or facilitate the benefits from different types of resource investment by rivals within an industry represents a needed area for research.

Managerial Implications

Our research also offers several practical implications for managers. First, not only can investment decisions made by managers help build a firm's resources (Barney, 1991) and generate value creation and appropriation, but they can also influence the firm's industry. This suggests rival firm investments can offer strategic benefits, such as increasing industry growth or munificence. It also validates the practice of monitoring rival firm investments, as investments by a few firms could alter the nature of the environment for all firms in the industry.

Second, a failure to balance value creation and appropriation investments can have detrimental effects, as illustrated by the opposing effects of investments in R&D and advertising on sales and profit growth. Agarwal, Echambadi, Franco, and Sarkar (2004) also reinforce the importance of balancing value creation and appropriation, after having found that employees are more likely to depart firms that specialize in value creation to establish entrepreneurial ventures that appropriate the value of discoveries made at their prior employers. Therefore, it is important to recognize that an imbalance in value creation and appropriation investments can have negative impacts within a firm as well as its industry. Further, our results

reveal curvilinear effects on industry growth and volatility that offer greater understanding of the complexities involved, as investment decisions influence outcomes in different ways. Finally, it is worth repeating that managers need to consider the implications of prior investments in their industry when making current resource allocation decisions.

CONCLUSION

We find that the resource investments made by a firm and by other firms in its industry play a strong role in defining their industry's environment. Some may argue that more attractive industry conditions facilitate increased firm investment. We do not dispute this possibility. Quite simply, our goal and resulting contribution involves showing that a *broader* perspective involves viewing firms and their industry as part of a system where firms' investments in resources *do* influence industry environment. New solutions, lower prices, and greater awareness that result from firm-level investments can have implications for the prospects of all firms in an industry.

Overall, we demonstrate that aggregate resource investments have differential effects on industry growth and volatility, depending on whether an investment targets value creation or appropriation. Therefore, a central and vital implication of our research is that investment decisions represent a choice and are not predetermined by a firm's environment. As a result, it becomes critical to recognize that choosing to invest in resources that stimulate value creation can rival the outcomes produced by investments in value appropriation, suggesting a balance between such investments is warranted. [Received: January 2009. Accepted: January 2011.]

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