Birger Wernerfelt

Product Development Resources and the Scope of the Firm

This article examines the relationship between a firm's strength in product development and its optimal scope. Firms with product development strength have two options: They can leverage it in horizontally related markets, and they can reach into the supply chain to take full advantage of it. The question is how this should be done. One possibility is for the firm to expand its scope, and another is to manage the linkage through contracts. On the basis of the adjustment cost theory of the firm, the author argues that the former solution is more appropriate when product development is fast-paced. This study tests the argument in a sample of several thousand firms and reports four tests. For both types of expansion, the author examines the incidence and the productivity of increased scope. The author uses several measures and finds results that are consistent with the theory.

Several recent studies on marketing strategy have used the resource-based view (RBV) of the firm (Wernerfelt 1984) as a theoretical lens (e.g., Boulding and Christen 2003; Day 1994; Dutta et al. 2002; Dutta, Narasimhan, and Rajiv 1999; Moorman and Slotegraaf 1999; Ofek and Sarvary 2003; Slotegraaf, Moorman, and Inman 2003). Much of this literature assumes that the resources in question should be leveraged inside the firm, though a few studies (e.g., Rao, Qu, and Ruekert 1999) consider how to leverage a resource through a contract with another independent firm. The current article asks, What does a specific set of resources—namely, those used in product development—imply for the optimal vertical and horizontal scope of the firm?

Expansions of the vertical and horizontal scope are similar insofar as both involve the firm's taking on more activities. Firms have a broader vertical scope when they make, rather than buy, more of their inputs, and they have a broader horizontal scope (i.e., they are more diversified) when they sell more lines of outputs. Although I argue that both types of integration are positively correlated with product development resources, the proposed theoretical mechanisms are somewhat different. I assume that the firm's original stock of resources is exogenous and, in accordance with the RBV, guides its choice of industry. If the industry places a premium on flexibility in dealings with the supply chain, the adjustment cost theory of the firm (Wernerfelt 1997) suggests that the firm expand its vertical scope by bringing in part of the supply chain. If the firm develops more resource capacity, the RBV suggests that the firm transfer any excess to other industries, but this view does not infer whether the firm should govern this transfer through a contract or horizontal expansion. In contrast, the adjustment cost theory is silent with respect to whether this transfer should take place, but it recommends that a horizontal expansion should govern a transfer process if it entails frequent and diverse adaptations.

The argument is independent of the nature of the firm's resources. However, this article focuses on product development resources and presumes that a firm's use of such resources is correlated with a need for frequent and diverse adaptations, which is the central exogenous variable in the adjustment cost theory. I am not claiming that all product development resources should lead to vertical and horizontal expansion or that other resources should not.

I begin the argument by presenting two managerial challenges that many firms engaged in intensive product development face: (1) how to manage the demands for flexibility in the supply chain that are brought on by changes in final product designs and (2) how to leverage the firm's ever-growing set of product development resources. The ultimate claim is that firms sometimes meet these challenges by expanding their vertical and horizontal scope, respectively. To lay the foundation for making this claim, I review some general theory about the scope of the firm. I summarize the adjustment cost theory of the firm and argue that it provides a lens through which the expansion of vertical scope can be understood. I then combine the adjustment cost theory with the RBV of the firm and use this combination to consider the expansion of horizontal scope. Armed with these theories, I return to product development and formulate several hypotheses. I present a preliminary empirical test and conclude the article with a discussion.

Side-Effects of Product Development

In this section, I attempt to develop the context by describing two managerial challenges that firms may face when competing in industries characterized by fast-paced new

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product activity. The empirical work reveals the extent to which the challenges are empirically important.

Flexibility in the Supply Chain

The implementation of a new product design almost inevitably requires that some inputs be changed, and thus it has implications for the supply chain. In many cases, the effects are quite widespread. For example, changes in a single component of a mechanical or electronic product often necessitate changes in several others.

The challenge occurs when the inputs are less standardized and procured under long-term contracts that must be renegotiated. A change is not problematic if it involves standardized items that are traded on the spot market, because in that case, a firm simply stops buying one item and starts buying another item. Similarly, if the changes take place at *ex ante* known times (e.g., seasonally, annually), they pose less of a problem because a firm is unlikely to have entered into contracts that extend beyond the dates at which it anticipates changes. However, it is unanticipated changes in needs for less-standardized inputs that present problems.

There are many costs with respect to these changes, and firms can incur several of them *ex post*. In particular, the firm must engage in difficult negotiations with the supplier, which is entitled to compensation for continued delivery of items that the firm no longer wants. This bargaining process takes time and may fail (Myerson and Satterthwaite 1983). In addition, there are some *ex ante* costs of entering into a contract that both parties know they will eventually need to change. The costs include attempts to withhold certain information from the trading partner (out of fear that it may be exploited at the time of renegotiation) and reductions in efforts due to the anticipated termination. In some cases, the costs are borne, but in others, they are so large that a firm may postpone or even drop otherwise efficient changes.

The managerial challenge is to keep the costs of change down while managing the trade-off between them and the disadvantages of delaying or abandoning improvements in design. As such, the issues are similar to those discussed in the literature on improvisation in new product development (Moorman and Miner 1998). That is, the focus is on finding a process for managing unplanned changes. The literature has suggested many avenues for dealing with the problems, often putting them in the categories of operational (Tang and Tikoo 1999) and strategic (Grewal and Tansuhaj 2001) flexibility. This study is interested in just one of these solutions: the possibility of using vertical integration to ameliorate the costs of unplanned change.

Leveraging Accumulated Assets in Product Development Processes

Any firm that undertakes product development will develop resources over time that make repetition easier. Part of this involves the firm's moving down the learning curve, and part of this involves channel partners' and consumers' coming to trust the firm. To some extent, these resources accumulate automatically (Lieberman 1984), but firms can often manage their learning and reputation (e.g., Hurley and Hult 1998; Hult, Ketchen, and Slater 2004).

The challenge that this article presents is associated with the resources that a firm can potentially apply beyond the industry of origin. A firm will accumulate many resources that help it compete more effectively in its current industry. However, some of the resources have potential value in other industries as well, perhaps not in all industries but at least in industries that are similar in some sense to the one in which they originated. I confine attention to two classes of resources.

The first class of such general resources is the "business-process experience," which pertains to the execution of the development process. Some of the skills reside in individual employees, and others are of a more social nature (e.g., the group learns to compromise and cooperate with respect to a set of issues related to product development). Examples include the elicitation of technical and commercial information, the integration of conflicting viewpoints, and the division of labor and authority in the group. The individual components of learning may be quite small, but the aggregate learning-curve effects may be substantial.

The second class of accumulating resources consists of a firm's "reputation" with members of the distribution channel and, ultimately, consumers. If a firm has introduced successful new products in the past, retailers are much more likely to trust its new offerings, and consumers will react favorably to its brand name. To illustrate the frequency with which this happens, Montgomery and Wernerfelt (1992) report that 83% of the products in their sample were umbrella branded.

The managerial challenge is to deploy these two classes of resources in the best possible way. When the resources are sufficiently large, it is rarely optimal to confine their use to the original industry. Thus, the questions are where and how to put them to greater use and, in particular, whether this should lead to an expansion of the horizontal scope of the firm.

Theory

In this section, I summarize the general theories used in the article. I describe the adjustment cost theory of the firm and focus on its implications for the vertical scope of the firm. Then, I outline the RBV of the firm and combine it with the adjustment cost theory to consider the expansion of the horizontal scope. Finally, I examine the context of product development more narrowly and derive specific hypotheses.

The Adjustment Cost Theory of the Firm

To make statements about the optimal scope of the firm, there must be a theory of how firms differ from markets. There is no such generally accepted theory, but most candidates are descendants of Williamson's (1975) transaction cost analysis (TCA), insofar as they stress a subset of the factors invoked in TCA. Variants of TCA have been used extensively in marketing, not only in studies of the choice between direct sales forces and independent representatives (Anderson 1985; Ghosh and John 1999; Klein, Frazier, and Roth 1990; Weiss and Kurland 1997) but also in more general contexts (Heide 2003; Jap 1999). Whereas most appli-

cations of TCA, including the property rights theory (Grossman and Hart 1986), have focused on the effects of specific investments, the current study stresses a different class of transaction costs. Specifically, it uses the adjustment cost theory (Bajari and Tadelis 2001; Simester and Knez 2002; Tadelis 2002; Wernerfelt 1997, 2004) to compare the costs of adapting a trading relationship under firm governance rather than under market governance. This theory examines ongoing trading relationships and asks by which process the parties should adjust the relationship by accommodating changes. Possible processes include an *ex ante* contract that covers all possibilities and an *ex post*, case-by-case negotiation. If the required changes are diverse and frequent, the theory predicts that an implicit contract in which one party is given decision rights and the other can quit at any time should govern the relationship. The theory defines the latter governance structure as an employment relationship or a firm. It is possible, but beyond the scope of this article, that other theories of the firm, including those based on specific investments, could be used to interpret the results. For example, Rajan and Zingales (2001a, b) suggest that the RBV is consistent with the property rights theory. However, this does not imply that it is inconsistent with the adjustment cost theory.

The following is a simple version of the adjustment cost theory and is based solely on the direct adjustment cost that a firm incurs in bargaining and negotiation processes. Other versions are based on indirect adjustment costs (i.e., incentive effects). The exposition is based on Wernerfelt's (1997) work.

To keep things simple, I assume that all adjustments are implemented perfectly such that governance mechanisms can be compared in terms of the direct adjustment costs of implementation. In each period, a buyer may receive a service from a seller. The service is costly to the seller, but it creates value for the buyer. Part of this value can be transferred to the seller through a payment (w). There is a set of feasible services (A), and the ideal service is that which generates the most gross surplus (buyer value less seller costs gross of adjustment costs). Between any two periods, costs and values of all services change, such that the identity of the ideal service changes with probability (λ). Thus, this parameter measures the frequency of adjustment. I assume that the buyer always knows the identity of the ideal and that the players always implement it. Given these assumptions, I can compare how alternative game forms govern adjustments. I focus on only three such forms:

1. *Negotiation-as-needed*: The players negotiate a new w whenever they switch to another service. Most residential construction projects are governed in this way.
2. *Price list*: The players negotiate a set of prices *ex ante*, after which the buyer selects from the menu at each opportunity to switch. This arrangement applies, for example, when buyers visit a beauty shop or a tax preparation service.
3. *Employment relationship*: The players first negotiate a constant w, and then they enter into an implicit contract in which the buyer dictates adjustments to the seller, and either player may terminate the relationship at any time. A classical example of this is the relationship between a manager and his or her secretary.

Negotiation-as-needed and the price list represent the market. There are other market game forms as well, but it is clear that a complete list cannot be produced. Conversely, the employment relationship (i.e., the firm) is not an arbitrary choice. There can be no game form that requires players to negotiate fewer prices and, consequently, no game form with lower variable costs per adjustment. Thus, for sufficiently frequent adjustments, no other game form can perform better.

The costs of negotiating a wage contract are C_f, the costs of negotiating a single price are C_b, and the costs of negotiating a price list of length ($|A_p|$) is $C(|A_p|)$. Thus, $|A|$ measures the diversity of adjustments. If a firm implements all adjustments, the price list must cover all elements of A. In an infinite horizon model, the average per-period net surpluses from the three game forms differ only in terms of the direct adjustment costs. If ρ is the rate of interest, the direct per-period adjustment costs are λC_b for negotiation-as-needed, $\rho C(|A|)$ for the price list, and ρC_f for the employment relationship. If the price list is partial, such that $|A_p|$ is smaller than $|A|$, it does not implement all adjustments and therefore performs worse. Either way, the employment relationship is more efficient than negotiation-as-needed when the frequency of adjustment is high and is more efficient than a price list when the set of possible adjustments is diverse. That is, if many adjustments are required, it is prohibitively expensive to negotiate all of them, and if the set of possible adjustments is large, it is too expensive to negotiate a complete price list (see Figure 1). Phrased as a theory of the vertical scope of the firm, the adjustment cost theory predicts that the firm should internalize supply relationships that require frequent and diverse adjustments.

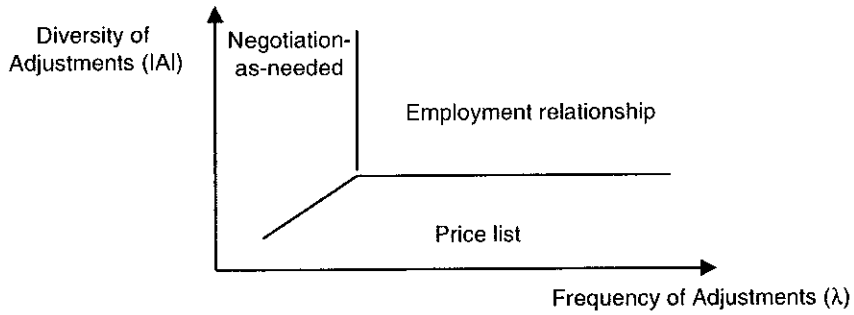
The RBV of the Firm

The RBV (Wernerfelt 1984) is based on the premise that firms differ, even within an industry. The differences occur in the firms' resources, and the main theory is that a firm's strategy should depend on its resources—if a firm is good at something, the firm should try to use it.

The simplest application of the RBV is at the level of business-unit strategy. That is, given that the firm participates in a specific industry, how should it compete? In general, the answers are straightforward. If a firm faces lower variable costs or can produce higher-quality products than those of its competitors, it can often increase profitability by positioning its products accordingly. Similarly, firms with strengths in product development should probably introduce more new products than their differently endowed competitors.

A deeper application pertains to the question of corporate strategy: In which industries should the firm participate? Again, the main prescription is simple: A firm should compete in industries in which its resources are important. For example, this implies that firms that are good at product development are likely to populate industries in which product development is important. If others were to enter, the firms would be at a significant competitive disadvantage and perhaps unable to survive.

FIGURE 1
Efficient Game Forms



Because firms are rarely designed from scratch, industry selection is often accomplished through a process of diversified expansion. In this process, a firm seeks one or more new industries to enter without questioning its continuing participation in its current markets. Under such circumstances, a resource is available only if the firm has capacity in excess of what is needed in its current markets (Penrose 1959).

Resources differ greatly in the likelihood that they appear in excess capacity. To help identify resources that are most likely to be in excess capacity, I classify them according to their short- and long-term capacity (Wernerfelt 1989). Resources with fixed capacity, typically physical assets, rarely play a role in considerations to expand a firm's scope. They support expansion only to the extent that misfortunes, such as declining sales, have caused the firm to have more fixed-capacity resources than the original application can use. At the other end of the spectrum, a firm can potentially use resources with practically unlimited capacity (e.g., brand equity) in a large number of industries. With respect to this type of resource, I place a firm's reputation in this category.

The last category consists of resources with fixed short-term but unlimited long-term capacity. Corporate culture is a standard example of this resource category, but a firm's learning curve may be a more important case. Individual employees can transfer some learning to other firms, but the firm-specific nature of a significant part of the learning curve suggests that much of the effect resides at the team level (Lieberman 1984). Resources developed through a firm's learning provide most of the examples in Wernerfelt's (1984) study, and the current study also examines firms' ever-growing skills in product development as a resource in this category.

Hypotheses

In this section, I apply the theories to the managerial challenges previously discussed and formulate several hypotheses about vertical and horizontal scope. To help situate the concepts, consider Time Warner as a firm with large vertical scope and Procter & Gamble as a firm with broad horizontal scope.

Vertical Scope

If a firm has resources in new product development, it should leverage them by participating in an industry in which product development, and thus the resource, plays an important role. Given this, the firm must trade with the adjacent stages, even if it brings no special skills to those industries. As I have argued, product development processes typically require frequent adjustments in the supply chain. According to the adjustment cost theory, this implies that it may be too costly to engage in negotiations at every turn and cheaper to bring the supplier in-house. Thus, I hypothesize that, on average, firms that pursue more intensive product development benefit more from a larger vertical scope than a horizontal one.

H_1: A larger vertical scope is more efficient for firms with more product development resources.

Assuming that firms optimize, this implies the following:

H_2: Firms with more product development resources are more likely to have a large vertical scope.

Horizontal Scope

To apply the adjustment cost theory to the attempt to leverage product development resources, in some detail I consider exactly how the services of these resources enter the development process. I argue that firms typically deploy process-management skills and reputations, two resources that this article examines, in ways that involve frequent reactions to a diverse set of circumstances.

To make the argument for skills in the management of product development processes, I engage in a counterfactual thought experiment. Consider how a firm with expert skills in product development could charge money in exchange for helping another firm, the client, with its product development. The process could begin with advice about the collection of certain kinds of information and then use a particular organizational structure. However, this process is not likely to contain additional news for the client. Because this type of advice is unconditional, it can be codified and sold, so the client probably knows it already. The expert might add more value after the process begins, when the client must react to information as it is

revealed. At this point, codification is impossible, and judgment is required. To transfer this, the expert firm would likely move groups of its own experienced people into "shadow positions" so that they could give ongoing advice to key members of the client's organization. Other people in the firm could be consulted occasionally. In the end, the client will have received several small services, mostly in the following form: "In this situation, we will try such-and-such." In other words, such a service may require a lot of contracting. According to the adjustment cost theory, this is likely to be prohibitively expensive, which suggests that the expertise be leveraged through a broader scope instead.

For reputation resources, including brand names, it is less the use and more the value-relevant aspects of this use that change frequently and widely. For example, all the uses of a brand affect its value, and though the brand's owner might approve of a single, specific use of it, even minor variations would need approval. However, I do not mean to make an absolute statement. Some brand names are licensed to other firms, but the majority of names are not. In contrast, it is hardly possible for a firm to rent out its reputation to other retailers.

In summary, attempts to leverage some of the most important resources involved in new product development—namely, process-management skills and reputations—typically involve frequent reactions to a diverse set of circumstances. The adjustment cost theory suggests that a firm should leverage these resources through a broader horizontal scope.

H_3: A larger horizontal scope is more efficient for firms with more product development resources.

Again, invoking the optimization assumption, this implies the following:

H_4: Firms with more product development resources are more likely to have a broader horizontal scope.

The main focus of this article is the behavior hypotheses (H_2 and H_4), which predict that firms with more resources in new product development have a larger vertical and horizontal scope. The performance hypotheses (H_1 and H_3) cannot be tested on real data under orthodox assumptions. If firms are optimizing, there cannot be any observations of less-than-optimal performance, and thus the hypotheses are not testable. A test is only possible if there are some mistakes among the observations. Thus, there is some tension between the two sets of tests. One relies on the assumption that, on average, firms do not make mistakes, and the other requires that at least some firms do. Although it is possible that most, but not all, firms behave correctly, this does not avoid the problem entirely. It is logical to treat scope decisions as endogenous in one test and exogenous in another. However, it is not possible to appeal to a distinction between long- and short-term endogeneity by asserting that firm scope changes more slowly than does performance. A more pragmatic argument is that the equations are likely to suffer from omitted variables. Variance in the equations may allow for the estimation of the effects by driving a wedge between the truly optimal scope and the best guess based on a subset of the relevant variables.

Empirical Test

Data

Theoretical arguments rooted in the RBV have far outstripped empirical tests, at least partially because it has been difficult to obtain objective measures of firms' resource stocks. Some resources are difficult to identify, and even if they can be identified, many measures suffer from endogeneity problems, whereas others require hard-to-get qualitative information. Another problem is that many resources exist at the business-unit level (Rumelt 1991), whereas most data are typically available at the more aggregate firm level. (Montgomery [1994] reports that the average *Fortune* 500 firm operates in 11 industries.) In an attempt to overcome these problems, I have tested the predictions on the well-known PIMS database, which offers both qualitative and quantitative information at the business-unit level. This database, which Buzzell and Gale (1987) describe, is unique because it contains both financial information and several qualitative items. Researchers have used the database in more than 100 academic papers. In the 1970s and the 1980s, researchers used the database to study all the important questions of the period, such as the value of market share, the profitability of early entry, and the importance of product quality. Currently, the research community uses PIMS more selectively, often in the context of more theory-driven work (e.g., Boulding and Christen 2003). The database is still being updated, and the PIMS Europe consulting company in London maintains it.

Compared with what would be available in a customized data-collection effort, the size of PIMS is a major advantage. A more important advantage is that the unit of observation is a business unit rather than a firm. Because most large firms are diversified, firm-level data are essentially averaged. By avoiding this, PIMS provides a much more precise picture of individual relationships (even if the data are subject to some measurement error from allocation rules). A disadvantage of using this database is that researchers cannot ask new questions with "new" variables but are limited to a fixed set of preexisting items. Furthermore, because the data are disguised, industry or firm effects cannot be controlled.

Testing Strategy

I test the behavior hypotheses (H_2 and H_4) by examining measures of scope as functions of a set of exogenous indicators of resources in product development. The logic is standard, and the tests are conceptually straightforward. In particular, I base the tests of the behavior hypothesis on linear regressions of the following form:

$$S = \delta_0 + \delta_1 R, \quad (1)$$

where S is the vertical or horizontal scope, and R is a set of indicators of resources in new product development. I operationalize H_2 and H_4 as follows:

$$H_2, H_4: \delta_1 > 0.$$

It is more difficult to test the performance hypotheses, and though the analysis is informative, the interpretation

relies on some slightly uncomfortable assumptions. I propose to test H_1 and H_3 by estimating strategic-business-unit-level production functions and by examining productivity effects of scope as functions of exogenous indicators of resources in new product development. By using interaction variables, I can isolate circumstances in which changes in scope help and hurt labor productivity. As discussed previously, I estimate the production functions with the implicit assumption that horizontal and vertical scope are exogenous (because of omitted variables and mistakes) or at least fixed in the short run. Although this seems defensible, the same assumptions must be made about labor and capital, and in the case of labor, it is less compelling. To mitigate these problems, I estimate the log of performance on a per-employee basis. I postulate a constant returns-to-scale production function in which value added (V) depends on labor (L), capital (K), scope (S), and indicators of resources in new product development (R). (Because scaling disguises the data, there are not flexible returns to scale. Exploratory analysis implies that the true model has moderate returns to scale, perhaps to a power of 1.1.)

Specifically, I estimate the following:

$$V = \alpha(S,R)K^{\beta}L^{1-\beta}, \quad (2)$$

in the form

$$\text{Log}(V/L) = \gamma_0 + \gamma_1 S + \gamma_2 R + \gamma_3 SR + \beta \text{Log}(K/L). \quad (3)$$

If the functional form of Equation 2 is taken seriously, $\alpha(S,R) = \exp(\gamma_0 + \gamma_1 S + \gamma_2 R + \gamma_3 SR)$. To test the hypothesis that integration is the more efficient way to leverage resources in new product development, I hypothesize that the cross-derivative is positive. That is, for either type of S and R, I operationalize H_1 and H_3 as follows:

$$H_{1a}, H_{3a}: \gamma_3 + (\gamma_1 + \gamma_3 ER)(\gamma_2 + \gamma_3 ES) > 0,$$

where E is the expectation operator. If there is uncertainty about the functional form of the production function, a weaker hypothesis is as follows:

$$H_{1b}, H_{3b}: \gamma_3 > 0.$$

Measures

To test the hypotheses, indicators of the presence of resources in new product development are needed. However, this is not a straightforward task. The most natural resource indicators are firm-level decisions that are subject to endogeneity problems. A correlation between a decision and scope could be interpreted as evidence that both are caused by the presence of product development resources. However, the extent to which the scope of the firm influences the decisions cannot be removed. For example, it would not be possible to interpret a single regression with product quality, firm advertising, or firm research and development. A firm may have a broad scope and advertise frequently because it has product development resources, or it may advertise because it has broad scope. Trying to steer clear of endogeneity problems to the extent that is possible, I found indicators that are reasonably exogenous. Two of them are at the industry level, and one is an outcome measure.

The industry measures capture the time that is typically needed to develop a new product and the extent to which it is difficult to predict when new products will be launched. The use of industry measures relies on the premise that firms elect to compete in industries with certain challenges only if they have the resources to cope with them. For example, in an industry in which the average participant develops new products quickly, all participants are likely to be fairly good at fast-paced product development. In an industry with several participants, this is a fairly exogenous proxy for the resources of any individual firm.

The outcome measure is the percentage of firm sales accounted for by new products. Because price and other marketing variables indirectly control the outcome measure, it is less exogenous than the industry measures. However, it is better than advertising or quality, which are completely endogenous. With more direct indicators, different hypotheses about horizontal and vertical scope might be possible. However, because this does not seem possible, I use the same explanatory variables to predict both aspects of firm scope. I use the most recent observation for each firm of the variables subsequently discussed. This means that some data points are relatively new, whereas others may be as many as 25 years old.

Development time for new products (DT). DT is measured by management responses to the following question: "For this firm and its major competitors, what is the typical time lag between the beginning of a development effort for a new product and its market introduction?" The possible answers are "less than one year," "one to two years," "two to five years, "more than five years," and "little or no product development occurs in this firm." These are coded as 1, 2, 3, 4, and 5, respectively.

Random product changes (PC). PC are measured by management responses to the following question: "Is it typical practice for this firm and its major competitors to change all or part of the line of products or services offered annually? "Seasonally?" "Periodically, but at intervals longer than one year?" Or is there "no regular, periodic pattern of change?" Because this question confounds frequency and randomness, I used only observations with the last two responses and coded them as 0 and 1, respectively. (Approximately 5% of the data are lost by this procedure.) Thus, this is a coarsely measured variable.

Percentage of sales from new products (NP). NP refers to the products that firms have introduced in the past three years and is measured at the firm, rather than the industry, level.

Horizontal scope (HS). HS is measured by management responses to a question about the "extent to which your business unit shares facilities" with other units in the firm. The idea is not that firms have a broader horizontal scope to share assets but that firms with a broader scope have more options to share assets, such that the actual scope is positively correlated with this measure. Because answers are reported on a three-point scale ("less than 10%," "between 10% and 80%," and "more than 80%"), this measure is also coarse. Another concern is the underreporting of the horizontal scope, because many firms may have divisions that

TABLE 1
Means and Correlations

	Mean (S.D.)	VS	DT	PC	NP	VA/L	K/L
HS	1.70 (.77)	.038*	−.053*	.014	.051*	.252*	.120*
VS	54.8 (16.8)		−.049*	.061*	.063*	−.006*	−.217*
DT	2.98 (1.30)			.156*	−.262*	−.041*	.086*
PC	3.74 (.59)				−.184*	.050*	.024
NP	8.15 (14.9)					.014	−.043*
VA/L	57.7 (50.4)						.718*
K/L	50.5 (66.0)						

*$p < .01$.
Notes: N ranges from 3469 to 3526. S.D. = standard deviation.

do not share the plant and equipment with any other division of the firm. However, it is difficult to tell a natural story in which this creates a bias in favor of the hypotheses. Suppose that the theory is wrong and that firms expand their scope for other reasons. In this case, it would be more difficult to share assets in fast-paced industries, which would result in a negative relationship between the measured incidence of diversification and the extent to which the business operates in a fast-paced industry. The same argument may defend against misinterpretations of the performance model.

Vertical scope (VS). VS is measured by the value added (sales less material costs) as a percentage of sales at the business-unit level. This measure has a long history in the literature that begins with Gort's (1962) work. I have omitted approximately 20% of the business units because they report internal sales or purchases. This is unfortunate because the average firm, thus omitted, would be expected to have larger vertical scope than those included. However, the internal flows cannot be tracked, and thus corporate scope cannot be measured. For the observations I use, VS is equal to both firm- and corporate-level scope for the product line in question. The good news is that there is still plenty of variance on the measure.

Labor productivity (VA/L). VA/L is measured in constant dollars as value added per employee.

Capital per employee (K/L). K/L is measured in constant dollars as total assets per employee.

Results

The descriptive statistics appear in Table 1. Because the sample size is so large, it is not surprising that most of the correlations are significant. The most notable result in Table 1 may be the nonsignificant correlation between VS (= VA over sales) and VA/L. In a model with constant returns to scale, there is no theoretical reason to believe that the two are correlated; all three variables should go up in concert. However, any measurement noise in VA would induce a false positive result. The absence of this boosts confidence in the data.

The correlations in Table 1 show the pattern that the theory predicts at the univariate level. Both HS and VS are negatively correlated with DT and positively correlated with the extent of PC as well as the importance of NP. Five of these six correlations are significant at the 1% level.

The estimates of the behavior regressions appear in Table 2. Whereas the absence of control variables causes the regressions to have low adjusted-R^2 values, the results of interest are strong. All the signs conform to the predictions, and five of the six coefficients are significant. Although the pattern of significance is different, the results are remarkably consistent with the hypotheses: Firms choose to have a larger scope when DT is short, when PC is important, and when NP is important.

Estimates of the two production functions appear in Table 3. The six test statistics of the form $\gamma_3 + (\gamma_1 + \gamma_3 ER)(\gamma_2 + \gamma_3 ES)$ all have the predicted sign, and four of the six interaction variables (γ_3) are significant. Both vertical and horizontal integration helps productivity when DT is short, when PC is important, and when NP is important. Although there are many reasons for insignificance, the results are also consistent with the claim that, on average, scope neither helps nor hurts productivity. (The net coefficients on VS and HS are .0073 and .0848, respectively, and both have t-values below 1.)

Discussion

I have used the adjustment cost theory and the RBV of the firm to make and test the claim that many product development resources make it more attractive for the firm to have a broader scope. I test this prediction on both vertical and horizontal scope in terms of both actual firm behavior and production functions. Although the measures are coarse, there are several of them. The results are strongly and robustly consistent with the theory.

TABLE 2
Extent of Vertical and Horizontal Scope

Independent Variable	Vertical Scope	Horizontal Scope
DT	−.5530** (−2.42)	−.0291** (−2.68)
PC	2.3487** (4.74)	.0104 (.28)
NP	.0742** (3.71)	.0022* (2.32)
N	3413	3245
Adjusted R^2	.0106**	.0042**

*$p < .05$.
**$p < .01$.
Notes: t-statistics are in parenthesis.

TABLE 3
Estimates of Log Labor Productivity

Independent Variable	Productivity of Vertical Scope		Productivity of Horizontal Scope	
Log K/L	.6004	(79.23)	.5621	(72.13)
VS	.0100**	(2.75)		
HS			.1438	(1.06)
DT	.0262	(1.54)	.0279	(2.06)
PC	.0241	(.59)	−.0750	(−1.57)
NP	−.0030	(−1.70)	.0006	(.52)
VS × DT (Hyp < 0)	−.0013**	(−4.30)		
HS × DT (Hyp < 0)			−.0419**	(−5.76)
VS × PC (Hyp > 0)	.0006	(.75)		
HS × PC (Hyp > 0)			.0835**	(3.28)
VS × NP (Hyp > 0)	.0001*	(2.32)		
HS × NP (Hyp > 0)			.0005	(.85)
N	3412		3244	
Adjusted R^2	.6578**		.6440**	

*$p < .05$.
**$p < .01$.
Notes: t-statistics are in parentheses.

The limitations of the data, which result in a lack of control variables, open the door for alternative explanations. However, most alternative theories do not speak to the variables that I used, and because the same three variables predict increased scope in four different cases, the bar has been raised for alternative explanations.

Another problem, which I discussed previously, is that not all product development resources justify expansions in the scope of the firm. Because the measures do not allow for distinction between different types of resources, I rely on a maintained hypothesis about the relative importance of different types of resources for the average firm in the sample. This means that there are many counterexamples to the averages that the empirical work has measured. However, it is more difficult to find counterexamples to the theoretical claims.

I do not wish to suggest that vertical and horizontal scope go hand in hand in general. The extent to which a firm has resources in product development may be one of the only variables that correlates positively with both types of scope. In both cases, it increases the need for frequent and diverse adjustments, but the mechanisms that underlie the two correlations are quite different. Resources in product development correlate with vertical scope because they cause demands for adjustments on other levels of the supply chain. They correlate with horizontal scope because their application generates demands for adjustments.

As should be clear from the theoretical part of the article, the empirical research can be refined in several directions. In particular, better measures might allow for the distinction between different classes of product development resources and environments with stronger or weaker demands for adjustments. It would also be interesting to examine other resources.

REFERENCES

Anderson, Erin (1985), "The Salesperson as Outside Agent or Employee: A Transaction-Cost Analysis," *Marketing Science*, 4 (Summer), 234–54.

Bajari, Patrick and Steven Tadelis (2001), "Incentives Versus Transaction Costs: A Theory of Procurement Contracts," *RAND Journal of Economics*, 32 (Autumn), 387–407.

Boulding, William and Markus Christen (2003), "Sustainable Pioneering Advantage? Profit Implications of Market Entry Order," *Marketing Science*, 22 (Summer), 371–92.

Buzzell, Robert D. and Bradley T. Gale (1987), *The PIMS Principles: Linking Strategy to Performance*. New York: The Free Press.

Day, George S. (1994), "The Capabilities of Market-Driven Organizations," *Journal of Marketing*, 58 (October), 37–52.

Dutta, Shantanu, Mark E. Bergen, Daniel Levy, Mark Ritson, and Mark J. Zbaracki (2002), "Pricing as a Strategic Capability," *Sloan Management Review*, 43 (Spring), 61–66.

———, Om Narasimhan, and Surendra Rajiv (1999), "Success in High Technology Markets: Is Marketing Capability Critical?" *Marketing Science*, 18 (Fall), 547–68.

Ghosh, Mrinal and George John (1999), "Governance Value Analysis and Marketing Strategy," *Journal of Marketing*, 63 (Special Issue), 131–45.

Gort, Michael (1962), *Diversification and Integration in American Industry*. Princeton, NJ: Princeton University Press.

Grewal, Rajdeep and Patriya Tansuhaj (2001), "Building Organizational Capabilities for Managing Economic Crisis: The Role of Market Orientation and Strategic Flexibility," *Journal of Marketing*, 65 (April), 67–80.

Grossman, Sanford J. and Oliver D. Hart (1986), "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy*, 94 (August), 691–719.

Heide, Jan B. (2003), "Plural Governance in Industrial Purchasing," *Journal of Marketing*, 67 (October), 18–29.

Hult, G. Tomas M., David J. Ketchen, and Stanley F. Slater (2004), "Information Processing, Knowledge Development, and Strategic Supply Chain Performance," *Academy of Management Journal*, 47 (April), 241–53.

Hurley, Robert F. and G. Tomas M. Hult (1998), "Innovation, Market Orientation, and Organizational Learning," *Journal of Marketing*, 62 (July), 42–54.

Jap, Sandy D. (1999), "Pie-Expansion Efforts: Collaboration Processes in Buyer–Supplier Relationships," *Journal of Marketing Research*, 36 (November), 461–75.

Klein, Saul, Gary L. Frazier, and Victor J. Roth (1990), "A Transaction-Cost Model of Channel Integration in International Markets," *Journal of Marketing Research*, 27 (May), 196–208.

Lieberman, Marvin B. (1984), "The Learning Curve and Pricing in the Chemical Processing Industries," *RAND Journal of Economics*, 15 (Summer), 213–28.

Montgomery, Cynthia A. (1994), "Corporate Diversification," *Journal of Economic Perspectives*, 8 (Summer), 163–78.

——— and Birger Wernerfelt (1992), "Risk Reduction and Umbrella Branding," *Journal of Business*, 65 (January), 31–50.

Moorman, Christine and Anne S. Miner (1998), "The Convergence of Planning and Execution: Improvisation in New Product Development," *Journal of Marketing*, 62 (July), 1–21.

——— and Rebecca J. Slotegraaf (1999), "The Contingency Value of Complementary Capabilities in Product Development," *Journal of Marketing Research*, 36 (May), 239–57.

Myerson, Roger B. and Mark A. Satterthwaite (1983), "Efficient Mechanisms for Bilateral Trading," *Journal of Economic Theory*, 29 (2), 265–81.

Ofek, Elie and Miklos Sarvary (2003), "R&D, Marketing, and the Success of Next-Generation Products," *Marketing Science*, 22 (Summer), 355–70.

Penrose, Edith G. (1959), *The Theory of the Growth of the Firm*. New York: John Wiley & Sons.

Rajan, Raghuram G. and Luigi Zingales (2001a), "The Firm as a Dedicated Hierarchy: A Theory of the Origin and Growth of Firms," *Quarterly Journal of Economics*, 116 (August), 805–851.

——— and ——— (2001b), "The Influence of the Financial Revolution on the Nature of Firms," *American Economic Review*, 91 (May), 206–211.

Rao, Akshay R., Lu Qu, and Robert W. Ruekert (1999), "Signaling Unobservable Product Quality Through a Brand Ally," *Journal of Marketing Research*, 36 (May), 258–68.

Rumelt, Richard P. (1991), "How Much Does Industry Matter?" *Strategic Management Journal*, 12 (March), 167–85.

Simester, Duncan I. and Marc Knez (2002), "Direct and Indirect Bargaining Costs and the Scope of the Firm," *Journal of Business*, 75 (April), 283–302.

Slotegraaf, Rebecca J., Christine Moorman, and J. Jeffrey Inman (2003), "The Role of Firm Resources in Returns to Market Deployment," *Journal of Marketing Research*, 40 (August), 295–309.

Tadelis, Steven (2002), "Complexity, Flexibility, and the Make-or-Buy Decision," *American Economic Review, Papers and Proceedings*, 92 (May), 433–37.

Tang, Charles Y. and Surinder Tikoo (1999), "Operational Flexibility and Market Valuation of Earnings," *Strategic Management Journal*, 20 (August), 749–61.

Weiss, Allan M. and Nancy Kurland (1997), "Holding Distribution Channel Relationships Together: The Role of Transaction-Specific Assets and Length of Prior Relationship," *Organization Science*, 8 (December), 612–23.

Wernerfelt, Birger (1984), "A Resource-Based View of the Firm," *Strategic Management Journal*, 5 (April–June), 171–80.

——— (1989), "From Critical Resources to Corporate Strategy," *Journal of General Management*, 14 (Spring), 4–12.

——— (1997), "On the Nature and Scope of the Firm: An Adjustment-Cost Theory," *Journal of Business*, 70 (October), 489–504.

——— (2004), "Governance of Adjustments," *Journal of Business*, 77 (April), S3–S24.

Williamson, Oliver E. (1975), *Markets and Hierarchies: Analysis and Antitrust Implications*. New York: The Free Press.