REPORT TO THE GOVERNMENT-UNIVERSITY-INDUSTRY RESEARCH ROUNDTABLE

HERE OR THERE ?

A SURVEY OF FACTORS IN MULTINATIONAL R&D LOCATION

JERRY THURSBY AND MARIE THURSBY

NATIONAL ACADEMY OF SCIENCES,
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and

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Preface and Acknowledgments

The Government-University-Industry Research Roundtable (GUIRR) of the National Academies has a long-standing interest in the globalization of science and engineering and the implications of globalization for the U.S. research enterprise. Since 2002, a GUIRR working group led by Harold H. Schmitz of Mars, Inc., and Robert L. Powell of the University of California at Davis has explored the trend of multinational corporations (MNCs) based in the United States and other developed countries launching research and development (R&D) facilities in emerging economies, primarily in Asia. To further inform its discussions, GUIRR asked Professor Jerry Thursby of Emory University and Professor Marie Thursby of the Georgia Institute of Technology to conduct a survey of MNCs to find out where they are planning to locate R&D facilities in the near future and the factors influencing those location decisions. Jerry and Marie Thursby are presenting their findings as a report to the Roundtable. The statements made in this paper are those of the authors and do not necessarily represent positions of the Roundtable or the National Academies.

This project was conducted with generous support from the Ewing Marion Kauffman Foundation, as well as the industry partners of GUIRR, the Georgia Institute of Technology, and Emory University. Numerous individuals have aided in the design and implementation of this survey, but the authors are particularly indebted to Merrilea Mayo of GUIRR, Ross Armbrecht, former president of the Industrial Research Institute, Andrew Dearing of the European Industrial Research Management Association,

Harold Schmitz of Mars, Inc., Jean-Lou Chameau of the Georgia Institute of Technology, Tim Ryan of GFK Custom Research, Inc., Peter Kelly of the American Chemical Society, and Paul Roman and the staff of the Center for Research on Behavioral and Human Services Delivery of the University of Georgia.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Academies' Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the authors in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

We wish to thank the following individuals for their review of this report: Lee Branstetter, Columbia University; Susan Butts, The Dow Chemical Company; Michael Storper, University of California, Los Angeles; and John Walsh, University of Illinois at Chicago. Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the content of the report, nor did they see the final draft of the report before its release. The review of this report was overseen by Robert Frosch, Harvard University. Appointed by the National Academies, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authors and the institution.

Marye Anne Fox
Co-Chair, GUIRR

Lydia Thomas
Co-Chair, GUIRR

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Executive Summary

This document presents results from a survey of over 200 multinational companies across 15 industries regarding the factors that influence decisions on where to conduct research and development (R&D). The survey was originally proposed by the Government-University-Industry Research Roundtable (GUIRR) of the U.S. National Academies out of a concern that policy discussions be informed by data rather than anecdote.

Respondents to the survey were high-level R&D personnel of companies who had been involved with R&D location decisions. The majority of companies responding have home offices in the United States or Western Europe. Most are also truly multinational, with almost 90 percent having some R&D facilities outside the home country. For roughly 20 percent of the companies, more than half of their technical employees in R&D are outside the home country.

In asking about location, questions were in terms of employees rather than dollar investment. Further, the questions on the types of R&D these employees conduct, as well as factors in choosing location, were tied to specific R&D facilities the company had established or was in the process of establishing. Finally, respondents were asked first about a site outside the home country and then about a site within the home country. In each case respondents were instructed to pick the site most central to their firm's R&D strategy; thus, results are most relevant to important sites rather than necessarily to all sites.

The results are striking in several ways. First, the decision to locate R&D is quite complex and influenced by a variety of factors. Second, they show that regardless of where companies locate R&D, four factors stand out: output market potential, quality of R&D personnel, university collaboration, and intellectual property protection. How these factors influenced decisions, however, varied depending on whether sites were in developed or emerging economies.

For companies locating in emerging economies, the most important attraction was the growth potential in the market followed by the quality of R&D personnel. Tied for the third most important reason were costs (net of tax breaks), the expertise of university faculty, and the ease of collaborating with universities. For these economies, the quality of intellectual property protection was a detractor.

When companies located R&D facilities either at home or in another developed economy, the most important factors were the quality of R&D personnel and the quality of intellectual property protection. Next in importance were the expertise of university faculty and the ease of collaborating with universities. Also important were market factors such as growth potential and the need to support sales of the company.

Thus output and input market factors, as well as the intellectual property infrastructure, are all paramount. A critical point on R&D input factors is that the most important factor is the quality of the inputs. The implication of this is that although cost, net of tax breaks, is high in developed countries, these economies can still have a comparative advantage in R&D because of the quality of personnel, particularly given the intellectual property environment.

Other striking results concern the ways in which companies protect and capitalize on intellectual property as well as the types of R&D they conduct in various locations. Respondents stated that over 45 percent of the effort in the home or developed economy sites is for new science, whereas roughly 22 percent of the effort in emerging countries is for new science.

One of the most novel results to come out of the survey is the important role of universities in the global innovation system. Note that university factors are as important as costs in emerging economies and more important in developed economies.

Finally, it is important to note that over 75 percent of the respondents

said the R&D facility under discussion was part of an expansion in R&D. Less than 30 percent of the sites were characterized as relocation. In addition, there was more relocation within the home country than toward other countries.[1]

[1]Note that these results cover only the facilities discussed. If facilities not discussed had different characteristics and constituted a high proportion of the total for the sample companies, this would alter the results.

Introduction

The idea that the United States dominates cutting-edge science and technology is under attack as a result of a declining U.S. share of patents and scientific awards and media reports of increasing corporate reliance on offshore research and development (R&D). A search of the archives of the *Wall Street Journal* and the *New York Times* over the period 2002–2005 showed 61 articles focused on the offshoring of R&D. Thirty-eight of these articles mentioned costs as a factor in the decision to offshore R&D, and 29 noted the quality of R&D personnel as a factor. No other factors were mentioned as prominently as costs and the quality of R&D personnel. Only 10 articles noted the role of output markets, and only 4 mentioned intellectual property regimes. Three discussed the role of universities in the process.

R&D globalization has also taken center stage in policy circles as questions are raised as to how the United States and Western Europe can provide environments conducive to innovation.[1] Over a concern that policy discussions be informed by data, rather than case studies or anecdote, the

[1]See, for example, the Council on Competitiveness (2004), *Innovate America: Thriving in a World of Challenges and Change* (Washington, DC), and the Committee on Science, Engineering, and Public Policy (2006), *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, DC: The National Academies Press).

Government-University-Industry Research Roundtable (GUIRR) of the National Academies asked the authors to undertake a survey of the factors behind R&D site location, with particular attention paid to the decision to locate in the home country versus other countries.

The survey instrument was developed after extensive consultation with representatives of GUIRR, the Industrial Research Institute (IRI), the European Industrial Research Management Association (EIRMA), and the American Chemical Society. In-depth discussions were held with industry R&D managers from 11 companies based in the United States and Europe as well as representatives of the Organization for Economic Cooperation and Development, the European Commission, and the Swedish Institute for Growth Policy Studies. These discussions probed a variety of issues related to R&D strategy and factors, both internal and external to the firm, that were considered in deliberations on placement of R&D facilities, as well as the mechanisms used to protect and capitalize on intellectual property created in sites at home and elsewhere. Detailed comments were solicited on a series of draft survey documents. In April 2005, the survey document was transcribed to the web-based survey software of SurveyMonkey. Survey beta tests were conducted in late April and early May. Survey responses were obtained beginning in late May 2005. The appendix provides information on the potential pool of respondents, response rate, and information on the statistical tests reported in the text.

General Background

Two hundred and fifty respondents answered some questions. Not all respondents are appropriate for all questions (see below). Of the 250, 109 (43.6 percent) gave the United States as the home country, 122 (48.8 percent) gave a country in Western Europe, and 19 (7.6 percent) gave another country as the home country.[1] Throughout this report, the term "U.S. firm" refers to a respondent noting the United States as the home country and "Western European firm" refers to a respondent noting a country in Western Europe as the home country.

The respondents represent a variety of industries, with the largest industry being chemicals with 22.9 percent of the respondents. This is due, in part, to the prevalence of chemical firms in IRI and EIRMA. Not surprisingly, many respondents noted more than one industry so that there are 280 industry classifications noted by respondents. Industry classifications are given below (an "other" category was provided), and the percentage of respondents by industry is given in Figure 1. In the analysis that follows, results are not broken down by industry, in part because there are too few responses from many of the individual industries to make a detailed comparison statistically meaningful. Nonetheless, subject to data limitations, future research will address industry differences.

[1]The home country was not always obvious. When there was doubt, respondents were instructed to give as their home country the country where the chief technology officer resides.

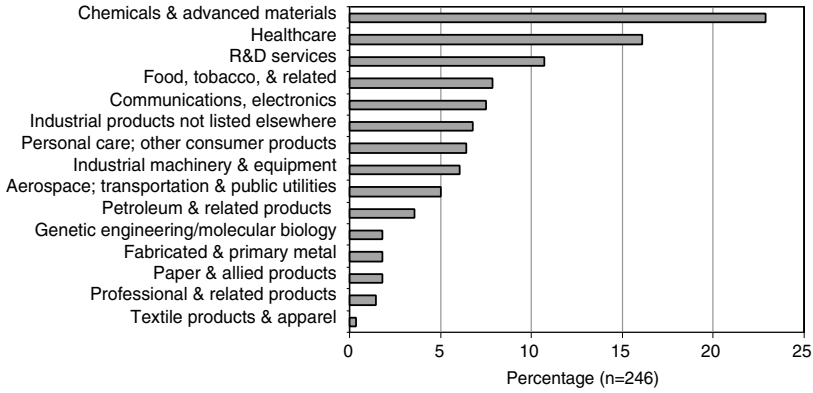

FIGURE 1 Industry of respondents (percentage).

Industrial Classifications

1. Chemicals & advanced materials
2. Healthcare
3. R&D services
4. Communications, electronics
5. Food, tobacco, & related
6. Industrial products not listed elsewhere
7. Personal care; consumer products not listed elsewhere
8. Industrial machinery & equipment
9. Aerospace; transportation & public utilities
10. Petroleum & related products
11. Fabricated & primary metal
12. Genetic engineering/molecular biology
13. Paper & allied products
14. Professional & related products
15. Textile products & apparel

Questions regarding the distribution of R&D effort were in terms of employment rather than expenditure. There is general consensus from our interviews with R&D managers that this minimizes error, not only from exchange rate conversion, but also from the ability to answer questions easily. Questions on employment also translate directly into policy issues of interest.

To minimize errors associated with cross-industry responses, R&D, technical staff, and production were defined early in the survey. The definitions given were

For the purpose of this survey, we consider research and development, that is, R&D, to encompass the following: 1) R&D that entails new applications of science to develop new technologies, 2) R&D to improve technologies currently used by you, 3) R&D to create new products or services, and 4) R&D to improve existing products or services sold or licensed by you.

Whenever we use the phrase "technical staff" we mean employees who conduct or support R&D. These include researchers, research assistants, lab technicians, and engineers involved in any of these types of R&D.

Whenever we use the word production we mean either manufacturing of a good or provision of a service.

Product means either a good or provision of a service.

Figure 2 gives the distribution of R&D employment between the home country and elsewhere for 246 respondents. It is clear that the majority of the firms in our sample have a substantial presence outside the home coun-

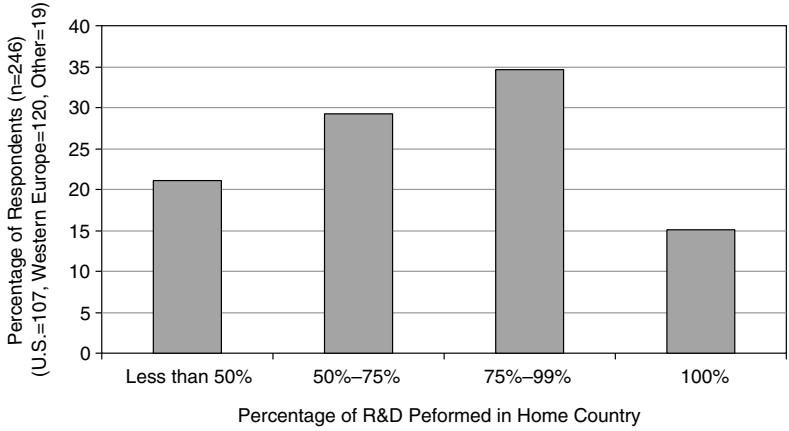

FIGURE 2 Fraction of R&D performed in the home country.

try; only about 15 percent conduct all their R&D in the home country and slightly more than 20 percent conduct less than half of their R&D in the home country. These are truly multinational R&D firms. Interestingly, in a comparison of U.S. versus Western European firms, it is the European firms that are more likely to have a majority of technical workers outside the home country (35 percent versus about 10 percent).

Respondents were asked whether over the next three years they "anticipate that the worldwide distribution of technical staff will change substantially." Two hundred and nine respondents answered this question, with only 37.8 percent indicating that they expected a substantial change. Ninety-seven of the respondents are U.S.-based firms, and 101 are based in Western Europe; there is not a statistically significant difference between the U.S. and Western European responses. For those who indicated that they anticipated a substantial change, there were several follow-up questions about the regions where they anticipated the largest changes:

If any regions will have growth in technical employment, in which regions do you anticipate the largest growth?

If any regions will have a reduction in technical employment, in which regions do you anticipate the largest reduction?

Each question was followed by five choices

United States
Western Europe
Former Soviet bloc countries
China
India
Other

Respondents could choose multiple locations in answering each question. Those who chose the "other" category were asked to indicate the country/region. Figure 3 gives the number of countries/regions identified.

Fifteen respondents plan to increase technical employment in the United States over the next three years, whereas 23 firms anticipate a decrease. Two of the 15 anticipating an increase in U.S. technical employment and 15 of the 23 anticipating a decrease in U.S. technical employment are U.S. firms. To put this in perspective, recall that 209 firms answered this question. Thus, 7.2 percent of the respondents expect an increase in technical employment in the United States, whereas 11 percent

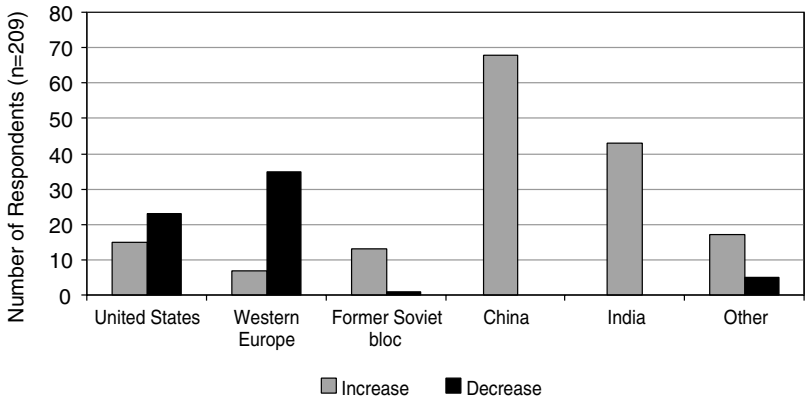

FIGURE 3 Regions/countries where a change is R&D employment is anticipated.

anticipate a decrease in the United States. In contrast, only 3.3 percent (7) firms anticipate an increase in technical employment in Western Europe, whereas 16.7 percent (35) anticipate a decrease. China and India are the main targets for expansion. The "other" category is largely composed of respondents who indicated that the target region would be in Asia.

R&D Location Strategies

The primary objective of the survey was to identify and rank the importance of factors that drive firm decisions on the location of R&D facilities. Questions regarding location decisions began with general questions about the importance of various drivers for the location of R&D. These questions did not refer to the location of particular facilities. Specifically, respondents were asked

Strategically, how important are each of the following drivers for the geographical location of your firm's R&D? Use a scale of 1 to 5 where 5 is very important and 1 is not important at all.

The following seven statements were presented (shorthand notation for each is given in parentheses):

1. *Sponsored research at universities or research institutes. (SponUniv)*
2. *Research collaborations with other firms. (CollabFirm)*
3. *Internet based searches for solutions to technical problems.*[1] *(Internet)*

[1]The role of this factor was investigated because in up-front interviews with industry R&D managers, several indicated the importance of Internet companies that specialize in finding R&D solutions for firms. A number of these Internet companies are, in fact, spin-offs and/or alliances formed by multinationals. The system basically works as follows: A firm seeking a solution to some problem sends the problem to one of these Internet companies,

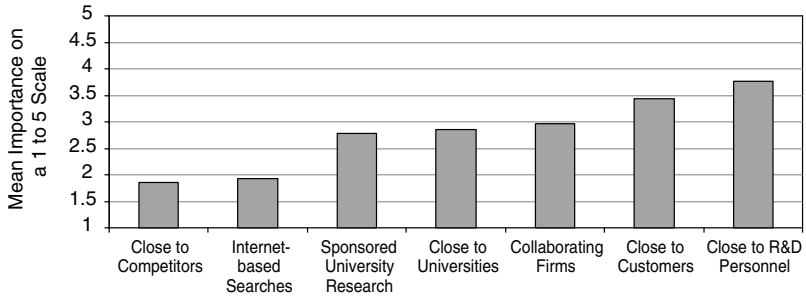

FIGURE 4 Drivers of R&D location strategy.

4. *Locating close to universities. (CloseUniv)*
5. *Locating close to highly qualified R&D personnel. (CloseR&D)*
6. *Locating close to competitors. (CloseComp)*
7. *Locating close to customers. (CloseCust)*

The only statistically significant difference between U.S. and Western European firms (5-percent level) is in the importance of locating close to universities. Western European firms rate this as more important than do U.S. firms, though the mean scores are close (2.99 versus 2.65).

Because the importance of these factors does not vary significantly across regions (with the exception noted above), all regions are combined (including those outside the United States and Western Europe) in Figure 4. In tests for significant differences (1-percent level), there are four groupings: (1) Least important are Internet searches and locating close to competitors; these are not significantly different. (2) Research collaborations—whether through sponsored research, collaborations with other firms, or being close to universities—are next in importance. These are not significantly different from one another. (3) Locating close to customers is next in importance and significantly different from all other drivers. (4) Finally, of greatest importance—and significantly different from all other drivers—is being close to highly qualified R&D personnel.

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which then openly advertises the problem so that the available talent pool for solutions is worldwide. The Internet company acts as a broker between firms seeking R&D solutions and R&D researchers.

Location of Recent or Planned R&D Sites

A major goal of the survey was to determine the relative importance of factors in deciding where to place R&D facilities and how the importance of these factors depends on whether facilities are inside or outside the home country.

To minimize noise in the data, the survey did not pose questions about respondents' general perceptions of the pros and cons of locating R&D facilities in the home country versus possible locations elsewhere.[1] Rather, respondents were asked if they could think of an R&D facility *outside* the home country that was either recently established or is in a planning phase. If such a facility did not come to mind, then no further questions were asked about factors for facilities outside the home country. Focusing on actual decisions, in principle, minimizes the probability that respondents answer what they believe "should" influence decisions. The specific phrase was as follows:

Think about some of the more recent R&D facilities established by your firm. This can include facilities you are in the process of building or staffing or

[1]For notable examples of the alternative approach, see the Economist Intelligence Unit (2004), *Scattering the Seeds of Invention: The Globalisation of Research and Development,* White Paper (London), and the Council on Competitiveness (2005), *National Innovation Survey* (Washington, DC).

which are only in the planning phase. Choose one of these that is OUTSIDE the home country and that is both considered to be central to your firm's current R&D strategy and about which you are familiar.

Does such a facility come to mind?

A "yes" response was followed by a series of questions about that facility; these questions were skipped if the response was "no." The above was repeated substituting "INSIDE the home country" for "OUTSIDE the home country."

Those respondents familiar with a recent or planned facility were asked about the destination country, the year the facility was established (or expected to be established), and the number (or expected number) of technical employees. Table 1, Part A gives the distribution of facilities by destination and by home country of all respondents. The left-most column is the home country or region of the respondent. The remaining columns give the destination. For example, 19 U.S. respondents identified a recent or planned facility in Western Europe. Note that only four firms responding

TABLE 1 Location of Recent or Planned Facilities

Part A. Number and Destination of Facilities *Outside* the Home Country

	Destination					
Home Country	United States	Western Europe	China	India	Other	Row Total
United States	0	19	30	9	13	71
Western Europe	14	10	23	9	12	68
Other	0	0	2	0	2	4
Column Total	14	29	55	18	27	143

Part B. Number of Facilities *Inside* the Home Country

Home Country	
United States	34
Western Europe	51
Other	7
Column Total	92

to this question listed their home country as outside the United States and Western Europe. Part B of Table 1 gives the number of respondents by home country who were able to identify a recent or planned facility in the home country. There is a mix across U.S. and Western European firms and a mix of sites in developed economies and in developing or emerging economies. Note that these responses are not for all recent or planned sites; they are only for the sites that respondents were familiar with and which they considered central to their overall R&D strategy.

From Figure 3 it is clear that over the near future there will be expansion of R&D into emerging economies with some contraction in developed economies. It is interesting to note that when asked for recent or planned facilities that are *central* to the firm's current R&D strategy, respondents responded about more facilities at home or in another developed economy than they did about facilities in an emerging economy. Also, U.S. respondents were more likely to respond about a site in Western Europe than in India, and Western European respondents were more likely to respond about a site in the United States than in India.

Respondents were asked for the number of technical employees employed or expected to be employed in the facilities about which they were responding. They were also asked for the number of technical employees employed worldwide. Together these pieces of information provide a picture of the importance, in terms of employment, of these facilities. Table 2 provides the means and medians for employment worldwide for respondents as well as for sites identified inside and outside the home country.

Facility employment is highly skewed. A majority (58.2 percent) of new or planned facilities outside the home country have fewer than 50 employees, and 72.3 percent have fewer than 100 employees. For new or planned facilities inside the home country, 44.7 percent have 50 or fewer technical employees, and 60.6 percent have fewer than 100 employees.

TABLE 2 Mean and Median Size of R&D Facilities (Number of Technical Employees)

	Mean	Median
Worldwide	3788	700
Outside/Emerging	205	50
Outside/Developed	127	44.5
Inside	219	90

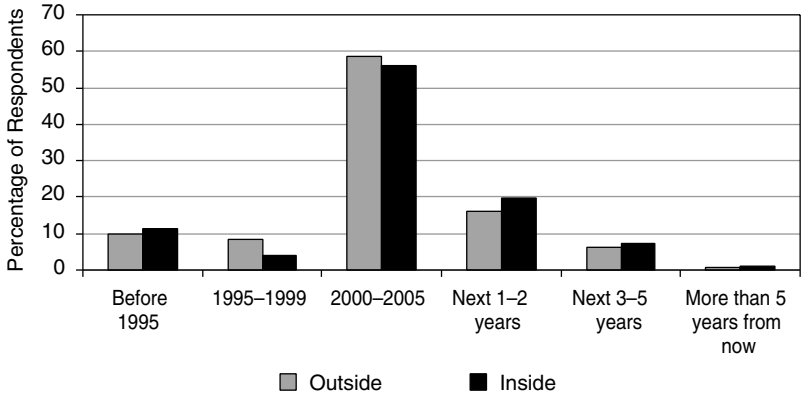

FIGURE 5 Relative frequency of site dates.

For each facility (whether inside or outside the home country) respondents were asked for the year established or, if it is a planned facility, for the expected time before the facility would become operational. Figure 5 gives the relative frequency distribution for inside and outside sites. There is not a statistically significant difference between sites that are inside and sites that are outside the home country. By far the most common answer is for sites established in the past few years.

Next, respondents were asked whether the site characteristics found in Box 1 were correct for this facility.

Figure 6 presents results on the questions for all respondents according

BOX 1 General Site Characteristics

1. This was part of an overall expansion of my firm's R&D effort. (Expand)
2. This was an acquisition of an existing R&D site. (Acquire)
3. This was to establish or support research relationships with other firms. (SupResFirm)
4. This was to establish or support research relationships with local universities or research institutes. (SupResUniv)
5. This was to support needs of existing production facilities. (SupProd'n)
6. This was a relocation of my firm's R&D effort. (Relocate)

to whether the site is in the home country, another developed economy (DEV), or a developing or emerging economy (EMG). In comparing responses by characteristic and across sites, there are few significant differences. A site in another developed economy is more likely to be an acquisition than is a site in an emerging economy (5-percent level). More interesting is the significantly higher percentage (5-percent level) of respondents for emerging economy sites who indicated that the site was to support research relationships with local universities or research institutes. This result likely follows from the fact that these companies have already established extensive research networks with universities in developed economies (home or otherwise), but they are in the process of developing those networks in emerging economies. Finally, note that the most likely characteristic is that the R&D site is an expansion. In contrast, it is very unlikely that the site is a relocation of R&D activity.

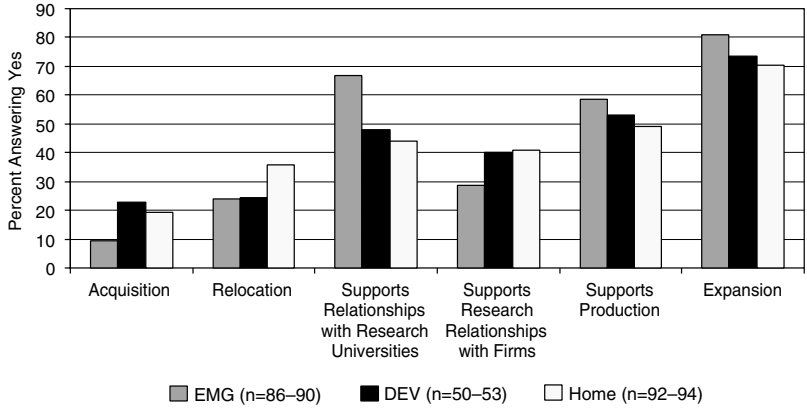

FIGURE 6 General site characteristics.

Statistical Tests for Figure 6 (5-percent level):

Emerging economies	***Developed economies***	***Home***
NeedsProd=SupResUniv	*Expand=NeedsProd*	*NeedsProd=SupResUniv=SupResFirm=Relocate*
SupResFirm=Relocate	*NeedsProd=SupResUniv=SupResFirm*	
	SupResFirm=Relocate=Acquire	
	SupResFirm=Acquire=SupResUniv	

Factors in the Selection of R&D Sites

Respondents were asked two questions about each of a set of factors that might or might not have been relevant in selection of the site. First, respondents were asked whether they agreed or disagreed with a statement about a factor that might have led them to locate in the country. They were then asked how important or central the factor was in the deliberations on whether to locate in the country.

We want to know the factors that you considered in locating R&D in this country. First, we will ask if you agree or disagree with a statement about this location as it affects your firm. We use a 5-point scale where 5 indicates that you strongly agree and 1 indicates that you strongly disagree. 3 will indicate that you neither agree nor disagree. Second, we will ask how important or central the factor was in deliberations on whether to locate in this country. Use a scale of 1 to 5 where 5 is very important and 1 is not important at all.

The following statements were provided (Box 2). In parentheses after each statement is the shorthand notation for the factor.

This exercise was first carried out for sites outside the home country, then it was repeated for sites identified inside the home country, with the exception that factors 10–13 were not considered for home facilities. This was done because of the belief that these factors were less crucial for sites in the home country. In an effort to keep the survey short, they were deleted from the questions on sites at home.

BOX 2 Factors in Selection of Site

1. There are highly qualified R&D personnel in this country. (QualR&D)
2. There are university faculty with special scientific or engineering expertise in this country. (UnivFac)
3. We were offered tax breaks and/or direct government assistance. (TaxBreaks)
4. In this country it is easy to negotiate ownership of intellectual property from research relationships. (Ownership)
5. Exclusive of tax breaks and direct government assistance, the costs of R&D are low in this country. (Costs)
6. The cultural and regulatory environment in this country is conducive to spinning off or spinning in new businesses. (Spin)
7. It is easy to collaborate with universities in this country. (CollabUniv)
8. There is good protection of intellectual property in this country. (IPProtect)
9. There are few regulatory and/or research restrictions in this country. (FewRestrict)
10. The R&D facility was established to support sales to foreign customers. (SupSales)
11. This country has high growth potential. (Growth)
12. The R&D facility was established to support production for export to other countries. (SupExport)
13. The establishment of an R&D facility was a regulatory or legal prerequisite for access to the local market. (LegalReg)

Note that each statement was worded so that agreement implies that the factor is favorable, from the standpoint of the firm, for the location.

The data generated by this procedure allow a variety of comparisons regarding the factors that influence location. Factors can be compared for sites in the home country versus sites outside the home country. Sites outside the home country and in a developed economy can be compared to sites in a developing or emerging economy. Another stratification of interest is between the responses of U.S.-based firms versus those firms whose home country is in Western Europe. With the exception of a few factors, however, U.S. and Western European firms did not differ in their responses

regarding sites outside the home country. The data for U.S. and Western European firms are combined.

RESULTS FOR SITES OUTSIDE THE HOME COUNTRY: EMERGING ECONOMIES

Figure 7 presents the mean agree/disagree and importance responses for respondents identifying a recently established or planned site in an emerging economy. As shown in Table 1, 51 percent of these sites are in China or India. Factors are ordered by mean level of importance.

For the first five factors in Figure 7, respondents, on average, either disagree that the factor is correct for emerging economies or they are neutral with respect to agreement. In addition, these factors tend not to have been important or central in deliberations on the site selection.

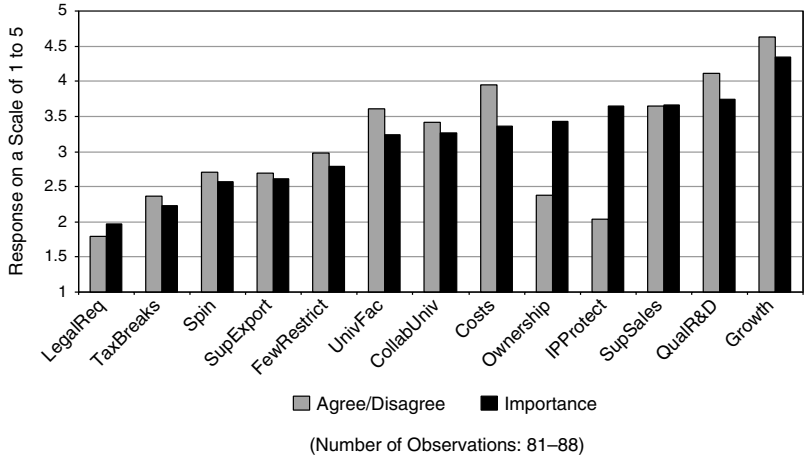

FIGURE 7 Factors in selecting a site in an emerging economy.

Statistical Tests of Importance for Figure 7 (5-percent level)

LegalReg=TaxBreaks
Spin=SupExport
SupExport=FewRestrict
UnivFac=CollabUniv=Costs=Ownership
Costs=Ownership=IPProtect=SupSales
Ownership=IPProtect=Supsales=QualR&D

The results for TaxBreaks are a bit surprising given the use of such breaks in the United States to attract manufacturing and service facilities. It is possible that the mean values mask the importance for some of the firms in the sample, but a closer look reveals that only 3 of 80 respondents (3.8 percent) either agreed or strongly agreed (i.e., a score of 4 or 5) that they had been offered tax breaks and/or direct government assistance and also noted the importance of TaxBreaks as either a 4 or 5. Thus, one can reasonably reject the argument that tax breaks and/or direct government assistance are luring firms to establish R&D facilities in developing or emerging economies.

The seven factors from UnivFac to QualR&D are generally equivalent in level of importance.[1] Only the final factor, the growth potential of the country (Growth), is significantly different from all other factors. The story here is that the selection of an R&D site in an emerging economy is a complex process, with the growth potential of output markets standing out from the rest.

The results on costs net of tax breaks are particularly interesting. Although respondents agree that costs of R&D in emerging economices are low, the level of importance in the deliberations is statistically significantly lower (1-percent level). Thus, although low costs of R&D in developing countries (and, in particular, China and India) are often mentioned as driving firms in developed countries to conduct their R&D in developing countries, the picture that emerges here is somewhat different. Costs are lower, but they tend not to be as important or central in location decisions as are other factors. Note, in particular, that five of the factors are more important—and two are significantly higher—than are costs for locating in a developing or emerging economy.

The largest differences between levels of agreement and importance are for the two intellectual property factors. Respondents disagree that it is easy to negotiate ownership of intellectual property from research relationships, and they disagree that the quality of intellectual property protection is good.

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[1]One of the reviewers of this report argued that including the QualR&D question was not necessary, given that companies would be unlikely to admit to choosing a site where highly qualified personnel are not present. However, our questions about factors were designed to determine how central a factor is to a site decision and the relative importance of factors. The fact that Growth was considered more important than QualR&D for emerging economies constitutes a significant result.

However, these factors were important or central in their deliberations regarding the sites. It is interesting that respondents disagreed that ownership is easy and they disagreed that intellectual property protection is good and they did consider both factors, but they nonetheless placed a site in a developing country.

OUTSIDE HOME COUNTRY DESTINATIONS: DEVELOPED ECONOMIES

Figure 8 shows the results for factors behind the choice of sites outside the home country and in another developed economy. Eighty percent of these sites are either in the United States or in Western Europe. Factors are ordered by mean level of importance.

For the first six factors in Figure 8 (LegalReg to SupExport), respondents, on average, either disagree that the factor is correct for sites outside the home country and in developed economies or else are neutral with respect to agreement.

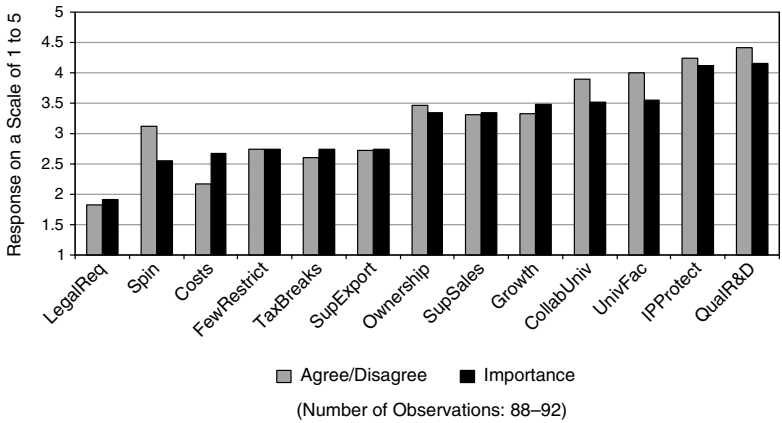

FIGURE 8 Factors in selecting a site outside the home country and in a developed economy.

Statistical Tests of Importance for Figure 8 (5-percent level)
Spin=Costs=SupExport=TaxBreaks=FewRestrict
SupSales=Ownership=Growth=CollabUniv=UnivFac
IPProtect=QualR&D

Earlier it was noted that both the average level of agreement and importance for TaxBreaks were low for sites in developing or emerging economies. As well, it was noted that only 3 of 80 respondents (3.8 percent) either agreed or strongly agreed that there were tax breaks and also noted the level of importance as either a 4 or 5. The averages here are also low. However, there is greater variability in respondent answers. Of 50 respondents, 12 (24 percent) gave both an agreement level of 4 or 5 and an importance level of 4 or 5. The results suggest that tax breaks are more prevalent in developed countries.

Note that respondents disagree that costs are low in developed countries, but, on average, costs are not important in their deliberations.

For the remaining factors, two stand out as being particularly important in firm deliberations about developed country sites: protection of intellectual property and quality of R&D personnel. These two are not statistically significantly different from each other, but they are significantly different from all other factors. Factors from supporting sales to university faculty with particular expertise are not significantly different. As was the case with emerging countries, site selection in developed countries is a complex process.

INSIDE THE HOME COUNTRY

Figure 9 shows results for factors for site selection inside the home country. Recall that we did not solicit responses for all 13 factors.

These results are very similar to those for developed countries that are not the home country. For sites inside the home country, the lack of restrictions (FewRestrict) is more important than for sites in other developed countries. This is particularly clear when we consider individual responses rather than average responses. For developed sites outside the home country, only 5 of 45 respondents (10.2 percent) either agreed or strongly agreed that there are few restrictions and also noted an importance of 4 or 5. However, for sites inside the home country, the corresponding statistic is 20 out of 89 (22.5 percent). For sites within the home country, the quality of R&D personnel and the protection of intellectual property are close in importance (4.5 versus 4.3), though the difference is statistically significant.

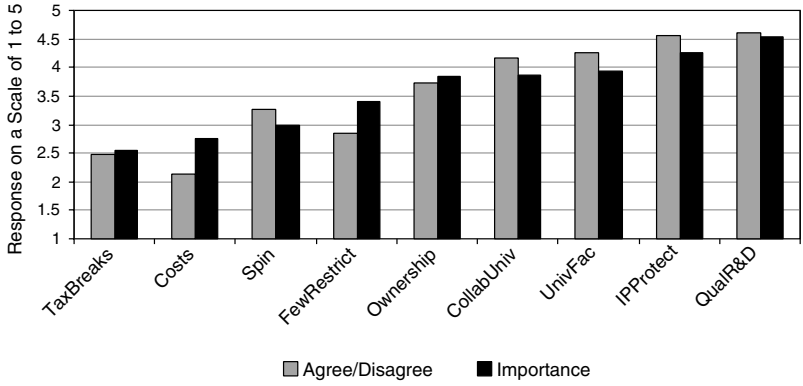

FIGURE 9 Factors in selecting a site inside the home country.

Statistical Tests of Importance for Figure 9 (5-percent level)

TaxBreaks=Costs

Costs=Spin

Ownership= CollabUniv= UnivFac

IPProtect=QualR&D

SUMMARY OF RESULTS

To summarize results on the factors that influence R&D location, the issue is not why firms locate at home or not, but why they locate in a developed economy versus an emerging economy. The results are striking and summarized in Table 3. The table combines the information on agreement and importance to show whether a factor on "net" can be viewed as an attraction to go to a site or as a detraction in choosing a site.

To interpret the table, note that an "Attractor" is defined as a factor with an average agreement score of more than 3 (recall that 4 and 5 are agree or strongly agree) and for which the average level of importance in the site deliberations is greater than 3 (recall that 4 and 5 are important and very important). A "Detractor" is a factor with an average agreement score that is less than 3 (hence, respondents do not agree with the factor statement) and for which the average level of importance is greater than 3. Thus, factors with average importance scores of less than 3 are not consid-

TABLE 3 Attractors/Detractors: Emerging versus Home and Other Developed

	Attractors
Emerging	Output Markets Quality of R&D Personnel Costs = University Factors
Home/Developed	Quality of R&D Personnel = IP Protection University Factors Output Markets
	Detractors
Emerging	IP Factors
Home/Developed	No Detractors

Output Markets are Growth & SupSales.
University Factors are CollabUniv and UnivFac.
IP Factors are IPProtect and Ownership.

ered particularly relevant in selecting the site. Note that there are no detractors for developed sites. In particular, recall from Figures 8 and 9 that costs are high in developed sites, but, on average, costs are not considered an important part of the decision for developed economies.

The order by which factors are listed in the table reflects the relative order of importance by stage of development. In addition, natural combinations of factors have been made; for example, both growth potential and supporting sales are output market factors, so they have been combined.[2] An "equal" sign signifies no difference in the factors.

[2]Naturally, these combinations reflect the authors' interpretation of the data.

Protecting and Capitalizing on Intellectual Property and the Types of Research Conducted

For each R&D site outside the home country, respondents were asked about methods for protecting and capitalizing on intellectual property. Specifically, they were asked:

We want to know the approaches used to protect and capitalize on intellectual property either developed in this facility or transferred to it. First we will ask whether you agree or disagree that you use an approach. We will use a 5-point scale where 5 is strongly agree and 1 is strongly disagree. Second, we will ask how important the approach is for this facility. We will use a 5-point scale where 5 is extremely important and 1 is not important at all.

The intellectual property strategies are given in Box 3.

Respondents generally provided the same response for both the level of agreement and the level of importance. In no case is there a statistically significant difference between the levels of agreement and importance; thus, only the levels of agreement are presented in Figure 10.

Based on a 5-percent significance level, respondents are more likely to agree that they use the same intellectual property strategies in a developed economy and the home country than they are to agree that they use the same strategies in an emerging economy and the home country. However, the only strategy for which there is a statistically significant difference (5-

BOX 3 Strategies for Protecting and Capitalizing on Intellectual Property

1. Essential elements are omitted from documents to make it more costly to copy or design around. (Omit)
2. We license-out intellectual property. (IPLicense)
3. We require payments for know-how transferred. (PayKHow)
4. We establish strong ties to local authorities. (TiesLocal)
5. The potentially important intellectual property is developed in the home country. (HomeDev)
6. We use trade secrets. (TradeSec)
7. We try to establish our products as the market standard. (MktStan)
8. We use patents. (Patents)
9. We use the same intellectual property strategies at home and abroad. (SameIP)

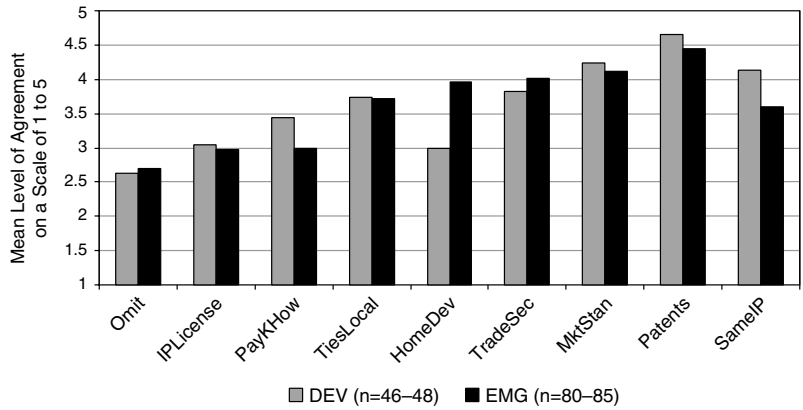

FIGURE 10 Protecting and capitalizing on intellectual property outside the home country.

Statistical Tests for Figure 10 (5-percent level)

Developed economies	***Emerging economies***
Omit=IPLicense=HomeDev	*Omit=IPLicense=PayKHow*
PayKHow=TiesLocal=TradeSec	*TiesLocal=HomeDev=TradeSec*
PayKHow=HomeDev=IPLicense	*TradeSec=MktStan*
TradeSec=MktStan	

percent level) is statement 5: *The potentially important intellectual property is developed in the home country.*

In interviews with industry R&D managers, the case was often made that ties to local authorities are very important for intellectual property protection in China, and this is the primary reason for its inclusion in the strategies list. The results in Figure 10 include responses about other emerging economies as well. For sites in China the mean response for TiesLocal is 3.9, but it is not statistically significantly different from the mean for developed economies.

A related series of questions concerned the type of research conducted at home versus sites outside the home country; that is, the questions focused on the creation of intellectual property rather than on protecting and capitalizing on intellectual property. The focus is on whether the science application is novel or not and on whether the R&D is for the creation of products or services that are new to the firm or already offered to customers of the firm. Respondents were provided with the following:

> *We are interested in the types of R&D conducted OUTSIDE the home country as they relate to new technologies and markets defined as follows.*
>
> *A NEW TECHNOLOGY is a novel application of science as an output of the R&D. It may be patentable or not.*
>
> *Improving FAMILIAR TECHNOLOGY refers to an application of science currently used by you and/or your competitors.*
>
> *R&D for NEW MARKETS is designed to create products or services that are new to your firm.*
>
> *R&D for FAMILIAR MARKETS refers to improvement of products or services that you already offer your customers or where you have a good understanding of the end use.*
>
> *This gives four possible types of R&D:*
> *1) Improving familiar technologies for familiar markets*
> *2) Improving familiar technologies for new markets*
> *3) Creating new technologies for familiar markets*
> *4) Creating new technologies for new markets.*

Note that "new" versus "familiar" markets does not refer to geographical markets. Rather, the focus is on whether the firm is currently selling such a product or service. This taxonomy can be summarized in four quadrants:

		Technology	
		Improve Familiar	Create New
Market	New	%	%
	Familiar	%	%

Respondents were asked for the percentage of the technical staff in each quadrant:

Approximately what percent of the technical staff employed OUTSIDE the home country are engaged in R&D for the purpose of

a. Improving familiar technologies for familiar markets
b. Improving familiar technologies for new markets
c. Creating new technologies for familiar markets
d. Creating new technologies for new markets.

This exercise was repeated both for identified R&D sites inside the home country and for sites outside the home country. Results are shown in Figure 11.

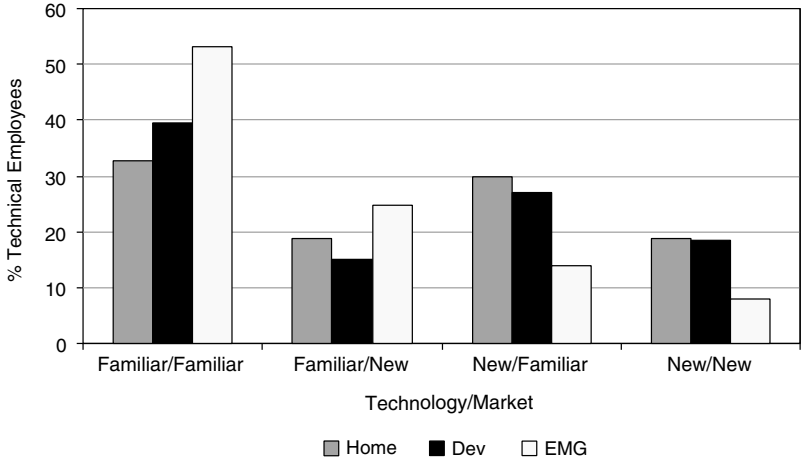

FIGURE 11 Type of research conducted.

Results by quadrant are not statistically significantly different by home versus other developed economies. However, results for home and other developed sites are significantly different from results for emerging economy sites. The potentially important R&D (new technologies and familiar products and new technologies and new markets) is conducted typically in developed economies (home or elsewhere) where intellectual property protection is greatest.

Concluding Remarks

The major findings of this study can be summarized as follows:

- Decisions on site location are complex and involve many factors.
- Although there is and will be some relocation of R&D, the dominant feature is one of expansion of corporate R&D. In addition, there was more relocation within a home country than relocation to sites outside the home country.
- The factors behind the choice of a particular country are not about home versus another country, rather, they are about a developed country versus a developing country.
- In an emerging economy the most important factor for selection of the site is the growth potential of the country.
- In developed economies the most important factors are the quality of R&D personnel and the strength of intellectual property rights.
- The role of universities and university faculty is important in selection of sites. This factor is often overlooked in much of the public discourse on R&D site selection and offshoring.
- Costs are important in the selection of an emerging economy site, but costs are of less importance than a number of other factors. Costs are not a deterrent in selecting a site in a developed economy. This may seem to be contradictory, but it may stem from the finding reported here that the nature of R&D conducted in a developed economy tends to be different

from that conducted in a developing economy. This leads to the final notable finding.

- The intellectual property regimes in emerging economies are poor and are a detractor for selecting sites in such economies. Intellectual property regimes are an important attractor for developed economy sites. R&D using "new" technology or science is more likely to be done in developed countries.

Future directions of research based on the survey results include more formal econometric analysis of the data in a search to uncover additional regularities in the decision-making process on site selection. In addition, comparisons between India and China, the two countries where the greatest expansion is expected to take place, are possible. Industry differences have not been discussed here. For the broad questions asked in the survey, preliminary analysis suggests that there are few industry differences. This might follow from the fact that there are only a few industries with many respondents. Some industry analysis, however, is possible, since for five of the industries there are 20 or more respondents.

Appendix
Respondent Pool, Statistical Tests, and Presentation of Results

The potential pool of respondent firms has two characteristics: (1) the firms are research intensive; and (2) access is available via a third party to an R&D manager who is familiar with decisions on the placement of R&D facilities. The "third" parties for the second characteristic are industrial research groups that not only provided contact information on R&D managers who are members of the organization, but also sent letters introducing the survey and encouraging participation. Without letters of introduction, response rates would be very low. Membership in the organizations who aided our survey is self-limited to research-intensive firms and, in general, to large firms.

It is appropriate to have multiple respondents from a single firm. If decisions on R&D site locations are made independently by multiple entities in a single firm, then each entity is an appropriate respondent. For example, if decisions are made at the level of business units, then each business unit could potentially provide a response. A total of 418 firms were contacted, and responses from 203 firms were received. This is a 48.6 percent response rate. One reason for the high response rate is that we had multiple potential contacts for many firms. Thus, a non-response from one contact from a firm might be negated by a response from another contact at that same firm. As noted, it can be appropriate to have multiple responses from the same firm so long as each respondent is responding for a different decision-making unit.

From the 203 firms there are 250 responses. Each respondent was asked for the name of the unit for which they were responding so that a check could be made that multiple responses were not being received from the same decision-making unit. Of the 250 responses, 76 (30.4 percent) were from business units and 174 (69.9 percent) were responding for a corporate R&D unit. There is no way to determine whether a non-respondent would have answered for a business unit or for a corporate R&D unit.

Results of statistical tests are presented in the text and below the figures. With the exception of the test reported for the comparison of the data in Figure 5, all tests are standard tests of equality of means. It is assumed that variances are unequal and observations are not paired. Alternative tests would consider whether distributions of responses are significantly different. Since the comparisons in the figures and the discussion in the text are for differences of means, the tests are tests of equality of means rather than distributions. The statistical test reported for the data in Figure 5 is Pearson's chi-square test of whether the distributions of years for sites inside and sites outside are significantly different.

The level of significance reported for tests is the largest significance level at which the null hypothesis of no difference is rejected. Thus, if it is reported that a group of comparisons are significantly different at the 5-percent level, then every test statistic has a p-value of 0.05 or less. Some might be less than 0.01 (that is, a 1-percent significance level). If differences are reported as not being significantly different, then a significance level of 5 percent has been used.

The number of respondents answering questions is presented below most figures. This is typically a range since the figures are drawn from a number of questions. Thus, for example, below Figure 4 it is reported that there are 223–230 respondents, indicating that a minimum of 223 respondents answered each of the seven questions in Figure 4 and for some questions there were 230 respondents.