Differences in Reported R&D Data on the NSF/Census RD-1 Form and the SEC 10-K Form: A Micro-data Investigation[1]

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Abstract

There are two major micro-level sources for data on U.S. industrial research and development: the confidential RD-1 survey conducted by the Bureau of the Census for the National Science Foundation and the data on R&D spending reported to the Securities and Exchange Commission by firms on their 10-Ks, which is available to the public via such sources as Standard and Poor's Compustat files. During the 1980s, the aggregate growth rate of industrial R&D reported by these two sources diverged. We compare the data reported to these two sources in 1991 and 1992 in an effort to ascertain the reasons for discrepancies in R&D reporting and we interview a small sample of firms for which the discrepancies are large. Our recommendations for improvement in the collection of R&D data by the Census Bureau include refining the definition of key terms like development and the introduction of methods to track spending by multi-national firms and by firms involved in mergers and acquisitions.

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Differences in Reported R&D Data on the NSF/Census RD-1 Form and the SEC 10-K Form: A Micro-data Investigation

Bronwyn H. Hall and William F. Long

"Economists have not been very successful in explaining what has happened
to the economy during the last two decades, nor have they been
able to agree on what should be done about it. I will
argue that data and measurement difficulties may
in fact be a major source of this failure."[4]

Zvi Griliches
Presidential Address
American Economics Association
Annual Meeting, 1994

1. Introduction

Assessment of an economy's technological competence, knowhow, and productivity has become an increasingly important part of the collection of statistical data on economic performance during the past few decades. See, for example, the ongoing OECD emphasis on the creation of Science and Technology Indicators and the growth of data collection efforts in this area outside the United States. The single most important and widely collected science and technology indicator around the world is national spending on Research and Development (R&D). A major component of this spending in most economies is private industrial R&D spending.[5] In recent years, it has become increasingly clear that a variety of factors such as increased R&D in the service sector, definitional issues, and globalization have produced divergence in the two major sources of information on private industrial R&D spending in the United States -- this report presents the results of our investigation into these data sources and their differences.

United States companies report R&D data to the Census Bureau on Form RD-1; it is these data

[4]Griliches (1994), p. 10. In the introduction to his talk, Griliches noted: "Great advances have been made in theory and in econometric techniques, but these will be wasted unless they are applied to the right data." ibid., p. 2.

[5]For example, such spending accounted for 51, 72, 65, 43, and 51 percent of total R&D spending in the U.S., Japan, Germany, France, and the U.K. respectively in 1989. The percentage of R&D performed by industry was even higher: 72, 70, 72, 60, and 67 percent. (National Science Foundation, *Science and Engineering Indicators* 1991). Obviously, for the U.S., these numbers are based on the data source we are evaluating in this report.

which are the basis of the industry aggregates published annually by NSF.[6] As with all Census-collected data, the RD-1 data for individual firms is confidential and is not published. However, many of these same companies also report R&D data with the SEC, on form 10-K; as with all accounting data reported on 10-Ks, these data are available to the public. As micro-data, they are sold in a convenient machine-readable form by Standard and Poors in its Compustat database, which we have used for the study. They are also often aggregated into industries and sold at a fee by private vendors.

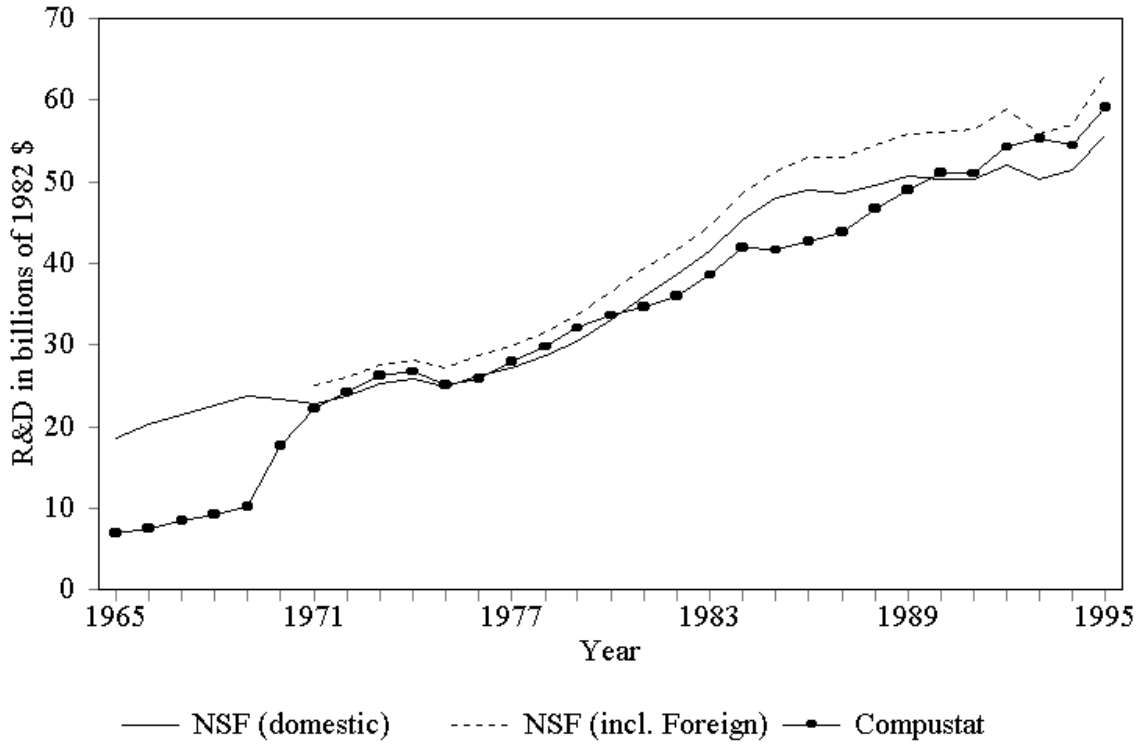

Figure 1: **Total Company-funded R&D in the U. S. Manufacturing Sector (1982$B))**

[6] See National Science Foundation (1992), where the form and reporting instructions are included in an appendix.

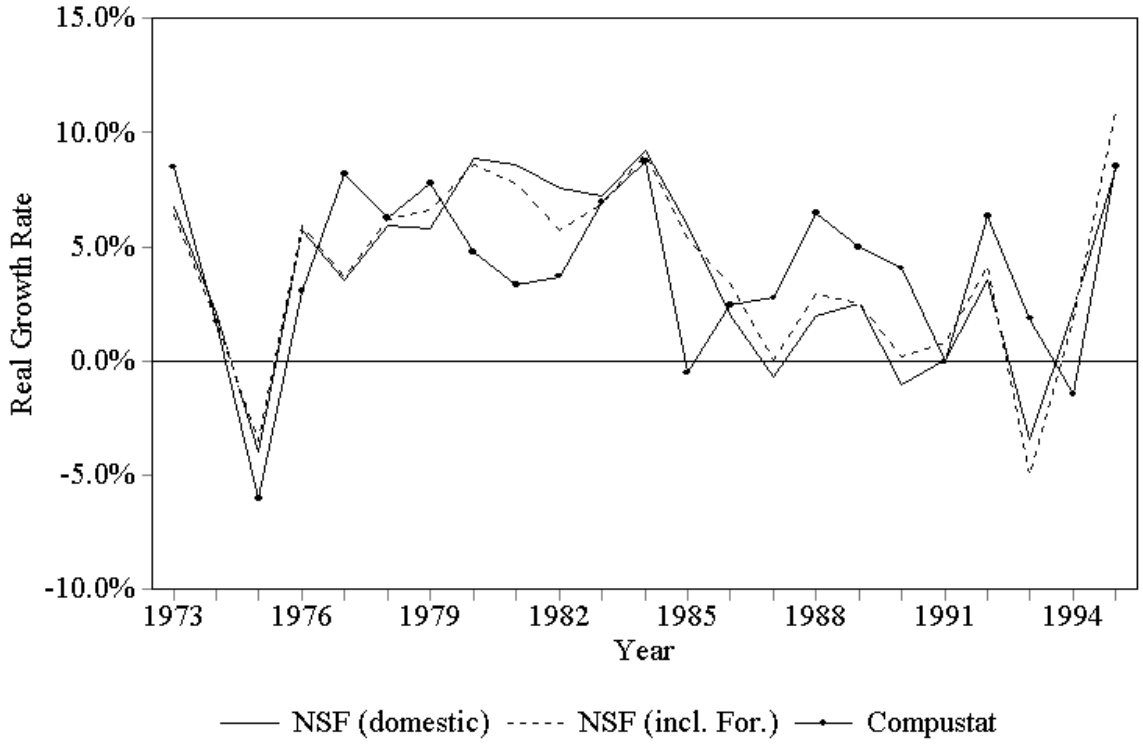

Figure 2: **Real Growth Rate of Company-funded R&D in Manufacturing**

At the aggregate industry level, the two sources tell somewhat different stories about the growth of

R&D spending in manufacturing during past two decades.[7] Figure 1 shows aggregate spending on R&D estimated from the two sources. The 10-K figures are for spending by the worldwide firm that is funded by the firm itself, and excludes federally-funded R&D and engineering expense (in principle). However, they cover only the publicly-traded manufacturing sector. Two sets of numbers for the NSF are shown in the figures: one set is based on numbers for the domestic parts of the firms surveyed and the other set includes their reported spending on R&D outside the United States (about ten percent of company-funded R&D occurs outside the United States during this period).

The RD-1 based data are somewhat higher than the 10-K data during this period, especially during the 1980s and they also show a substantially greater rate of growth during the first half of the 1980s, and a slowing in the latter half relative to the 10-K numbers. Figure 2 shows annual growth rates, corrected for inflation. Table 1 summarizes the numbers, showing that although the growth rates were roughly comparable between 1976 and 1980, the NSF numbers grew faster than 10-K in the earlier eighties, and substantially slower in the late 1980s. The apparent slowing of the growth rate in the RD-1 data had two consequences: it led some to believe that US corporations faced insufficient incentives for the performance of R&D and to call for various forms of subsidy and tax incentives.[8] The second consequence was that the Census Bureau and the National Science Foundation reexamined their sampling frame to ensure that smaller firms and non-manufacturing firms were being adequately covered. This fact probably explains why the growth rates have picked up again in the 1990s, to the point where the two data sources now display roughly the same growth rates, although the levels of spending are still somewhat different, with the 10-K total somewhat lower, as it should be.[9]

Table 1
Real Growth of Industrial R&D Aggregate

5-Year Period	Compustat (10-K)	NSF (RD-1) Domestic	NSF (RD-1) Total
1976-80	6.00%	6.00%	6.20%
1981-85	4.40%	7.70%	7.00%
1986-90	4.10%	1.00%	1.80%
1991-95	3.10%	2.20%	2.50%

[7]Also see Hall (1993), Appendix B and Figure 1.

[8]The most extreme critics argue the wave of corporate restructuring was the root of the slowing of the growth of R&D spending in manufacturing, but this view was critiqued by Hall in a series of studies (Hall 1990 and Hall 1994) and by Long and Ravenscraft (1993b).

[9]Because 10-K covers only publicly traded firms, it should be less than the NSF totals that include R&D performed by domestic firms abroad.

Thus our purpose in undertaking this project was to determine the causes of the differences in the two data sources, to identify likely measurement problems in the RD-1 survey, to suggest which of the two different stories is closer to reality, and to make recommendations about detailed improvements to the survey.[10] Our approach was to match the firms in the two samples (10-K and RD-1) and then examine the discrepancies in their various measures of R&D spending. From a set of matches that seemed to show particularly large discrepancies or other problems, we drew a small sample of firms for field interviews. Because the RD-1 data for individual firms is confidential, we can only summarize the results of our interviews in this report.

2. Report on the R&D Match

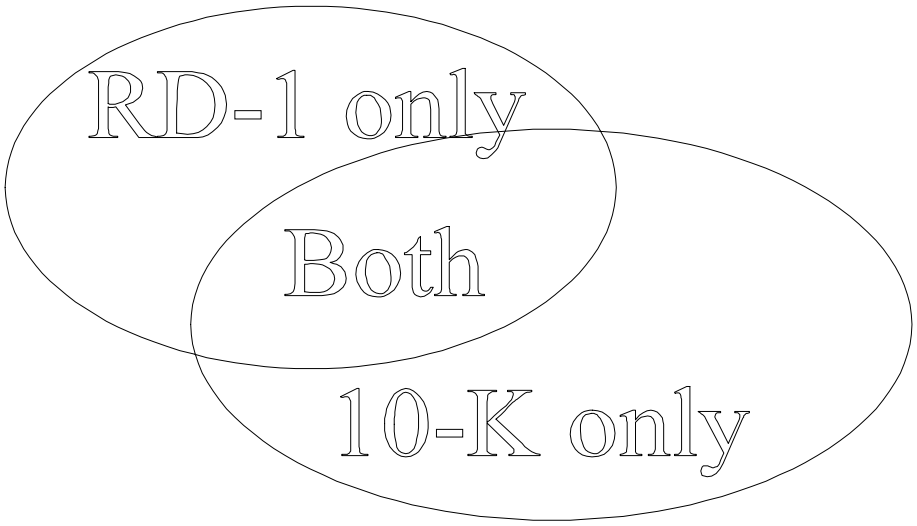

Figure 3: **Survey Sample Coverage**

The first stage of our project was done at the Center for Economic Studies at the Census Bureau in Washington, because the RD-1 company data had to be treated confidentially under Title 13. We matched the two files, company-by-company. The Compustat file of 10-K data contains 5,102 firms for 1991 and 5,550 for 1992, over 3,000 of which are in manufacturing, and over 2,100 of which report some R&D expenditures. The RD-1 file contains 3,451 firms in 1991 and 5,218 in 1992, most of which are also in manufacturing. We expected to find 800-1,000 companies that are in both

[10]Recent research projects at CES have explored data quality issues for a number of variables reported on Form RD-1. See Adams (1992), Adams and Champion (1992), and Long and Ravenscraft (1993a).

datasets in 1991, more in 1992. Merging the two files is problematic, since the only field in common is the company name; we used software developed by Long for this match and checked the results by hand for errors in matching.[11]

As mentioned earlier, Census and the NSF revised their sampling procedure in the early 1990s. Because 1992 was a "new sample" year for the RD-1 survey, we focused the matching on that year and on the year prior, 1991. A substantial number of companies were added for the 1992 survey, with some of them being in non-manufacturing industries which had previously not been specifically covered in the survey, so it is important to match the 10-K companies to this most current sample.

The matching step created, for a given sample year, three groups of companies: (1) those in both RD-1 and 10-K; (2) those in RD-1 only; and (3) those in 10-K only. Only publicly traded companies are required to file 10-K reports, whereas RD-1 reports are filed by both public and private companies, so group 2 will be non-empty.[12] Furthermore, some very small R&D performing companies are public, and report R&D data to the SEC, but are not included in the RD-1 sample, so group 3 will not be empty, either.[13] The results of the matches for 1991 and 1992 are shown in Table 2. We restricted analysis there and in the rest of the report to companies for which sales is positive, so the numbers of companies are slightly smaller than those reported in Table 1. There were approximately 1,000 firms on both files in 1991, and about 1,600 in 1992.

[11] See Long and Ravenscraft (1993a).

[12] 10-K and RD-1 R&D differ in that the 10-K records R&D where it is paid for, whereas the RD-1 survey records R&D where it is performed. Therefore a further reason for differences in R&D reporting will be situations where one firm hires another to perform R&D. This will affect a relatively small number of firms, so far as we know, but such arrangements may be increasing in importance.

[13] More precisely, they could have been in the RD-1 sampling frame, but not selected for survey, so not in the sample.

Table 2

Results of Match between RD-1 and 10-K Data

1991 - RD-1 Firms	Match to 10-K[14]	No Match to 10-K	Total
RD-1 R&D non zero	995 (30.7%)	2251 (69.3%)	3246
RD-1 R&D = zero	18 (13.6%)	114 (86.4%)	132
Total	1013 (30.0%)	2365 (70.0%)	3378

1991 - 10-K Firms	Match to RD-1	No Match to RD-1	Total
10-K R&D non zero	710 (33.6%)	1405 (66.4%)	2115
10-K R&D = zero	303 (10.4%)	2603 (89.6%)	2906
Total	1013 (20.2%)	4008 (79.8%)	5021

1992 - RD-1 Firms	Match to 10-K	No Match to 10-K	Total
RD-1 R&D non zero	1611 (32.9%)	3281 (67.1%)	4892
RD-1 R&D = zero	2 (10.0%)	18 (90.0%)	20
Total	1613 (32.8%)	3299 (67.2%)	4912

1992 - 10-K Firms	Match to RD-1	No Match to RD-1	Total
10-K R&D non zero	1265 (54.5%)	1054 (45.5%)	2319
10-K R&D = zero	348 (12.4%)	2810 (87.6%)	3158
Total	1613 (29.5%)	3864 (70.5%)	5477

As the table shows, approximately the same fraction of RD-1 firms match to the 10-K files in 1991 and 1992, but the success of the 10-K match is much higher in 1992, especially for those firms that report R&D to the SEC. This fact is due to the substantially increased coverage of the RD-1 survey. However, counting the number of firms that are in both datasets or in only one of them is not

[14]Row percentages are shown in parentheses.

sufficient for an overall view, because it does not take firm size or the level of R&D spending into account. Table 3 shows the aggregate R&D for the 10-K firms that reported positive R&D, broken down by whether or not they matched to the RD-1 sample. Clearly the R&D coverage of our match was much higher than the firm coverage in both years. For 1991, the average reported R&D for those firms we were able to match to the RD-1 file was almost $140 million, while the average size for those for which we did not find a match was about $20 million. For 1992, the comparable numbers are $90 million and $20 million.

Table 3

Matched and Unmatched 10-K Firms with Positive R&D

1991	Matched with RD-1[15]	Not Matched with RD-1	Total
Number of firms	711 (33.6%)	1404 (66.4%)	2115
Total R&D (billions)	$98.6 (79.6%)	$24.4 (20.4%)	$123.0
Average R&D (millions)	$138.7	$17.4	$58.2

1992	Matched with RD-1	Not Matched with RD-1	Total
Number of firms	1269 (54.5%)	1050 (45.5%)	2319
Total R&D (billions)	$115.7 (85.5%)	$18.3 (14.2%)	$134.0
Average R&D (millions)	$91.2	$17.4	$57.8

Tables 4 and 5 show the pattern of zero and non-zero R&D figures for the firms that matched. As expected, many more firms report zero R&D on the 10-K when the RD-1 survey reports positive R&D (approximately 300 in each year) than the other way around (less than ten in each year). The reporting requirement for the 10-K is that R&D be "material," which is widely interpreted as R&D being greater than 1 percent of sales. Table 5 shows that of the firms with zero 10-K R&D and non-zero RD-1 R&D, more than 80 percent of them have an R&D-to-sales ratio on RD-1 less than one percent, and they account for approximately two percent of the RD-1 R&D total in each of the two years. Only 4 percent of the matches in 1991 and 2 percent of the matches in 1992 with RD-1 R&D-sales ratio greater than two percent do not report R&D on the 10-K.

[15]Row percentages are shown in parentheses.

Table 4
R&D Characteristics of Matched Firms
(Billions of dollars)

1991 (1013 matches)[16]	10-K R&D non zero	10-K R&D = zero	Totals
RD-1 R&D non zero	RD-1: $61.2 10-K: $98.6 Count: 711	RD-1: $1.2 10-K: Count: 284	RD-1: $62.4 10-K: $98.6 Count: 995
RD-1 R&D = zero	RD-1: 10-K: (D)[17] Count: 6	RD-1: 10-K: Count: 0	RD-1: 10-K: (D)[13] Count: 6
Totals	RD-1: $61.2 10-K: $98.6 Count: 717	RD-1: $1.2 10-K: Count: 284	RD-1: $62.4 10-K: $98.6 Count: 1001

1992 (1613 matches)	10-K R&D non zero	10-K R&D = zero	Totals
RD-1 R&D non zero	RD-1: $68.2 10-K: $115.7 Count: 1269	RD-1: $1.9 10-K: Count: 342	RD-1: $70.1 10-K: $115.7 Count: 1611
RD-1 R&D = zero	RD-1: 10-K: (D)[18] Count: 2	RD-1: 10-K: Count: 0	RD-1: 10-K: (D)[14] Count: 2
Total	RD-1: $68.2 10-K: $115.7 Count: 1271	RD-1: $1.9 10-K: Count: 342	RD-1: $70.1 10-K: $115.7 Count: 1613

[16]Due to some missing values, the totals in this table are based on somewhat fewer firms than actually matched. The actual number of firms is given in parentheses after the total.

[17]Not separately reportable because of potential disclosure of individual company data; data are included in the previous row.

[18]Not separately reportable because of potential disclosure of individual company data; data are included in the previous row.

Table 5
RD-1 R&D/Sales Percentages, Matched Firms[19]
Number of firms (billions of dollars)

1991 (995 matches)	10-K R&D positive	10-K R&D zero	All Firms
< 1 percent	172 ($2.40)	242 ($0.59)	414 ($2.99)
1-2 percent	99 ($2.78)	25 ($0.56)	124 ($3.34)
>= 2 percent	440 ($56.04)	17 ($0.055)	457 ($56.10)
Total	711 ($61.22)	284 ($1.21)	995 ($62.43)

1992 (1595 matches)	10-K R&D positive	10-K R&D zero	All Firms
< 1 percent	223 ($2.57)	279 ($0.75)	502 ($3.32)
1-2 percent	147 ($2.81)	43 ($0.78)	190 ($3.59)
>= 2 percent	899 ($62.80)	20 ($0.38)	919 ($63.18)
Total	1269 ($68.18)	342 ($1.91)	1611 ($70.09)

Using the results of the firm matches in 1991 and 1992, we asked a series of questions intended to pinpoint the contributions of the obvious sources of differences between the two files:

1. Do those firms with calendar year not equal to fiscal year have a higher R&D or sales discrepancy?

2. How much of the R&D discrepancy is explained by the fact that firms are multinational? 10-K figures are for the worldwide firm while the primary RD-1 figures are for R&D performed within the United States (although there is a question about foreign-performed R&D elsewhere in the survey).

3. Do firms with higher R&D have higher R&D discrepancies?

We defined the discrepancy measure in the following way:

DISC = 2*Abs(*10-K figure* minus *RD-1 figure*)/(*10-K figure* plus *RD-1 figure*)

That is, the discrepancy is the absolute difference between the two figures divided by their average.

[19]The total domestic R&D spending reported on the RD-1 survey by the firms in the cell is shown in parentheses next to the count.

It is bounded between zero and two.

Table 6 shows that the answer to our first question (about calendar year versus fiscal year) is a resounding NO. We might have expected the numbers to be different for firms whose fiscal year does not coincide with their calendar year, since the RD-1 survey is done on a calendar year basis, but if anything, there are more firms with larger discrepancies in both years when the fiscal and calendar years coincide. In the case of sales, the two groups are nearly identical. In our field interviews, firms did identify several problems associated with calendar/fiscal year reporting (see below), but apparently these problems are not large enough to produce gross discrepancies for a large number of firms.

Table 6
Discrepancies due to Calendar/Fiscal Year differences

R&D Discrepancy

1991	Less than 0.5	Greater than 0.5	Total
Fiscal Yr. not Calendar Yr	220 (55%)	183 (45%)	403
Fiscal Yr = Calendar Yr.	285 (48%)	313 (52%)	598
Total	505	496	1001

1992	Less than 0.5	Greater than 0.5	Total
Fiscal Yr. not Calendar Yr	461 (65%)	253 (35%)	714
Fiscal Yr = Calendar Yr.	514 (57%)	385 (43%)	899
Total	975	638	1613

Sales Discrepancy

1991	Less than 0.5	Greater than 0.5	Total
Fiscal Yr. not Calendar Yr	293 (73%)	110 (27%)	403
Fiscal Yr = Calendar Yr.	450 (75%)	148 (25%)	598
Total	743	258	1001

1992	Less than 0.5	Greater than 0.5	Total
Fiscal Yr. not Calendar Yr	588 (83%)	126 (17%)	714
Fiscal Yr = Calendar Yr.	742 (83%)	157 (17%)	899
Total	1330	283	1613

Our second investigation was into the discrepancies possibly due to foreign R&D activity. These are likely to be important, because the SEC 10-K data reported in Compustat are for the worldwide

company, whereas the primary data reported on the RD-1 form are for the US part of the company. Collateral data are reported on each of the two forms which may be used to achieve more conformity, and we report efforts along those lines next.

Compustat reports a geographic breakdown of sales for most large multinational firms. Unfortunately, it does not report a breakdown for R&D spending. We approximated the amount of R&D performed inside the United States by these firms using the ratio of domestic sales to total sales times the total amount of R&D, and Tables 7 and 8 show the results of this computation.

Table 7
Frequency Distribution of Foreign Sales Percentages, 10-K Firms

1991

Foreign Sales Share	Number (R&D in billions)	Frequency
0 % - 20 %	62 ($2.53)	26.6 % (15.4%)
20 % - 40 %	100 ($6.40)	42.9 % (39.0%)
40 % - 60 %	52 ($6.50)	22.3 % (39.6%)
60 % - 80 %	11 ($0.98)	4.7 % (5.9%)
80 % - 100 %	8 (D)[20]	3.4 % (D)[16]
Total	233 ($16.42)	100.0 %

1992

Foreign Sales Share	Number (R&D in billions)	Frequency
0 % - 20 %	95 ($3.18)	32.8 % (18.3%)
20 % - 40 %	109 ($6.40)	37.6 % (36.7%)
40 % - 60 %	61 ($6.63)	21.0 % (38.1%)
60 % - 80 %	15 ($0.96)	5.2 % (5.5%)
80 % - 100 %	10 ($0.25)	3.4 % (1.4%)

[20]Not separately reportable because of potential disclosure of individual company data; data are included in the previous row.

Total	290 ($17.42)	100.0 %

We do not expect that this approximation is very good, as there is considerable evidence that firms tend to have a higher domestic share for R&D than for sales (see, for example, Patel and Pavitt 1997). From Table 8, one can see that about a quarter of the discrepancies that are greater than 50 percent become less than 50 percent using this rule, but that a similar fraction of those that are less than 50 percent become greater than 50 percent, so that there is no change overall. Thus the geographic breakdown of sales available from Compustat is nearly useless for assessing the role of R&D spending abroad in accounting for discrepancies between RD-1 and 10-K reporting.

The specific definition of "foreign" in the Compustat file we used is also a potential problem, since it appears to underrepresent companies with foreign activities. Specific categories for "domestic or US" and "foreign" apparently depend on the use by the reporting company of the explicit phrases, so that for a company that used phrases like "US and Canada" or "North America", Compustat staff analysts would not enter any data for a domestic geographic segment. Because a domestic segment is not identified, a foreign segment cannot be identified, either.

Table 8
Discrepancies Due to Foreign R&D Activities
10-K Based Analysis

1991

R&D estimated from geographic segments	Modified R&D Discrepancy<.5	Modified R&D Discrepancy>.5	Total
R&D Discrepancy<.5	111 ($9.65)[21]	25 ($4.05)	136 ($13.70)
R&D Discrepancy>.5	24 ($1.45)	73 ($1.27)	97 ($2.72)
Total	135 ($11.10)	98 ($5.32)	233 ($16.42)

1992

R&D estimated from geographic segments	Modified R&D Discrepancy<.5	Modified R&D Discrepancy>.5	Total
R&D Discrepancy<.5	149 ($10.74)	28 ($3.69)	177 ($14.43)
R&D Discrepancy>.5	24 ($1.53)	89 ($1.46)	113 ($2.99)

[21]Total 10-K R&D (in billions of dollars) accounted for by these firms shown in parentheses.

Total	173 ($12.27)	117 ($5.15)	290 ($17.42)

The RD-1 form contains information on company R&D that is performed by foreign subsidiaries of the US firm that files the report. These data are spottily reported by respondents, and may be subject to some fairly serious complications because it is unclear exactly what data are expected to be reported in this item by a US company that is owned by a foreign company. Should the number reflect all the non-US R&D of the foreign parent, or only that part that is performed directly by the parent US company? If the latter, would the number change merely as a result of an internal reorganization of legal subsidiaries of the foreign parent?[22]

Leaving these issues aside for the moment, we have used the RD-1 foreign R&D data to supplement the US R&D data to get an estimate of world-wide R&D. Then, using the same assumption as above, that the R&D/Sales ratio is the same for the US and foreign parts of the firm, we have estimated world-wide sales. Finally, we have used the estimated world-wide sales for the RD-1 companies to recalculate the discrepancy measure.

We show in Table 9, in a manner comparable to Table 7 for the 10-K firms' sales, the distribution of foreign R&D to world-wide R&D, based on the RD-1 data.

[22]Later in this report we provide evidence from our conversations with firms that this is not just speculation on our part, but reflects real confusion on the part of the individuals who fill out the RD-1 survey.

Table 9
Frequency Distribution of Foreign R&D Percentages, RD-1 Firms

1991

Foreign R&D Share	Number (R&D in billions)	Frequency
0 % - 20 %	177 ($32.29)	73.1 % (79.8%)
20 % - 40 %	48 ($7.89)	19.8 % (19.5%)
40 % - 60 %	13 ($0.12)	5.4 % (0.3%)
60 % - 80 %	4 ($0.18)	1.6 % (0.4%)
80 % - 100 %	(D)[23]	(D)
Total	242 ($40.48)	100.0 %

1992

Foreign R&D Share	Number (R&D in billions)	Frequency
0 % - 20 %	224 ($37.21)	68.1 % (81.1%)
20 % - 40 %	63 ($7.72)	19.1 % (16.8%)
40 % - 60 %	29 ($0.72)	8.8 % (1.6%)
60 % - 80 %	8 ($0.24)	2.4 % (0.5%)
80 % - 100 %	5 ($0.003)	1.5 % (0.0%)
Total	329 ($45.89)	100.0 %

Next, in Table 10, we present data which relate our previously measured discrepancy measure to one based on the estimates of world-wide sales and the calculations of world-wide R&D from the RD-1 form. Unlike the case of Table 8, this table does indicate that some of the discrepancy in our measures of sales is reduced when we estimate world-wide sales for the RD-1 firms using reported foreign R&D. However, the fact remains that for most firms the breakdown of R&D between domestic and foreign is quite different than a similar breakdown of sales. Thus, although we know that 10-K and

[23]Not separately reportable because of potential disclosure of individual company data; data are included in the previous row.

RD-1 numbers will differ when part of the firm's operations are outside the United States, we cannot actually compare the numbers across the two data sources, since the 10-K gives only a sales breakdown and the RD-1 gives only an R&D breakdown (if they give anything at all).

Table 10
Discrepancies Due to Foreign R&D Activities
RD-1 Based Analysis

1991

Sales estimated from foreign R&D	Modified Sales Discrepancy<.5	Modified Sales Discrepancy>.5	Total
Sales Discrepancy<.5	161 ($23.42)[24]	3 ($0.10)	164 ($23.52)
Sales Discrepancy>.5	37 ($7.69)	41 ($9.26)	78 ($16.95)
Total	198 ($31.11)	44 ($9.36)	242 ($40.47)

1992

Sales estimated from foreign R&D	Modified Sales Discrepancy<.5	Modified Sales Discrepancy>.5	Total
Sales Discrepancy<.5	213 ($26.03)	14 ($0.21)	227 ($26.24)
Sales Discrepancy>.5	43 ($9.66)	59 ($9.82)	102 ($19.48)
Total	256 ($35.69)	73 ($10.03)	329 ($45.72)

Our final preliminary investigation was into the size distribution of firms that have discrepancies in the reported R&D on the two files. The results are shown in Table 11a for 1991 and 11b for 1992. Almost all of the approximately 25-30 percent of the firms with maximum discrepancies of two have zero R&D on the 10-K and positive R&D on the RD-1, as we saw earlier in Table 4. In 1991, firms with smaller R&D programs (on either file) appear to have somewhat larger discrepancies in their R&D measures and firms with larger R&D programs somewhat smaller discrepancies, but this effect is not large. In 1992, this pattern is even weaker, except that firms with low levels of R&D on the RD-1 still tend to report quite different, but non-zero numbers on the 10-K (the cell with 175 firms in the top panel of Table 11b). It is clear from both Tables that there is a substantial number of firms with good-size discrepancies between the two sets of numbers and good-sized R&D programs (larger than $20 million per annum).

[24]Total 10-K R&D (in billions of dollars) accounted for by these firms shown in parentheses.

Table 11a
Discrepancies by R&D Size Class

1991	RD-1 R&D Intervals				
R&D Discrepancy	0 to 1 M$	1 to 5 M$	5 to 22.5 M$	>22.5 M$	Total
0 to .1	21	60	76	96	253
.01 to 0.47	15	47	82	99	243
0.47 to 1.99	59	66	39	47	211
>1.99, RD-1 R&D > 0	174	66	41	7	288
= 2.0; RD-1 R&D = 0	18	0	0	0	18
Total	287	239	238	249	1013

1991	10-K R&D Intervals				
R&D Discrepancy	<=0.0 M$	0 to 4 M$	4 to 26 M$	>26 M$	Total
0 to .1	0	64	101	88	253
.01 to 0.47	0	51	89	103	243
0.47 to 1.99	0	91	57	63	211
>1.99, 10-K R&D > 0	0	4	3	3	10
= 2.0; 10-K R&D = 0	296	0	0	0	296
Total	296	210	238	249	1013

Table 11b
Discrepancies by R&D Size Class

1992	RD-1 R&D Intervals				
R&D Discrepancy	<0.7 M$	0.7 to 3 M$	3 to 14 M$	>14 M$	Total
0 to .02	115	109	94	74	392
.02 to 0.3	43	82	127	172	424
0.3 to 1.5	68	105	117	111	401
>1.5, RD-1 R&D > 0	175	106	73	40	394
= 2.0; RD-1 R&D = 0	2	0	0	0	2
Total	403	402	411	397	1613

1992	10-K R&D Intervals				
R&D Discrepancy	<=0.2 M$	0.2 to 2.4 M$	2.4 to 14 M$	>14 M$	Total
0 to .02	36	171	110	75	392
.02 to 0.3	12	99	140	173	424
0.3 to 1.5	14	114	138	135	401
>1.5, 10-K R&D > 0	7	7	8	32	54
= 2.0; 10-K R&D = 0	342	0	0	0	342
Total	411	395 39	396	415	1613

3. Telephone and Field Interviews

In the next phase of the project, we developed a short list of representative companies with large discrepancies for interview by telephone (38 companies in all) and then from this list selected 12 for field interviews. We visited 10 of these 12 in the Fall of 1997; the other 2 canceled the time of the interviews after they had been set up and we were unable to change our travel plans.[25]

After matching the firms and computing the discrepancy measures we filled out tables like that shown in Table 12 (below) for some representative firms in our sample. We are not able to show examples of this process because of data confidentiality restrictions. Using tables like these and applying "reasonableness" criteria to the differences in the data, we identified potential outliers for interviews. In order to reduce this list from hundreds to a manageable number, we grouped them by industry and ranked them by our best estimate of likely US R&D expenditures. We covered service (e.g., software) as well as manufacturing firms and firms that have gone through restructuring in the 1980s.[26]

For the phone interview exercise, we designed printed forms for the interviewer (Mr. Sebastian Barletta) to use, and trained him in their use.[27] Together with Mr. Barletta, one of us visited a selection of ten companies for which R&D activity is substantial and questions were not resolvable by telephone contacts.

Telephone Survey Results

Non-response is almost always a problem with surveys, and this one was no exception. A substantial percentage of the RD-1 company sample supplies only three mandatory data items each year; those companies declined to participate in this project. In addition, 11 of the 38 companies failed to provide data by the time we had to stop calling them, leaving 27 firms for which we received usable data. The 12 non-respondents had agreed to participate in the survey, but were unable to provide data in time for it to be useful to this study.

Most of the 27 companies that provided answers cited a single reason for the differences we presented to them. Six reported two or more reasons, and four had no explanation to offer.

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[25]Both the telephone and field interviews have been processed in accordance with procedures in use in the Industry Division of the Census Bureau, and the interview questionnaires and analyses of them will become part of the operational records of the Special Services Branch, which conducts the RD-1 survey.

[26]All of our interviews were of U.S.-based firms, due to funding restrictions on travel and the lack of complete data for foreign firms in the sources with which we work, as well as the difficulty of obtaining responses from these firms.

[27]Company contacts for the RD-1 report are part of the files at the Census Bureau. Although there are other sources for R&D and financial personnel contacts, we were successful in obtaining the information we needed by speaking with those who prepared the RD-1 report and their staff.

Table 12
R&D and Sales for Geographic Sections of a Company, and by R&D Type

Company Financed R&D, Sales								
		1. Basic Res.	2. Appl. Res.	3. Develop-ment	4. Appl. R&D (2+3)	5. Oth.	6. Tot. R&D (1+4)	7. Sales
I. US								
	A. Phys. Sci.	RD-1	RD-1	RD-1	RD-1		RD-1	RD-1
	B. Soc. Sci.							
	C. All Sci.							10-K
II. Foreign								
	A. Phys. Sci.						RD-1	
	B. Soc. Sci.							
	C. All Sci.							10-K
III. World Wide								
	A. Phys. Sci.							
	B. Soc. Sci.							
	C. All Sciences						10-K	10-K

Among answers we did receive, the highest number of respondents cited differences between fiscal

and calendar years as the reason for the data difference. This explanation was followed by differences between definitions for the two reporting programs and the handling of transfers of R&D services to foreign subsidiaries. In addition, several respondents noted that they did not have any foreign R&D in 1992, so the discrepancy we calculated had to depend on purely domestic definitional and reporting considerations.

A smaller number of responses were recorded for other issues, such as the handling of customer-sponsored R&D, restatements by Compustat of data for 1992 after a company reorganization in some later year, and difficulties in handling data for different business reporting units.

4. Results of the Field Interviews

Although only a small number of companies were interviewed in depth, the interviews covered a variety of industries and were quite wide-ranging in their discussion, so that we feel that most of the difficulties in filling out the survey and the definitional issues for R&D have been identified. The key issues discussed fell into two classes: substantive comments on the difficulties of determining exactly which numbers to supply and comments on the logistics of the survey and ways to improve government data collection in this area.

The substantive areas of concern include the problem of dealing with inter-company transfers of R&D assets, the distinction between R&D and engineering costs, the treatment of computer software, the definition of R&D (especially the subcategories), and a variety of miscellaneous concerns. We discuss each of these in turn:

Inter-company transfers:

The problems here often concern cross-border transactions involving R&D or partially-finished products. There is a widely-expressed view that the RD-1 survey is somewhat archaic, in that it does not allow for the extensive foreign operations of firms today or for the frequency of merger and acquisition activity. Non-U.S. operations appear to be only an afterthought for the Census Bureau, but they are becoming increasingly important to the firms. The survey instrument itself specifies that figures are to be reported for the entire *domestic* operations of the company (with the exception of the item labeled foreign-performed R&D), but the firms themselves clearly regard their foreign R&D operations as an intrinsic part of the firm R&D effort.

An example of the kind of problem involved: a firm has an independent foreign subsidiary that does R&D and returns the results of this activity to the parent firm. The associated R&D is not included in the total R&D of the parent firm, because the subsidiary is an independent company. The next year the subsidiary is acquired completely by the parent and accounts are consolidated; now the R&D done by the subsidiary is included in the total R&D of the parent, but nothing about the world has changed, only the details of the firm's legal structure.

Another problem is the situation where there are significant cross-border transactions within a

multinational in both directions: it is unclear from the survey whether eliminations (netting out) are to be applied before filling out the numbers. The 1994 and 1995 RD-1 surveys did not state clearly whether companies must exclude inter-company sales or R&D in their totals. A related problem is that foreign subsidiaries use different accounting systems so consolidating the numbers is difficult.

The central issue here appears to be the design of the survey, which does not admit the possibility of substantial cross-border transfers, and the lack of clear instructions as to precisely which numbers are wanted, at least for the total R&D figures (including foreign-performed). A secondary issue is what happens to the data when the firm is involved in a major acquisition or merger, and how discontinued operations should be treated.

R&D and Engineering Costs:

A central problem in several companies seemed to be that engineers work both on new products and on activities that might be viewed as "routine" product testing, and these two activities cannot be distinguished in the firm's accounts (since the engineer's salaries and costs are in one entry). However, another firm thought that distinguishing applied (development) R&D from engineering might make more sense than distinguishing basic, applied, and development R&D. One firm had been excluding engineering cost completely until told by their accounting firm that they probably ought to include it as development R&D.

A large firm whose products are subject to government regulation devotes a substantial amount of engineering time to satisfying the regulatory requirements. All of this cost would seem to come under the heading of "routine" product testing, but the firm feels that much of it has the character of true R&D and would like guidance on this point. Besides their normal contribution to conventional R&D, these same engineers often perform R&D tasks during production which are viewed as "routine" by the company, but should they be? This firm feels strongly that much of its routine product enhancement and time spent satisfying the government is R&D and reports it on the RD-1 survey, but also that this same work is disallowed by the 10-K requirements.

Computer software:

FASB allows for some of the expense of developing computer software in-house to be capitalized, using a set of criteria that are intended to evaluate the certainty of cost recovery: technological, market, financial feasibility, and management commitment. The idea appears to be that in some cases, the development of computer software creates an asset whose returns are somewhat more certain than those from R&D in general.

According to one of the firms interviewed, Standard and Poors Compustat staff know about this and occasionally include some of the firm's capitalized software expense off their balance sheet into their R&D spending. Presumably the R&D figure on the RD-1 survey will not contain this expense, leading to a discrepancy between the two sources.

Miscellaneous definitional issues:

NSF and SEC use the same definition for R&D, with one exception: NSF excludes social science research. One interviewee stated clearly that it was unlikely firms kept track of social science research separately in order to satisfy NSF.

A pharmaceutical firm feels that it is quite difficult to distinguish applied R&D from development cost in that industry. They also report that they incur large amounts of expense for external R&D, since they conduct clinical trials using outside institutions.

In addition to these substantive comments about the definitional issues surrounding R&D, our interviewees had many thoughtful comments on the logistics of the RD-1 survey and how government data collection might be improved. In general, they felt that the lack of clarity in the RD-1 instructions together with the fact they were encouraged to use estimates meant that the numbers on the survey were not as accurate as they might be. One respondent even thought that they might be less accurate than the number reported to the SEC, which requires exact figures.

Fiscal year vs. Calendar Year Issues:

Reporting data on a calendar year basis is a problem for those whose fiscal year end is on a different basis, especially if the fiscal year ends in the early part of the next year (so that the annual numbers are not available in time for the RD-1 survey deadline). This problem particularly affects those who make acquisitions, since they may not be included in the calendar year data but will be in the fiscal year data. However, we found that problems of this kind are not that evident in the aggregate figures. One of the firms we interviewed had changed accounting systems to a quarterly system (making it easier to obtain calendar year figures) but found there was no place on the RD-1 survey to record the fact that they had changed the basis for their numbers.

Data collection coordination:

Several firms called for coordination of the data collection efforts of the NSF, SEC, and IRS in this area and two specifically mentioned the R&E tax credit information reported to IRS, arguing that it could be the basis of the NSF report. Given the differences in definition of research eligible for the tax credit, however, this might be problematic to implement. A major concern for firms here is the reduction of the reporting burden.

One way reporting might be facilitated is the preprinting of the 10-K figures on the forms sent to companies that also report to the SEC. Several firms felt that this would be useful, and then they would simply fill in missing information. An advantage of this methodology might be that it allows NSF/Census to define the boundaries of the company in which they are interested. More than one interviewee commented that on the current RD-1 survey there was a reference to reconciling with the 10-K that ought to be moved to the top of the survey. It was clear that some firms had more confidence in the accounting figures they were supplying than in the RD-1 report. However, one

firm felt that ***no*** numbers should be preprinted, on the grounds that supplying numbers would encourage bad numbers to propagate from year to year. Two other firms said that they simply didn't keep records at the level of detail required by the RD-1 survey, although they were able to supply 10-K numbers.[28]

Census Bureau Questionnaire Administration:[29]

Several firms commented on the lack of follow-up from the Census Bureau, saying that they assumed they were doing it right since they didn't hear from them. One high technology company (not small) had been filling out the survey since 1991 and did not receive one in 1995, although they did for 1996; they wonder why the Census Bureau did not call to find out why they had not returned the 1995 survey.

5. Conclusions and Recommendations

Conclusions

We have used the information from our statistical work on the matched samples, the telephone interviews and the field visits to reach several conclusions. They are in the areas of RD-1 program administration, the effects of calendar year and company size, definitions of key reporting terms, and the impact of globalization on reported data quality.

Company File Matching. Matching the two samples was quite difficult because the two programs do not use any standard company identifier, and because M/A and name changes are not tracked well in the RD-1. That situation is improving somewhat, because 10-K reporting instructions ask the company to report its Employer Identification Number and that number can be located for most of the RD-1 reporting companies from files available from other parts of the holdings of the Center for Economic Studies.

The RD-1 sample was increased dramatically in 1992; we found about 1,000 matched companies in 1991 and about 1,600 in 1992. Some of the relations we examined were different for 1991 and 1992, but the differences were not striking.

Impact of Calendar Year Differences and Company Size. Calendar year discrepancies were a key for some individual companies, but we did not find them to be important for the whole set of companies we examined. And there is slight statistical evidence that smaller firms have larger discrepancies in reported R&D for the two programs.

[28]In at least one case of a large conglomerate firm, the detail mentioned was R&D financed by Other parties, and Company-financed Foreign R&D.

[29]In evaluating the results of questions in this area, it needs to kept in mind that the RD-1 survey is doubtless being administered under budgetary constraints, which may explain some of the lack of follow-up.

Definition Differences. Differences in definitions between the two reporting programs was a significant cause of differences in the reported numbers. An important issue here is how firms distinguish R&D activities from routine engineering and other product-related services.

Effects of R&D Globalization. Substantial foreign operations were associated with larger discrepancies between the 10-K and RD-1 R&D data, but with a substantial variance in results because of the weakness in the measurement procedures we were forced to use. For companies for which we conducted field interviews, a particular problem was how to handle transfers of R&D assets across national boundaries.

Recommendations

As noted in the introduction to this paper, via the presentation in Figure 1, basic data series for company-funded R&D in the manufacturing sector can be constructed for both the NSF and Compustat data sources starting in 1965. Going behind the basic data, we find that definitions and conventions and standards for reporting the data at the company level have changed over the years.

Before 1973 there was no standard reporting process for R&D for companies to use in their Annual Reports to Shareholders or the 10K Form to the SEC. So there was no standard definition of R&D. Since the promulgation of the Financial Accounting Statement on R&D by the Financial Accounting Standards Board (FASB) in that year, a substantial body of reporting expertise has developed over the years, much of it guided by refinements from time to time by FASB, by refinements in record-keeping at companies, by the accumulation of reporting knowledge at large accounting firms, and by the development of new computer programming tools which will support the systematic reporting of R&D activities within a company.

At the same time, there have been changes in the RD-1 form and data collection process, as well as in other aspects of the Census/NSF data collection and publication arena. One thing that seems to have been kept quite stable is the set of fundamental definitions of the three components of R&D (basic research, applied research, development) and in the demarcation line between those three and non-R&D work.

At the beginning of this research, we maintained that we had no particular reason to label either the 10K data or the RD-1 data as "better" than the other. We certainly took note of the differences in the numbers, of course, but we did not assume that one set of numbers was the "correct" set. We still do not intend to do that, but we also are faced with some practical realities. Substantial effort appears to have gone into getting the R&D numbers "right" by the professional accounting world, by which we mean following the definitions and reporting requirements carefully and systematically, both within a single company and across companies.

There does not seem to be a substantial counterpart process at work with the RD-1 data. We have concluded, therefore, that the best practical course is to use the 10K data as a benchmark, which we do below.

Our four recommendations therefore pertain to the definition of R&D, the issue of multinational companies, the impact of mergers and acquisitions, and to ongoing refinement of the measurement/survey process.

Recommendation 1. Do a better job of making the definitions of critical terms clear. This is especially important for the distinction between what is to be recorded as **development**, which in the 1997 instruction for the RD-1 is defined as activity to "apply **existing knowledge** to problems involved in the **improvement of a present product or process**." [emphasis in original]

The instructions also note that "routine product testing" is to be excluded from R&D, as are "technical services".

Later in the instructions, the respondent is told to count costs under development if they "represent technical activity concerned with non-routine [emphasis added] problems encountered in translating research into products or processes." Once again, routine technical services to customers are excluded.

In practical terms, we discovered that the distinction between what is to be classified as development, on the one hand, and routine customer service, on the other, is not made well by companies. On the basis of our admittedly small sample, we suspect that this explains a substantial part of the discrepancies between the Census/NSF and SEC data.

It may be that much hinges on the phrase "**improvement of a present product**" in the RD-1 definition. The practical definition that appears to have become standard in the 10K reporting world seems to favor a narrow definition, with the result that modifying a product to satisfy a specific customer's needs is classified as a routine customer service, and therefore does not constitute R&D, even if it is performed by the same employees who also conduct activities that would be classified as R&D. Some companies seem to be reading the two sets of definitions and reporting rules as indicating that such work should be classified as R&D for the RD-1.

A very practical hook on which to hang the implementation of the definition might be to ask the reporting company whether there are amounts reported for development on its RD-1 that are not reported as R&D on its 10K. This might signal places where discrepancies will occur. But a more comprehensive review of the definition of R&D and how this definition relates to the Frascati Manual (OECD 1994) will be in order if a decision is made to rely primarily on the FASB definition. Although this manual does explicitly mention routine product development, it provides the following general guidance:

Include in R&D	Prototypes, pilot plants

Exclude from R&D	After-sales service and trouble-shooting, routine testing, data collection, inspection, regulation and standards enforcement
Allocate partially to R&D; exclude if production process	Industrial design, engineering and tool-up, and trial production

Source: Frascati Manual 1993, Table 2.2 (summarized).

Recommendation 2. Handle multi-national companies in a clear and straightforward way. A place to start is with a layout like that in Table 12 above. It is clear that many very large technologically active companies straddle national boundaries, both those that are domiciled in the US and those that are domiciled elsewhere but have substantial activities in the US. It is also clear that R&D activities can take place both here and abroad for such a company, and that it can transfer the results of those activities across national borders. What is needed is a workable mechanism for handling the data that relate to R&D in this setting.

We think the current mechanism is neither clear nor workable. It just does not go far enough in addressing reality to provide much assurance that the US part of a multinational company is being adequately captured. With the pace of large cross-border mergers and acquisitions increasing, this problem needs to be addressed sooner rather than later. If it is not, then we face the prospect of seeing large changes in reported data for the US merely as the result of whether the firms created from the merger of a US firm with a large partner from another country are domiciled in the US or the foreign country. This has already happened, as those who use these data are aware.

Recommendation 3. Handle mergers and acquisitions (M&A) in clear, consistent, and pro-active ways. M&A is a fact of life, and so is advanced notice of any merger or acquisition of material size relative to the reporting of R&D data. The daily business press starts picking up on some M&A activity in the rumor stage. At the next stage, the parties make an announcement. More announcements are made over the next days or weeks, and can be quite varied. Eventually the combination becomes a legal fact, one or more of the old parties may vanish, a new one may be born, etc. All of this information is in the public domain.

Commercial databases that track and organize these data have been available for a few decades now. They are used systematically by others who have an interest in some aspect of M&A activity. They should be used by the Census Bureau to get advance warning about company reorganizations that may affect the reporting of R&D data.

Recommendation 4. Using the matches identified in this project for 1991 and 1992, start keeping track systematically of what each company reports on its 10K and on its RD-1. Look for anomalies and significant changes, and use the results of that scrutiny to improve RD-1 reporting. Once again, displaying data with a form like that shown in Table 12 should be useful.

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