

Choosing Equity Stakes in Technology-Sourcing Relationships: AN INTEGRATIVE FRAMEWORK

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Technology-sourcing relationships between firms involve one firm seeking access to another firm's technology as embodied in its products, services, or capabilities. Studies on technology-intensive industries reveal the widespread use of such relationships.¹ They span a continuum, ranging from non-equity arrangements at one end to complete ownership at the other. For instance, a pharmaceutical firm such as GlaxoSmithKline could have a non-equity partnership to in-license a molecule from its technology partner, or a hardware firm such as Cisco Systems could acquire a start-up firm for its product development team. Although both are examples of technology-sourcing relationships, they vary in terms of the level of equity that the technology-sourcing company holds in its partner.

Managers routinely use technology-sourcing relationships in industries where the pace of innovation is rapid, but numerous studies show that such arrangements have significantly high failure rates.² Given this situation, practitioners and academics have devoted a lot of attention to the *implementation* challenges that might lead to low success rates.³ They have observed that partnerships may fail because the parties involved are strategically or organizationally incompatible, are unable to trust each other, and do not have the appropriate means to elevate and resolve conflicts. While the implementation challenges are undoubtedly important, it is very likely that failure is also linked to problems with the fundamental *design* of the partnership. One of the most important design-related issues is the level of equity ownership that one partner should have in another.

In choosing equity stakes, managers face such questions as: Should our company take an equity position at all in its technology-sourcing partner? If yes, how much? Should it take a minority equity stake, form a joint venture, create a majority stake, or fully acquire its partner? Most importantly, what factors

should managers consider so as to choose the right level of equity ownership? These questions are clearly important; yet no integrated framework exists to help managers systematically think through them. As one manager we interviewed from a large pharmaceutical company noted, “We are very clear about the need to form external partnerships, such as alliances or acquisitions, to source new and innovative technologies. We have also done many such deals. Yet we are not sure whether we have a clear set of decision rules to decide how much equity we must own in these relationships. In fact, we have been struggling with this question for a long while.”

The lack of an integrated framework to guide decision making in this area is somewhat surprising given the wealth of academic research that is relevant to these questions. Researchers have long viewed technology-sourcing relationships as attractive settings to develop and test multiple theoretical perspectives on how companies access critical inputs.⁴ The lack of an integrative framework may be because the individual theories in each of these prior studies, by their very nature, provide a partial or limited view of the world. However, many existing theoretical perspectives on equity ownership are largely complementary rather than competing, and their underlying behavioral assumptions are not incompatible with one another. This article synthesizes existing research into a framework that enables managers to make decisions about equity ownership levels in technology-sourcing relationships.

The Costs and Benefits of Equity Ownership

Equity ownership in technology relationships between firms can confer both costs and benefits, and the integrative framework we develop recommends optimizing the tradeoff between them while making equity ownership choices. Our analysis focuses mainly on some of the *strategic* costs and benefits that might be relevant in this context. Not only are these benefits and costs extremely important in terms of affecting a company’s ability to successfully achieve its desired objectives in its technology relationships, but they are also hard to quantify. Difficulty in quantifying and measuring strategic benefits arises because of the longer time horizons in which they occur, their non-localized nature (which makes them hard to capture through traditional accounting techniques), and the

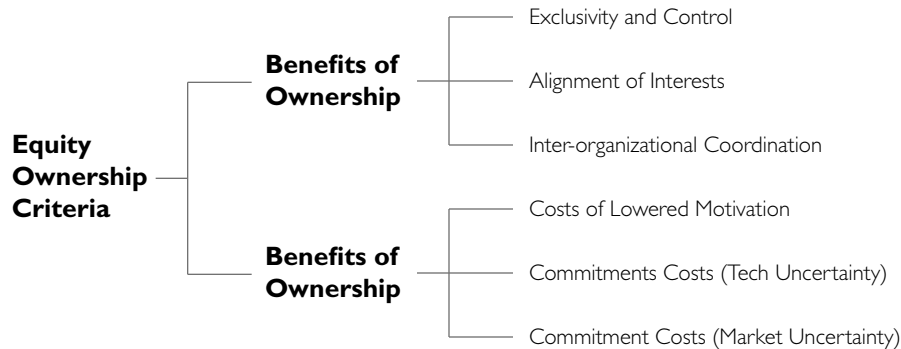
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fact that some of them are opportunity benefits (e.g., actions that avoid subsequent costs). Similarly, we do not focus on some of the more obvious, widely understood, and easily quantifiable costs of equity ownership: for example, the financial outlay for acquiring equity stakes, legal or advisory fees, and the restructuring costs involved in

divesting unwanted assets from an acquired partner. Instead, we focus on those that are hard to quantify and measure because they are not captured in conventional accounting techniques and may represent opportunity costs. Considera-

FIGURE 1. Equity Ownership: Benefits vs. Costs



tion of these strategic benefits and costs should, and indeed does, influence equity ownership decisions significantly, as a growing body of empirical literature in strategy and technology management shows.⁵

In general, increasing levels of equity ownership imply higher levels of costs and benefits. The increase, however, is not necessarily a smooth one; legal and accounting regulations may lead to some discontinuities at specific levels of equity ownership. For instance, in some countries, a minority equity ownership of 5% or more may provide a board seat (and consequently, rights of oversight), and a stake of 26% may provide “veto rights” on board/shareholder resolutions.⁶ Further, an equity stake of more than 50% may provide the opportunity to combine accounting statements, and a stake of over 76% may provide the ability to block veto rights of the partner. While the specific levels of equity at which these benefits are obtained may differ by regulatory regime, the key point here is that it is more realistic to think of an equity choice as a selection of the right equity bracket rather than as a smooth, continuous variable. For these reasons, when we discuss “increasing levels of equity ownership,” the reader should keep in mind that in practical terms, this translates into “when moving to an ownership structure with a higher level of equity.”

Figure 1 summarizes the main benefits and costs of equity ownership.

The Benefits of Equity Ownership

A company enjoys three important strategic benefits by virtue of owning equity in its technology-providing partner firm: preferential access to critical resources, assets, or capabilities; better alignment of interests between the respective partners; and better coordination and control between partners.

Preferential Resource Access

Many academics have argued that a company’s ability to sustain competitive advantage rests fundamentally upon its ownership of key resources and

competencies that are critical to its line of business.⁷ These include not only tangible resources such as capital or a manufacturing plant, but also important intangible resources such as know-how, brands, and technological capabilities. Resources and capabilities confer competitive advantage if they are valuable (i.e., create products or services that customers will pay for), rarely found in other companies, and difficult for other firms to imitate.

Technology and technological capability are often resources that are critical to the creation of long-term competitive advantage. While external relationships are an effective mechanism to get access to a “valuable” technological resource, equity ownership plays a very important role in ensuring that this valuable resource also remains unique and difficult to imitate, both of which are necessary conditions for competitive advantage. Increasing equity ownership in its technology-providing partner gives a company preferential access. Even at low levels of equity ownership, rivals are unlikely to consider creating technology-sourcing relationships with the focal firm’s partner. To take a hypothetical example, if company A were to take a 15% equity stake in company B, rivals of company A would be discouraged from forming a technology-sourcing partnership with B because of the role that A may play through its equity ownership to further its own interests at their expense. Full exclusivity can be achieved through complete ownership so that the sourcing firm can exclude potential rivals from getting easy access to this technology. High levels of equity ownership also enable the firm to exclusively appropriate the benefits stemming from the technology. Rivals that lack control over the technology concerned and its development over time are unable to imitate or replicate the technological capabilities of the firm that controls access to and has ownership of the technology.⁸ Therefore, when managers engage in technology-sourcing relationships, they need to clearly assess the importance of resource ownership and exclusivity or at least preferential access in the context of their business environment. If these aspects are critical to achieve competitive advantage, then they are best advised to pursue some degree of equity ownership in their technology partners.

In general, with greater expected benefits through exclusivity, managers would need to own higher levels of equity in their partners. At the extreme, this may call for outright acquisition of the technology partner. Microsoft’s acquisition of Vermeer Technologies in 1996 offers a good illustration.⁹ Vermeer was a Boston-based software company that had created a new Web-authoring product called FrontPage. Both Netscape and Microsoft were interested in gaining access to the software, as it could play a key role in furthering their own strategies for success in Web-related products and technologies. When Microsoft learned that Netscape, its primary rival in this segment, was exploring a similar move, it paid about \$130 million to get complete ownership of Vermeer. Microsoft derived two benefits from the deal. First, it got sole access to Vermeer’s product and the underlying technology and thereby immediately had an advantage over its rival. Second, it was able to prevent Netscape from gaining access to Vermeer’s technology platform and thus effectively hampered its future efforts to play catch-up. Control through ownership also gave Microsoft the ability to make further

investments in Vermeer's technology and maintain its own technological edge over Netscape.

In summary, the greater the value of preferential or exclusive access of a partner firm's resources and capabilities, the larger the equity stake indicated in a technology-sourcing relationship.

Alignment of Interests

In technology-sourcing relationships, as in other partnerships, companies often expose themselves to potential "hold-up" by their partner; the partner may behave opportunistically and renege upon its agreements or fail to live up to its commitments. For instance, consider a contract research agreement between a small biotechnology firm and a traditional large pharmaceutical company. Some biotechnology companies, like Millennium Pharmaceuticals, have business models that depend on such relationships. The partnership structure may require the pharmaceutical firm to make milestone payments to its partner following fulfillment of agreed-upon R&D objectives. However, in the course of undertaking research for the pharmaceutical firm, the smaller firm may need to make investments in equipment, chemicals, and training, much of which may be specific to the particular project and have limited value in other uses. This creates a possibility that the larger firm will behave opportunistically and delay or decrease the milestone payments. The smaller firm, forced to choose between receiving some payment and recovering no value at all from its dedicated investments, may have no option but to comply in order to avoid a lengthy legal resolution. The converse may also occur; the smaller firm may behave in an opportunistic manner with the pharmaceutical firm if the latter has made significant investments in preparation for manufacturing and commercializing the specific molecule obtained from the research. Strategists call this the "hold-up" problem.¹⁰

To protect themselves, companies take significant precautions, such as screening partners before selection, negotiating agreements that foresee and forestall potential hold-ups, and monitoring the activities of their partners to ensure compliance. Eventually, if a partner still behaves opportunistically, a company may incur significant litigation and settlement costs. A subtler problem may arise if both partners foresee the dangers of such opportunistic behavior and remain secretly uncommitted to the success of the project. These problems become particularly salient when there is considerable uncertainty about how the terms of the agreement would need to be modified in the future and when transactions between partners are frequent. Under these conditions, renegotiation becomes unavoidable and the possibility of opportunistic renegotiation is correspondingly higher. However, the root of the hold-up problem is in the need for one or both partners to invest in specialized assets that have limited value outside the partnership.

Equity investments in partnerships can address some of the concerns cited above. Equity ownership aligns the incentives and interests of the two partners. If Firm A has an ownership stake in Firm B, how well Firm A does depends to

some degree on how well Firm B does. Thus, Firm A would be less inclined to harm Firm B's interests. Higher levels of equity ownership may be necessary with a proportionate increase in relationship-specific investments by partners and therefore an increased likelihood of hold-up hazard. Given the benefits of aligning interests between partners, equity ownership is commonly observed in contract R&D partnerships between biotechnology firms and large pharmaceutical companies, as mentioned above. For example, both Roche and Eli Lilly took equity stakes in Millennium as part of their contract R&D arrangements in 1994 and 1995 respectively. Apart from aligning interests, equity ownership also provides the investing partner a means to exercise greater control and oversight over its partner and so prevent adverse partner behavior. The investor exercises such control either by gaining a seat on the partner firm's board or by getting decision-making and voting rights as a condition of the equity stake. While minority equity ownership is a partial step toward the alignment of interests, complete ownership through acquisition provides the greatest level of interest alignment and ability to monitor and control behavior.¹¹

In summary, when managers form technology-sourcing relationships, they need to clearly assess the hold-up hazards they will encounter in such relationships and the amount of effort necessary to monitor and avert any opportunistic behavior. This means clearly understanding the extent of relationship-specific assets they need to invest in. Hence, managers should seek greater equity stakes in their technology partnership when it involves greater investment in relationship-specific assets.

Coordination and Control

In order to meet the objectives of technology-sourcing relationships and successfully leverage the technology being accessed, knowledge flows and coordination between the partnering firms may be critical. Hence, managers in these firms may need to create inter-organizational linkages to enhance inter-partner coordination, control, and knowledge flows.

Scholars of organization design typically discuss two broad categories of formal organizational integration mechanisms: linking and grouping. Linking mechanisms provide a basis for coordination between discrete organizational units. Classic discussions of linking mechanisms typically feature plans and standards, hierarchical control, integration managers, and liaison mechanisms such as task forces or committees, which are sequentially arrayed in terms of increasing cost of implementation and coordination capacity. Plans and standards are the simplest coordination mode.¹² As a form of inter-organizational integration, they simply involve partner firms' agreeing on the division of labor and sequencing of tasks (with accompanying incentives) between themselves to achieve common objectives. For instance, a biotechnology firm may enter into a partnership with a pharmaceutical firm wherein it agrees to provide a chemical compound that meets certain standards (standardization) by a certain date (scheduling). Given the simplicity of the task and the clear division of labor and

sequencing, this form of coordination can be (and is often) achieved contractually, without any need for strong inter-organizational linkages.

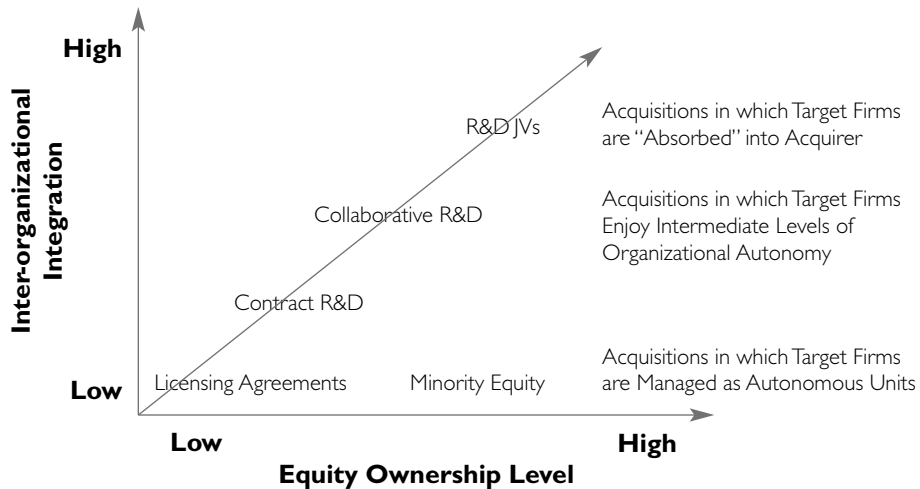
Partners may additionally need regular exchanges of information between various departments in their respective firms while undertaking the exchange of technological products or services between them. In such situations, they may use integration managers—a costlier coordination mode—to facilitate the exchange. Such boundary-spanning roles serve to coordinate activities by acting as channels of information between partners. Liaison mechanisms such as task forces, committees, or employee exchanges represent an even more powerful but costly coordination mode.¹³ In these cases, ongoing coordination between partners occurs through the creation of a semi-permanent structure involving members of both firms. R&D task forces and design-for-manufacture committees are instances of such deeper organizational linkages between partners. While these are very powerful in terms of their capacity to enable coordination, they are also expensive in terms of managerial involvement and time.

When linking mechanisms prove inadequate to the coordination task, resetting organizational boundaries through the regrouping of activities into organizational units can be a powerful though expensive coordination mode.¹⁴ The creation of combined units dedicated to the partnership (e.g., a joint venture, or complete absorption of a target into an acquirer's organizational structure) represent instances of such deep levels of organizational integration. Creating such a single, integrated organizational structure enables smoother information flows, brings the activities to be coordinated under one source of authority, and creates powerful incentives for cooperation by unifying objectives.

It is important to note that the level of equity ownership significantly influences the nature and extent of organizational integration between partners, though the relationship is not straightforward. Greater equity ownership gives a firm the authority to implement more elaborate coordination mechanisms and stronger organizational linkages.¹⁵ For instance, a minority equity position, under some legal regimes, suffices to provide a board seat that acts as a limited coordination mechanism. Ownership of a significant equity stake, on the other hand, may be necessary for undertaking deeper organizational integration between partners by creating dedicated integration managers or permanent liaison committees. An acquisition through complete ownership further extends the ability to create organizational linkages, as full ownership makes it possible to reconfigure organizational boundaries and units across partners if necessary. Consequently, the level of equity ownership that a firm takes in its partner provides increasing benefits in terms of the possibility to design and manage the extent of coordination required between them.

However, taking an equity stake does not create an obligation to implement proportionate levels of inter-organizational integration mechanisms. For instance, in some situations acquisitions may be followed by limited organizational integration (in which the acquired firm is maintained as a semi-autonomous subsidiary), whereas in others it may result in complete absorption

FIGURE 2. Equity Ownership and Inter-organizational Integration



of the target firm.¹⁶ In other words, larger equity stakes increase the possibility but not the necessity for using more complex and elaborate integration mechanisms. Figure 2 illustrates this relationship between equity ownership and inter-organizational integration. The space above the diagonal is empty because in general, more complex and elaborate integration mechanisms can only be implemented when backed by larger equity stakes. Positions on the diagonal reflect situations where firms increase their level of organizational integration in proportion to the equity ownership they have. On the other hand, the below diagonal positions are those in which firms take a high equity position in their partners but choose to have minimal or no organizational integration between them.

Intel and Cisco are good examples of companies that routinely evaluate the extent of inter-organizational linkage they need in any technology partnership for it to succeed and then subsequently decide the level of equity ownership that is most appropriate. A manager at Intel commented that they differentiate between the need to “keep track of the progress” of the technology versus the need to “get [their] hands around” it. A minority equity stake and board observation rights often achieve the former purpose, whereas the latter may require complete acquisition and ownership so as to be able to achieve fairly tight organizational integration of the partner. When Intel took a minority equity position in Berkeley Networks in 1997, it was with the former objective.¹⁷ Berkeley Networks (BN) was developing a new router architecture that was consistent with Intel’s strategy of “horizontalizing” the switch/router. This involved creating open interfaces between various parts so that Intel could dominate the processing portion and eventually move the entire switch onto a chip. Since Intel was, simultaneously, working on a similar concept internally, it had an incentive to

keep track of BN's progress and its equity stake mainly reflected such a limited motive. There certainly seemed to be few attempts to transfer knowledge between the parties. The CEO of BN, in fact, stated, "There was no technology exchange either to Intel or from Intel." There were few formal organizational linkages between the two partners in terms of R&D or joint development efforts.

In contrast, Intel acquired complete equity ownership in a company called Corollary in 1997 for its multiprocessor technology that was based on the Intel architecture. Intel saw an opportunity to leverage Corollary's capabilities in designing processors for servers in conjunction with Intel's own extremely deep skills in microprocessor design for PCs. Achieving this, however, required a significant amount of R&D coordination and knowledge sharing. This may partly explain why Intel decided to go for full ownership rather than to partner with the firm based on a minority equity arrangement. Corollary was substantially integrated into Intel's organizational structure within a year of the acquisition.

In technology-sourcing relationships, control over the future development of the technology is often key. This is an important reason that acquisitions of technology partners are common in the IT industry, where product life cycles are short and the underlying technology for any product evolves rapidly from "version 1.0" to "version 2.0" and beyond. In such cases, the need for coordination extends beyond the technologies that exist today to those that will be developed in the future. Cisco Systems grew in the 1990s by acquiring several small technology companies that helped it fill out its product line. However, the objective of these acquisitions went beyond filling immediate gaps in the product portfolio. As one manager from Cisco Systems said, "Usually we purchase a specific piece of technology or a product. But that is only half the story; we also want the team that will generate innovation in the future." His colleague concurred: "For us, it is never only the box or the block that is already here—it's all about the next-generation product."¹⁸ Networking technology was (and still is) evolving quite rapidly, and it was important that the technologies of all the products in Cisco's portfolio evolved in a synchronized, coordinated manner. This meant that coordination was necessary not only to make the acquired technologies interoperable with Cisco's existing technology architecture, but also to ensure that the acquired technologies developed in a manner such that they remained interoperable in the future. This implied the creation of longer-term organizational linkages and consequently made acquisition more attractive.¹⁹

Thus, equity ownership—and the authority it confers to create inter-organizational linkages—is a valuable mechanism to achieve knowledge sharing, coordination, and control between partners. The greater the need for such inter-organizational coordination, the larger the equity stake indicated.

Technology-sourcing relationships might derive benefits from one or more of the mechanisms described above. For instance, consider the following scenarios between two companies, A and B, where A sources some technological input from its partner B:

- Firm A sources specialized components from Firm B. Firm B will have to invest in specialized equipment to manufacture the components that A needs.
- Firm B makes a key input used by Firm A. Firm B's inputs are very critical to Firm A in terms of creating superior products compared to its rivals.
- Firm A and Firm B sell complementary products, a hardware product and a software product. A technological opportunity exists to enhance the interoperability of the two products by redesigning them.

In each of these situations, there is a credible case for Firm A to take some equity ownership in Firm B based on the benefits that it provides. In the first case, an equity stake can align interests and reduce hold-up hazards. In the second case, maintaining exclusive use of Firm B's input would justify equity ownership, whereas in the third, the need to achieve technical coordination through organizational linkages (e.g., joint R&D projects) may justify an equity stake.

The Costs of Equity Ownership

There are many organizational costs and difficulties associated with increasing (and especially complete) equity ownership in a technology partner. One set of organizational costs are the process costs associated with aligning incompatible systems related to accounting, IT, HR, and the costs of divesting unwanted businesses in the case of full acquisitions; these costs usually occur in the period immediately following the transaction. They can often be significant enough to deter the formation of equity relationships.²⁰ While these costs are clearly important, they are not strategic in the sense discussed earlier—they are relatively easy to quantify at least ex post, if not ex ante. Companies hire consultants, lawyers, investment bankers, and HR experts to assist with the implementation aspects of the relationship, and they allocate budgets towards defraying their expenses.

In addition to these process costs of implementation, another very important category of costs arises because of a change in the organizational conditions of employees in partner firms as a consequence of the relationship. These are costs in the form of diluted incentives and lost autonomy that create dissatisfied employees and high rates of turnover. Unlike the process costs of implementation, these are not a short-term or one-time phenomenon, but are a stable feature of the relationship over time. Therefore, they are extremely important for managers to factor into their thinking about the motives and design of technology-sourcing relationships between firms. Finally, another set of opportunity costs arise due to the commitment or lock-in that an equity stake represents. When the value of a partner firm's assets is uncertain, an equity stake can create flexibility—creating the option but not the obligation to completely acquire the partner at a later date. However, higher levels of equity imply lower levels of such flexibility. While hard to measure and quantify, flexibility and commitment can have enormous implications for the success or failure of a technology strategy.

Costs of Lowered Employee Motivation

Organizations rely on one of two mechanisms to motivate their employees to undertake desired effort: they either monitor the actions of the employees or provide them with appropriate incentives. In technology settings, wherein employee effort is primarily in the form of knowledge creation and contribution, the problem of hidden action (also called “moral hazard”) is usually present. Essentially, it is difficult to clearly observe the magnitude or quality of effort that employees contribute. Therefore, monitoring is not a very effective mechanism to motivate employees to work or to prevent them from shirking. Instead, externally provided incentives such as bonuses or stock options are often the primary mechanisms used to spur commitment and effort among knowledge workers. Of course, employees are also self-motivated because of their interests and preferences. This intrinsic motivation is seen when employees work on projects that truly excite them.

Many technology-sourcing relationships involve smaller, entrepreneurial firms and larger, established firms. Important strategic costs may arise when a large firm takes some equity ownership in its smaller technology partner. In small firms, the link between individual effort and reward is quite strong, as the contribution of each employee has a significant impact on the performance and survival of the company.²¹ When another company takes an equity stake in such a small firm, however, two mechanisms weaken that link. First, the owners and stock-owning employees of the smaller firm give up a certain portion of their rights to future gains. Consequently, they are less motivated to put in the desired level or quality of effort since they stand to get a smaller proportion of any gains that might be derived from it. Full acquisition can exacerbate the problem: Even if stock ownership in their own company is replaced with stock ownership in the larger organization, the link between individual effort and stock price is likely to be much weaker in the merged organization than in the original, smaller firm. Second, even non-stock-owning employees can suffer lower incentives because the linkage between their effort and firm performance will be much weaker once they are a part of a larger firm. Even if a salary is the only means of compensation, the continuation of the salary now depends on the success or failure of a much larger organization, and the employees’ own efforts have a much smaller impact upon this. The adverse consequences due to diluted incentives described above are popularly referred to as agency costs in the academic literature.²²

Acquisitions of entrepreneurial technology-based firms by larger firms offer a good illustration of these tradeoffs. When large companies like Intel or Pfizer acquire full equity ownership in some small technology firm, they sometimes find these motivation or agency costs to be quite significant. Since the capabilities of the smaller partner are essentially embedded in its engineers and scientists, and a substantial portion of their pay comes from stock options, weaker incentives lower the motivation of these individuals and consequently damage the capacity for innovation of the smaller firm. In such a situation, the

larger firm sometimes needs to reconsider its decision to go for full ownership and instead settle for a lower equity stake.²³

Another cost associated with equity ownership is the decreased employee motivation due to lost autonomy. A company gets the right to direct the actions of its partner's employees when it takes an equity stake in the partner. Roughly speaking, the greater the equity ownership, the stronger the right to direct the partner. For instance, a minority equity position allows for board representation, which is a weak form of control over the strategic direction of the partner firm. Full ownership, on the other hand, allows for much greater control and consequently the ability to implement even a major strategic redirection. Increase in control for the partner taking the equity ownership position, however, corresponds to a proportionate decrease in control for the other partner. As a result, both owners and employees of the latter partner have less autonomy to guide the future course of their actions and to decide how and where to put their effort. This loss of autonomy in terms of where to allocate their effort (as opposed to the agency problem, which deals with how much effort to put in) may result in lower motivation and reduced effort.²⁴ In contrast to the agency problem, which refers to lowered extrinsic motivation due to weaker incentives, the loss of autonomy problem is one of lowered intrinsic motivation. Unlike the agency cost problem, the loss of autonomy problem is relevant in all kinds of technology-sourcing relationships, including those between established firms.

When Microsoft acquired Vermeer in 1996, it required most of Vermeer's employees to move from Boston to Microsoft's campus in Redmond, Washington.²⁵ This was partly done to facilitate Microsoft's ability to direct Vermeer's future technology development efforts. Many of Vermeer's developers, however, were somewhat dissatisfied with Microsoft's project management style, perceiving it as much more rigid than that which they were used to in a start-up. Although most Vermeer employees continued to work on FrontPage, many clearly experienced some loss of autonomy because of the enforcement of Microsoft's software development process and a different set of priorities. Also, many Vermeer engineers were keener to work on improving their existing product rather than to make it interoperable with Microsoft Office products. Charles Ferguson, one of the co-founders of Vermeer, left almost immediately. Two other senior managers also left soon thereafter. Clearly, the loss of autonomy resulting from Microsoft's acquisition of Vermeer had some adverse consequences.

While equity ownership alone may create motivational problems and costs, the problems can become severe if equity ownership is accompanied by proportionately high levels of organizational integration. In principle, firms can minimize incentive dilution problems even after acquiring their partners by providing significant organizational autonomy—setting up appropriate performance measures and compensation systems that preserve the strong link between effort and reward. Therefore, the extent to which partners remain organizationally autonomous, or become organizationally integrated, is critical. For instance, acquirers might continue to operate target firms as autonomous divisions with their own P&L responsibility, which would correspond to a situation with low

organizational integration, low incentive dilution, and limited loss of autonomy. In contrast, if they completely absorb acquired firms into existing organizational units—i.e., engage in high organizational integration—it might create incentive dilution and loss of autonomy. Incentive dilution may also occur at lower levels of ownership, such as in alliances or joint ventures, if organizational integration measures weaken incentives. For comparable levels of equity ownership, the motivational costs will be stronger when there is a greater degree of organizational integration between partners, which adversely affects the incentives and autonomy of decision making. Organizational integration decisions must therefore balance a tradeoff, since integration creates benefits of coordination and control between partners, but also implies significant motivation costs.

In summary, when managers explore the possibility of taking an equity stake in their technology partner, they need to clearly assess the resultant motivational costs that might arise due to diluted incentives and loss of autonomy, in addition to the process costs of implementing the relationship. Lower levels of equity are indicated when these motivational costs are expected to be severe.

Technological and Market Uncertainty and Commitment Costs

Viewing equity stakes as “real options” provides some very valuable insights into determining the desirable level of equity ownership in technology-sourcing relationships. A real (call) option, in simple terms, provides a company the future right (but not the obligation) to increase its level of equity ownership in its technology partners. The real-options perspective helps managers focus on two important issues regarding equity ownership: first, *whether* their company should take any equity ownership at all in their partner; and second, if they do take an equity stake, then what the *right time* would be to change their ownership level from minority to full.

By taking a minority equity position in the partner, a company creates the option to acquire it later. More importantly, this option becomes more valuable as uncertainty about the value of the technology increases. Stated differently, the more the equity ownership at a given point in time, the greater the opportunity cost in terms of foregone option value. This opportunity cost, in turn, increases when there is more uncertainty in the technology concerned. As far as when to change the level of equity ownership, the real-options perspective suggests that a company can actually do so over time (and move from a minority position to full/majority position) as the level of uncertainty associated with the technology is resolved.²⁶

In technology-sourcing relationships, two types of uncertainties are most important: technological uncertainty and market uncertainty. The sourcing firm may not be sure about the true value-creating potential of its partner’s technology and about its competitive superiority from a purely technical standpoint. The technology being sourced may turn out to be a dud—or at least, fail to live up to expectations. In such cases, the sourcing firm could face adverse consequences, especially if it has invested a great deal of resources in acquiring control of this technology. In other cases, although the sourcing firm can fully assess the

technical superiority of the technology or capabilities provided by its partner, there may be uncertainty about the future demand for it. Will customers really accept the product or service being created based on their technology? Will they be willing to pay the right price for it? Will the market be sufficiently large to recoup all the investment made in the technology concerned? For example, when interactive television was first developed by a start-up firm called WebTV, many large TV manufacturers such as Philips and Sony were sure that the technology in question was far superior to the technology available then. However, they were very unclear about whether consumers would accept Web-enabled TVs or be willing to pay for such a service.

When there is a great deal of uncertainty about the superiority and market demand for the technology or capabilities of the technology partner, what level of equity ownership should the sourcing firm take? As noted earlier, if the sourcing firm considers the technology in question to be potentially critical to its business goals, it may want to take at least some equity position in the partner to prevent rivals from gaining access to it. At the same time, taking a majority or full ownership stake may prematurely increase the opportunity cost of commitment for the company; this is especially true if the technology in question fails to live up to its expected technical or market potential. Therefore, in deciding its level of equity ownership the company may need to walk a fine line between retaining its flexibility and realizing any gains on the one side, and minimizing the costs of commitment on the other.

A minority equity stake can provide this balance: It provides the sourcing firm a certain degree of control and exclusivity over the technology but also allows it to monitor the development of the technology and to assess any changes in the associated uncertainty. It also gives the firm enough flexibility to exploit any upside growth that may arise in the future. At the same time, it limits the cost of commitment to the initial funds that are invested for taking the equity position. On the other hand, if the sourcing partner takes full equity ownership under conditions of high technological and market uncertainty, it internalizes all the risk associated with the technology as well as incurs the entire commitment cost of buying 100 percent of its partner's equity. This alternative does not give the sourcing firm any downside protection.

In the WebTV example, given the high level of market uncertainty regarding the commercial acceptance of its new product, Sony and Philips were not keen to take full equity ownership in the company. Philips instead chose to take a minority equity position to minimize its commitment costs. Eventually, when there was greater relative certainty about Web TV's product both from a technical and market acceptance standpoint, Microsoft stepped in and acquired the company.

Managers at Cisco Systems rely on similar logic to distinguish between partners that are acquisition candidates and partners that are suitable only for a minority equity investment. Acquisitions and minority investments are even handled by different groups within its business development area. Targets with potential value but considerable uncertainty surrounding them are assigned to

the minority equity investments group. If their technological progress is satisfactory and the market signals are positive, the acquisitions group steps in. In contrast, Cisco straight away takes full equity ownership in companies that are very close to the product stage (i.e., when there is very little uncertainty). Several of Cisco's targets had at least a first-generation product with a small customer base.

Therefore, when managers engage in technology-sourcing relationships they should undertake as thorough an assessment as possible of the technical and market potential of the concerned technology before deciding how much of an equity stake their company should take in the partner. The greater the uncertainty, the lower the equity stake ought to be initially.

Applying the Framework

There are two distinguishing features to our framework for determining the extent of equity ownership in technology-sourcing relationships. First, in contrast to existing studies that focus mainly on one particular aspect or theory, this framework treats the insights from different studies as complementary rather than competing and recommends including *all* of them to make a more comprehensive and systematic decision on equity ownership. Second, the framework underscores the importance of thinking clearly about and taking into consideration *both* the strategic benefits and costs of equity ownership. In the process, it also highlights a number of criteria that are important in both categories. Each criterion provides a separate rationale and explanation for the mechanisms through which equity ownership leads to either the benefits or the costs concerned (Figure 1).

Table 1 lists some of the questions that managers can ask themselves to identify the importance of a particular criterion. For instance, as far as benefits are concerned, the alignment of interests is likely to be most important when partners need to make specialized investments to benefit from the technology being sourced or accessed; the need for coordination is relevant when R&D personnel in the partner firms need to regularly share knowledge and interact closely; and finally, the benefit of exclusivity matters most if the technology in question is relatively unique and can provide an advantage over rivals. As far as strategic costs are concerned, the opportunity costs of commitment matter significantly in those cases where there is considerable market and technical uncertainty; on the other hand, costs associated with lower motivation are likely to be most important when the partnership is likely to change the work conditions of partner-firm employees significantly in terms of incentives and autonomy. All criteria need to be evaluated before an equity ownership decision is made.

Which benefits are most important in a given situation, and how should managers weigh the relative benefits and costs? To address this issue, managers should first consider the extent of equity suggested by each of the three benefit criteria independently (exclusivity, alignment of incentives, and the need for organizational linkages) and then pick the *highest* level of equity suggested across the three criteria. Thus, if the need for aligning interests and the need for

TABLE I. List of Questions to Determine Level of Equity Ownership

Benefits of Equity Ownership	Key Questions	If the answer is “Yes,” then level of equity should be ...
Exclusivity and Control	Is there a benefit from excluding rivals from this technology in order to gain a competitive advantage?	High
Alignment of Interests	Is there a need for relationship-specific investments by one or both partners that may potentially create a hold-up situation?	High
Inter-Organizational Coordination	Is there a need for extensive knowledge sharing and coordination between engineers/scientists in the partner firms?	High
	Is the technology evolving rapidly?	High
Costs of Equity Ownership		
Market Uncertainty	Is there significant uncertainty regarding the market potential for the technology?	Low
Technological Uncertainty	Is there significant uncertainty regarding the viability of the technology?	Low
Motivation	Is employee motivation in the partner firm likely to drop as a consequence of changed work conditions (e.g., incentives, nature of work) after implementing the partnership?	Low

achieving coordination both seem moderate but the exclusivity criteria indicate full ownership, then managers should choose full ownership. This approach clarifies and emphasizes what the primary motivation for taking the equity stake is. This is very important in managing the partnership as well as in evaluating its success. Similarly, managers should consider the equity levels suggested by the cost criteria (motivation and uncertainty) and pick the *lower* level of equity indicated. For instance, if motivation problems appear to be relatively unimportant, but uncertainty about the value of the partner is significant, then managers should choose low levels of ownership.

When the benefit and cost criteria lead to similar conclusions, there is little difficulty in choosing the level of equity. More complicated situations arise, however, when the benefit and cost criteria point to different levels of equity. For instance, consider a situation in which significant coordination is required between partner firms to jointly leverage their capabilities, and the partners also need to make investments in specialized resources or assets. While the benefit criteria might indicate a high level of equity ownership, the situation becomes much more complex if the partner’s employees are likely to suffer from

motivation problems when the partnership is implemented. Unfortunately, there are no clear-cut answers in such situations. A solution might involve taking a level of equity between the levels suggested by the benefit and cost criteria. Joint ventures arguably represent finely balanced strategic benefits and costs in technology-sourcing relationships (Appendix 1). Some companies have created innovative solutions to minimize motivational problems arising with increasing equity ownership. Cisco Systems' decentralized structure, along with its extensive use of stock options and bonuses tied to business-unit performance, allowed it to provide acquired companies a fair degree of autonomy and strong incentives. Finally, when the benefit and cost criteria point in completely opposite directions, managers can also interpret it as a warning that the partnership may not be worth entering into.

How Do Decision Makers Weight the Criteria? A Policy-Capturing Exercise

Existing studies on equity ownership decisions typically provide a theoretical explanation of why one might see a particular level of equity ownership in companies based on a single, sharply defined criterion, such as the extent of relation-specific investment, technological uncertainty, the need for coordination, or the potential competitive advantage accruing from exclusive control of a partner's resources. Studies that consider multiple criteria simultaneously in an integrative fashion are limited, and we know little about how decision makers actually incorporate these different criteria when faced with equity ownership choices. To address this limitation, we used a policy-capturing technique to understand the criteria individuals actually use in making decisions about equity ownership levels in technology-sourcing relationships. In this methodology, we presented decision makers with a series of situations that are experimentally designed by manipulating the levels of the various criteria that might be important in a given context. After reviewing each scenario, decision makers provided their judgments regarding the equity ownership level they would choose in each case. The manner in which they weight and combine the various criteria can be inferred by studying the statistical relationships between each individual criterion and their decision. This approach, therefore, helped test and validate the relevance and relative importance of each criterion as used by actual decision makers.

The decision criteria were essentially the benefits and costs that we highlighted in our framework for making equity ownership decisions. We created a hypothetical example of company A seeking to access technology from company B through a partnership and created various scenarios by randomly manipulating the decision criteria. For each partnering situation, individuals were then asked to decide which of the following equity ownership levels they would choose: a contractual partnership with no equity ownership; a minority equity ownership; a majority (more than 50% but less than 100%) ownership; full acquisition through 100% equity ownership of the partner (but with

autonomous operation); or 100% equity ownership along with complete integration of the partner.

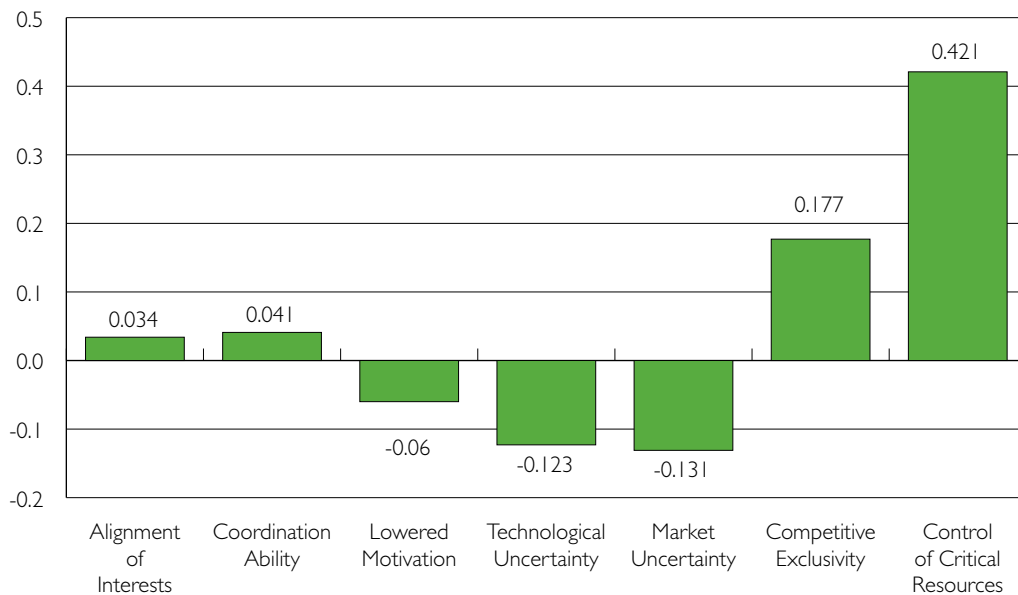
A group of 130 practicing managers and MBA students took part in this exercise. Each person considered 30 partnership scenarios that we had created and provided their decisions regarding equity ownership for each case. The respondents came from two groups. The first set of respondents consisted of 60 full-time working executives and managers from companies in a variety of industries such as pharmaceuticals, chemicals, computer hardware and software, telecom and engineering; extant research shows that technology-sourcing relationships are extremely important in these industries. The average sales revenue of these companies was \$7.8 billion for the year 2001. Each respondent was responsible for partnering, business development, or corporate development activities for his/her firm. A majority of them (75%) held positions such as Director/Vice-President Strategic Alliances, Director/Vice-President Corporate Development, Director Partnership Programs, or Director Business Development. The remaining held other senior management positions such as CEO, CFO, or R&D Head. Eighteen respondents were enrolled in a program on Alliances and Acquisitions in a top business school in the U.S. and the remaining 42 were from a random sample of 80 companies to whom we had sent out the survey instrument.

The second group of respondents consisted of 70 second-year MBA students enrolled in courses on Corporate Venturing and Strategic Alliances at two top business schools, one in the U.S. and one in Asia. These students had an average of five years of work experience before their MBA program and they were enrolled in these courses because they were interested in pursuing full-time careers in corporate development, business development, venture capital investing, investment banking, and consulting. The results did not vary significantly across groups, so we report combined results here. Figures 3 and 4 provide a summary of our analysis.

The chart in Figure 3 shows values that measure the strength of the relationship between each of the decision criteria and individuals' decisions regarding the level of equity ownership. The values reflect how an increase in the level of a particular criterion is linked to the decision to have greater equity ownership in that situation. A negative sign for the value indicates that an increase in the level of that criterion led to lower equity ownership; a positive sign indicates the opposite. The main points to note are:

- Decision criteria reflecting the benefits of equity ownership are positively linked to a higher level of equity ownership. The greater the level of the expected benefit, the greater the level of equity ownership chosen.
- On the other hand, criteria reflecting the costs of equity ownership are negatively linked to the level of equity ownership. The greater the expected costs, the lower the level of equity ownership chosen.
- All the values linking the decision criteria with the decision on equity ownership level are statistically significant. Therefore, collectively we see that individuals consider both benefits and costs of equity ownership

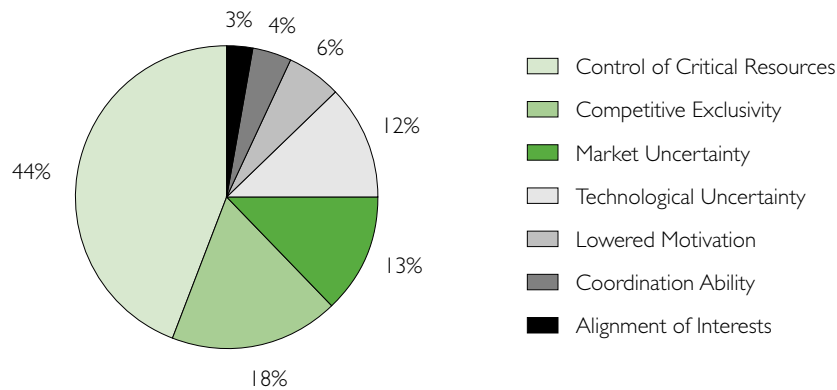
FIGURE 3. Equity Ownership and Decision Criteria Strength of the Relationships



when making their decisions, showing that the elements in our integrative framework do play an important role in managerial decision making about equity ownership levels in technology-sourcing relationships.

Figure 4 shows the relative importance placed by individuals on each criterion. The percentage value for each criterion reflects its relative weight in the entire set of factors. While making decisions on increasing equity ownership, individuals seem to place more emphasis on the strategic criticality of the technology or resource in question (44%) and the need to have exclusivity and control with respect to it (18%). In contrast, they place relatively less importance on the benefits of the alignment of incentives (3%) and better coordination offered by greater equity ownership (4%).²⁷ As far as costs are concerned, they place greater emphasis on the commitment costs associated with market uncertainty (13%) and technological uncertainty (12%) as compared to the costs of lowered motivation (6%). Overall, they seem to place more weight on the benefits of equity ownership (69%) than on the costs (35%). This suggests that although a priori there may be no reason to always deem some criteria more important than others, managers appear to weight some criteria more than others. One interpretation of the results is that decision makers are systematically biased toward placing undue importance on exclusivity criteria at the expense of other factors. We reiterate that there is no reason to favor one criterion over another; an examination of the specific context alone can determine whether the benefits of exclusivity are more important than those of coordination or interest

FIGURE 4. Relative Importance of Decision Criteria



alignment, and whether they are large enough to compensate for the costs of lost motivation or commitment to an uncertain course of action.

Conclusion

Although there has been an enormous increase in technology partnership formation, managers lack a comprehensive framework to guide them in making equity ownership choices that are based on a balanced examination of the associated costs and benefits. The research-based framework presented here combines insights from multiple perspectives to provide an integrated decision tool that highlights both the benefits and costs associated with owning equity in such partnerships.

APPENDIX Joint Ventures

The typical technology-sourcing partnership involves one firm taking an equity stake in another, as Firm A does in Figure A1. (Note that Firm B could also simultaneously consider taking an equity stake in A, guided by the same criteria). Unlike such partnerships, joint ventures (JVs) involve the creation of a distinct organizational entity in which both parties may own equity (see Figure A2). JVs provide a unique balance between strategic costs and benefits in technology-sourcing relationships. While providing the benefits of exclusivity, coordination, and interest alignment, they mitigate the motivational problems or commitment costs that may arise if the partner firm is fully acquired. In fact, as they enjoy a distinct status as a separate legal entity, the exposure to uncertainty is limited for the partner firms. They also provide a mechanism for avoiding significant restructuring costs that would follow an acquisition of a partner

having several assets besides the ones desired. However, the creation of a new corporate entity involves significant set-up costs, and JVs are advisable only when the strategic benefits are significant.

Notes

1. See J. Hagedoorn and R. Osborn, "Interfirm R&D Partnerships: Major Theories and Trends Since 1960," in F.J. Contractor and P. Lorange, eds., *Cooperative Strategies and Alliances* (Boston, MA: Pergamon, 2002).
2. A PriceWaterhouseCoopers report released in 1999 estimated that about 80% of technologically motivated acquisitions in the time period of 1994-1997 had failed to achieve their objectives. Also, see J. Bleeke and D. Ernst, "The Way to Win in Cross-Border Alliances," *Harvard Business Review*, 69/6 (November/December 1991): 127-135; P. Kale, J. Dyer, and H. Singh, "Alliance Capability, Stock Market Response and Long-Term Alliance," *Strategic Management Journal*, 23/8 (August 2002): 747.
3. For some of the main ideas see Y. Doz, "The Evolution of Cooperation in Strategic Alliances," *Strategic Management Journal*, 17, Special Issue (Summer 1996): 55-83.
4. For some of the main perspectives, see G. Pisano, "The R&D Boundaries of the Firm: An Empirical Analysis," *Administrative Science Quarterly*, 35/1 (March 1990): 153-176; R. Gulati and H. Singh, "The Architecture of Cooperation: Managing Coordination Costs and Appropriation Concerns in Strategic Alliances," *Administrative Science Quarterly*, 43/4 (December 1998): 781-814; T. Folta, "Governance and Uncertainty: The Tradeoff between Administrative Control and Commitment," *Strategic Management Journal*, 19/11 (November 1998): 1007-1028; H.K. Steensma and K.G. Corley, "Organizational Context as a Moderator of Theories on Firm Boundaries for Technology Sourcing," *Academy of Management Journal*, 44/2 (April 2001): 271-291.
5. The level of equity stakes also has implications for the reported earnings of the investing partner since different accounting norms have to be followed for different levels of equity holding in partner companies; the reported earnings can vary significantly based on the accounting treatment used. Although it is necessary for managers to fully understand these implications, technology-sourcing relationships, by definition, are not primarily motivated by these accounting benefits. Our interviews with managers are consistent with the viewpoint that firms do not form partnerships and adopt particular designs in them with the primary intention of gaining some benefits (or obviating some costs) due to differential accounting treatment. For this reason, we decided not to focus on this issue while discussing the benefits or costs related to equity ownership in these relationships.
6. Company Law in many countries—such as Britain (Company's Act Sec 378(2), 1985), Canada (CIL Section, 4: 358), and India (Company's Act Section 189)—requires at least a 75% majority to pass any special resolutions related to such things as sale or purchase of major assets or increase in share capital. Thus, if any one shareholder or entity has a greater than 25% equity stake, it effectively enjoys the right to veto such resolutions if necessary. As

FIGURE A1. Design Elements of a Technology Sourcing Partnership

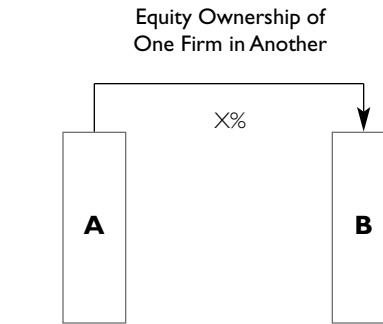
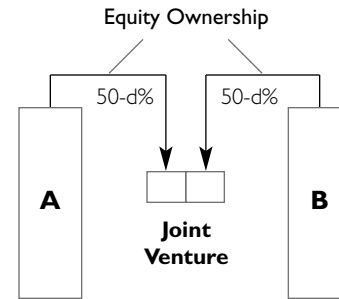


FIGURE A2. Design Elements of a Joint Venture



- a result, companies forming partnerships in such countries often seek greater than 25% equity to enjoy such benefits. In the U.S., however, which does not have a federal-level company law with such stipulations, veto rights linked to equity stakes are usually determined contractually on a case-by-case basis.
7. Jay Barney made one of the first basic statements of the Resource Based View of the Firm. J. Barney, "Firm Resources and Sustained Competitive Advantage," *Journal of Management*, 17/1 (March 1991): 99-120. For subsequent authors who extend this argument to organizational capabilities, see B. Kogut and U. Zander, "Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology," *Organization Science*, 3/3 (August 1992): 383-397; D.J. Teece, G. Pisano, and A. Shuen, "Dynamic Capabilities and Strategic Management," *Strategic Management Journal*, 18/7 (August 1997): 509-133.
 8. For a recent study, see M.A. Schilling and H.K. Steensma, "Disentangling the Theories of Firm Boundaries: A Path Model and Empirical Test," *Organization Science*, 13/4 (July/August 2002): 387-401.
 9. Some of these facts are drawn from Ashish Nanda and Georgia Levenson, "Vermeer Technologies (C): Negotiating the Future," Harvard Business School Case #9-397-081, 1997.
 10. See O.E. Williamson, *The Economic Institutions of Capitalism* (New York, NY: Free Press, 1975); B. Klein, R.G. Crawford, A. Alchian, "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process," *Journal of Law and Economics*, 21/2 (October 1978): 297-326.
 11. See Pisano, op. cit.; Gulati and Singh, op. cit.
 12. M. Tushman and M. Nadler, *Competing by Design: The Power of Organizational Architecture* (New York, NY: Oxford University Press, 1997).
 13. A. Van de Ven and W. Joyce, *Perspectives on Organization Design and Behavior* (New York, NY: Wiley 1981).
 14. Tushman and Nadler, op. cit.; P. Puranam and H. Singh, "Technological Coordination and Internal Firm Boundaries: The Case of Technology Grafting Acquisitions," London Business School.
 15. Gulati and Singh, op. cit.
 16. For example, R&D collaborations and minority equity investments may both involve similar extents of equity participation. However, they may differ very much in the nature of organizational integration mechanisms that connect the two firms. See Folta, op. cit., for these arguments. Similarly, all acquisitions involve complete ownership, but they may differ considerably in terms of the organizational integration that takes place between the acquirer and target after acquisition; see A. Pablo, "Determinants of Acquisition Integration Level: A Decision-Making Perspective," *Academy of Management Journal*, 37/4 (August 1994): 803-836.
 17. This section draws on some data from the H.W. Chesbrough and D. Lane, "Intel Capital: The Berkeley Networks Investment," Harvard Business School Case #9-600-069, 2000.
 18. P. Puranam, "Grafting Innovation: The Acquisition of Entrepreneurial Firms by Established Firms," published dissertation, University of Pennsylvania, 2001.
 19. It is also possible that shaping the trajectory of development of the technologies to suit Cisco would create specific investments and the danger of hold-up, thus creating another incentive to acquire.
 20. See J. Reur and M. Koza on the problem of digestibility of partner firm's assets as a factor in choosing between joint ventures and complete ownership of foreign subsidiaries. J.J. Reuer and M.P. Koza, "On Lemons and Indigestibility: Resource Assembly through Joint Ventures," *Strategic Management Journal*, 21/2 (February 2000): 195; J.J. Reuer and M.P. Koza, "Asymmetric Information and Joint Venture Performance: Theory and Evidence," *Strategic Management Journal*, 21/1 (January 2000): 81
 21. T. Zenger and M. Marshall, "Group Based Plans: An Empirical Test of the Relationship between Size, Incentive Intensity and Performance," AOM Best Paper Proceedings, 1997.
 22. Williamson, op. cit.; S. Grossman and O. Hart, "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy*, 94/4 (August 1986): pp. 691-719.
 23. Some cases in which such considerations motivate equity partnership rather than full acquisition have been documented by Y. Doz, "Technology Partnerships between Larger and Smaller Firms: Some Critical Issues," in F.J. Contractor and P. Lorange, eds., *Cooperative Strategies in International Business* (Boston, MA: Pergamon, 2002).

24. The seminal reference for the impact of job autonomy on employee motivation is J. Hackman and P. Oldham, "Development of the Job Diagnostic Survey," *Journal of Applied Psychology*, 60/2 (April 1975): 159-170.
25. A. Nanda and T. Mahmood, "Vermeer Technologies (A): A Company is Born," Harvard Business School Case # 9-397-078, 1997.
26. See Folta, op. cit.; T. Folta and K. Miller, "Real Options in Equity Partnerships," *Strategic Management Journal*, 23/1 (January 2002): 77.
27. There was a slight difference in the relative weight given to these criteria by the two groups. While the student group gave it a weight of about 2.8%, the managers' group gave it a relative weight of almost 6%. There were no significant differences in the weights given to the remaining criteria by the two groups.

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