# Treatment of International Research and Development as Investment

## Issues and Estimates

## Bureau of Economic Analysis/National Science Foundation R&D Satellite Account Background Paper


## By Daniel R. Yorgason





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## Preface

This paper presents an analysis of an international component in the R&D satellite account. It provides experimental estimates of the impact of treating R&D as investment on several dimensions of international transactions. It also discusses several important conceptual and methodological issues pertaining to the estimates.

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In recent years, the Bureau of Economic Analysis (BEA) has initiated a long-term effort to provide more extensive economic data and analysis about research and development (R&D) activity and its effects on the economy. A major part of this effort has been the development, in conjunction with the National Science Foundation (NSF), of the R&D satellite account (R&DSA), a project that examines the effects on BEA's economic accounts of capitalizing R&D, that is, treating the knowledge created by R&D as a long-lived, intangible asset that contributes to future production in much the same manner as physical (tangible) capital. Under such an approach, spending on R&D is treated as investment, rather than as an expense as is current practice in BEA's accounts.[1] The R&DSA was first released last year. Revised and extended estimates—the 2007 R&DSA—have been released recently.[2] This paper, although not wholly integrated with the central R&DSA work, is related to that work. Its purpose is to examine various international aspects of the R&DSA and, more generally, the effects of treating R&D as investment throughout BEA's international accounts. This paper and one on regional effects constitute 2007 R&DSA background papers.

[1] The phrase "treat R&D as investment" (or variations of that term) is used throughout this paper. Somewhat less frequently used is the phrase "capitalize R&D" (or variations). These are used synonymously.

[2] BEA has other satellite accounts besides the R&DSA. The 2007 release of the R&DSA, accompanied by a full report and an appendix, is accessible on BEA's website at <http://www.bea.gov/newsreleases/general/rd/2007/rdspend07.htm>. (The 2006 R&DSA, available in full at <http://www.bea.gov/newsreleases/general/rd/rdspend06.htm>, is also discussed in a SURVEY OF CURRENT BUSINESS article: Okubo, et. al (2006).)

The 2006 R&DSA focused on the effect of treating R&D as investment on GDP and other aggregate measures of economic activity. While some of the work on the 2007 account has been devoted to updating and improving these aggregate estimates, a substantial amount of work has been devoted to extending the methodology and estimates to an industry level. In addition, the 2007 effort takes an initial look at the possibilities and implications of extending R&D capitalization to regional and international accounts (and related data). Work on the regional and international areas will shed light on potential approaches to be taken, and issues to be confronted, in future extension of the R&DSA work in these two directions.

Broadly, this paper discusses the international aspects of the R&DSA and the prospects for, and possible effects of, treating international R&D as investment, both in the data that enter the international transactions accounts (ITAs) and international investment position (IIP), and in the data on multinational-company operations collected by BEA. Specifically, it notes the incorporation of estimates of trade in R&D services into the central (domestic) R&DSA; it provides estimates (that are not used in the central R&DSA) of R&D capital held by multinational companies (MNCs); and it applies those to adjust estimates of direct investment income flows (and, in turn, estimates of international investment income and current account flows) and the direct investment position (and, in turn, the international investment position). It also discusses certain R&D-associated activities that have not been incorporated into the quantitative analysis, including trade in R&D-generated intangible assets and spillovers of R&D-generated knowledge.

In analyzing the international aspects of treating R&D as investment, the paper addresses a variety of issues—some conceptual, others practical. Conceptual issues focus on the extent to which the goal of treating R&D as investment is yet a well-defined goal, one that might produce straightforward, informative estimates. Practical issues focus particularly on BEA's capability to produce such estimates at a sufficiently high level of precision with its existing resources and data programs. The paper also provides a first-pass set of estimates in which potential ways of dealing with some of the conceptual and practical issues are illustrated. These are rough, aggregate-level "order-of-magnitude"

estimates that quantify the effects of treating R&D as investment on key international data series. Throughout, the paper endeavors to maintain consistency with the basic approach to the treatment of R&D as investment taken in the central R&DSA work. In particular, estimates of international R&D capital stocks are generated using the perpetual inventory method. Changes in the R&D capital stock value are (roughly) R&D investment flows less R&D depreciation. Depreciation, like the underlying capital stock, must be estimated, as direct data are not collected. A time series of capital stock estimates is constructed recursively from a time series of investment estimates.

The paper consists of several sections. Discussion of both the practical issues and, to a lesser extent, the conceptual issues requires context. Consequently, the first section following this introduction, section I, identifies the types and sources of international data collected and/or published by BEA that are relevant to the R&D capitalization project. Magnitudes of selected data are also presented to give a sense of the scale of R&D relative to other related activities. Next, section II discusses a selection of major R&D-related conceptual issues—such as joint ownership of knowledge capital within MNCs (from which arises the problem that the measurement domain fails to encompass the relevant ownership unit), knowledge spillovers, and net entry of firms into the direct investment universe—particularly important in, but typically not unique to, the international dimension. Practical data issues specific to the R&D-associated data collected by BEA and to the other key series potentially affected by a change in treatment of R&D are then discussed in section III. That section also discusses ways these data collections might be supplemented. Section IV, the longest section, discusses the methodology and assumptions used to generate the order-of-magnitude estimates, after which it presents those estimates. Section V summarizes the paper and discusses possible directions for future development of work treating R&D as investment in the international accounts and other BEA international data.

The order-of-magnitude estimates—which are computed in current dollars, not constant dollars—suggest that the effects of treating R&D as investment on total capital stocks and value added of MNCs would not be inconsequential. Smaller effects would be

seen for the series entering the international accounts. Highlights of the effects of treating R&D as investment include:

- The current-account deficit falls by $1.3 billion, or 0.2 percent, in 2004 as direct income receipts rise more than direct income payments. The $1.3 billion change generates larger relative effects for other, lower-level balances: the surplus on direct investment income rises by 0.9 percent, and the surplus on total international investment income rises by 2.3 percent.

- The 2004 outward direct investment position rises by $125.0 billion, or 5.1 percent, and the inward direct investment position rises by $149.2 billion, or 8.6 percent. The net (outward minus inward) direct investment position—currently estimated to be a positive value—falls by $24.2 billion, or 3.2 percent. The $24.2 billion change causes the net international investment position—which includes both direct and other types of investment, and is currently estimated to be a negative value—to rise (i.e., become more negative) by 1.1 percent..

- The 2004 value added of majority-owned foreign affiliates of U.S. MNCs rises by $25.9 billion, or 3.1 percent, with R&D treated as investment. The relative increase in the value added of U.S. and foreign MNCs located in the United States—which together account for four-fifths of U.S. R&D—is larger: for majority-owned U.S. affiliates of foreign MNCs value added rises by $28.l billion, or 5.5 percent; for U.S. parent companies, value added rises by $148.2 billion, or 6.7 percent.

It is widely recognized that MNCs play a major role in the creation of "knowledge capital" and in the international dissemination of technology and "know how." However, gauging the impact of these activities on the economies of the United States and other countries presents challenging measurement issues—in particular, the identification and classification of knowledge sharing (or joint ownership of knowledge) within MNCs. A major goal of this paper—one that is intended to spotlight and augment understanding of some of these issues—is to examine how the treatment of the R&D of MNCs as

investment would impact the measurement of the international dimension in the U.S. economic accounts.

The paper presumes a certain familiarity with the R&DSA and its associated goals and methods. It does define and provide context for the key issues discussed, but some details are ignored when not vital to the discussion (or some issues are glossed over altogether) that receive more extensive treatment in that report. In addition, for simplicity, the phrase "international R&D data" will be used in this paper to denote data on R&D that is connected in some manner to BEA's international accounts. These international R&D data are discussed next.

## I. Types of international R&D data

This section identifies the main types and sources of R&D data currently available to BEA's international program in preparation for discussions in subsequent sections of how such R&D can best be treated as investment (capitalized). It also identifies other estimates published by the international program for which a switch from R&D expensing to capitalization would have important implications. Besides identifying data, the section touches, at a very broad level, on possible approaches to estimating the effects of capitalization. In addition, it compares a few published estimates of R&D to related data to give a sense of the magnitude of the international R&D data.

BEA's international accounts include the ITAs, the IIP, and collections of estimates of the finances and operations of MNCs. In principle, a switch from expensing to capitalizing R&D would affect several key data series in the ITAs through its effect on income calculations. It would affect the stock series in the IIP by adding a new class of assets to direct investment holdings. Treating R&D as investment would also affect several items in the MNC-operations estimates. However, unlike the primary sources for the ITAs and IIP, source data for the MNC- operations estimates do include information on R&D expenditures. These expenditure data permit the computation of the effects of the treatment of R&D as investment, not only for the operations estimates themselves, but also for the ITAs and IIP.

Although the three basic types of international accounts are the ITAs, the IIP, and the MNC operations data, it is convenient to categorize the international data somewhat differently for the purpose of discussing R&D capitalization. In this alternative categorization, international R&D data are assigned to one of three categories: A) international trade, B) international investment income and position, and C) operations of MNCs. The first is a subset of the ITAs. The second is a another (separate) subset of the ITAs, combined with the IIP. These categories are briefly described below, along with a discussion of the extent to which relevant data are available to BEA.

**A) International trade data**

Direct R&D-associated transactions between a party in the United States and a party outside the United States are considered international trade in R&D, and are included in the ITAs as trade in services. *Treating R&D as investment does not affect the trade balance or the value of exports and imports, as whether R&D is treated as investment or as an expense does not affect how its trade is recorded.* However, recognition of international trade in R&D does affect domestic measures of R&D investment and capital. If these transactions represent the flow of long-lived assets, then given the volume of R&D, recognizing exports of R&D reduces measured domestic R&D investment and capital stock and recognizing imports of R&D increases these two measures.

The international trade data category includes two conceptually distinct types of R&D-associated international transactions—trade in R&D services and trade in those intangible assets resulting from R&D.[3] Data on trade in R&D services measures the transactions value of R&D activity performed by one entity on behalf of another entity

[3] To a certain extent trade in R&D services can be thought of as trade in R&D inputs, and trade in intangible assets can be thought of as trade in R&D outputs. However, this distinction is not necessarily iron-clad. For instance, one firm might contract to have another perform R&D on its behalf. The contract might connect payment with the performing firm's expenditures, whether or not the R&D ultimately proves to be of benefit to the funding firm. Or, the contract may arrange for payment only to the extent that certain pre-specified outcomes are realized. The contract might also be a combination of these two possibilities, with some remuneration for the performing firm's efforts/inputs, but with additional incentives for meeting output targets.

located in a different country (with one of the entities located in the United States). Payment for R&D services is typically contractually arranged. In the ITAs, estimates of R&D services are included, but not separately identified, in the "research and development and testing services" category of business, professional, and technical services trade. Although the testing component of this category includes services that are not considered R&D, it is generally thought that R&D makes up a substantial portion of the category's actual trade.

In contrast, data on trade in R&D-generated intangible assets, or R&D outputs, measure the transactions value of international transfers of the intangible asset (knowledge) resulting from *previously performed* R&D, often along with the associated, though possibly circumscribed, legal rights to use such knowledge. Transactions of these sorts may be either outright sales of knowledge or other more restricted arrangements, such as payment for the right to use the knowledge for a specified period and/or in a specified context. In the ITAs, estimates of such transactions are included within the broader category of royalties and license fees, a category that includes transactions of several types of intangible assets, several of them likely to result from processes other than R&D. The intangible asset category most likely to result from R&D is denoted as "rights related to industrial processes and products."[4]

BEA's surveys of trade in international services and intangible assets request that transactions with affiliated persons—that is, with foreign parents, other foreign affiliates

[4] "Rights to general use computer software" is another category in which the intangible assets might be the result of previous R&D activity. However, BEA's NIPAs currently treat computer software as a separate type of asset, one distinct from R&D capital. Intangible assets in other categories—books, compact discs, audio tapes; trademarks; broadcast and recording of live events; business format franchising fees; and other intangibles—are less likely to derive from R&D as defined on NSF surveys and BEA's surveys of MNCs, but may, in part, derive from R&D more broadly defined to include research in the social sciences and humanities, as suggested by the *Franscati* manual (Organisation for Economic Co-operation and Development (2002)). The distinction between definitions currently used for data collection and those recommended in international guidelines is discussed later in the text.

of foreign parents, or foreign affiliates—be reported separately.[5] These surveys have recently been restructured and rationalized. Prior to 2004, data on unaffiliated transactions were only collected annually; now they are collected quarterly. Prior to 2006, data on affiliated transactions were collected on separate surveys from data on unaffiliated transactions; starting with 2006 (2007 for quarterly data), they have been collected on the same survey. Also, before 2006, data on affiliated transactions in "rights related to industrial processes and products" royalties and license fees were not separately collected, but were indistinguishably categorized with all other royalties and license fees; they are now distinguished just as for similar unaffiliated transactions. Improvements to the surveys also occurred in earlier years. In 2001, data on affiliated R&D and testing services trade began to be separately identified; previously they were included in affiliated business, professional, and technical services trade.[6]

In 2004, U.S. exports of R&D and testing services were $8.8 billion, 2.7 percent of total private services exports.[7] Receipts for rights related to industrial processes and products were likely substantially larger. Estimates of these receipts, as a separate component of royalties and license fees, are only separately published for unaffiliated transactions; these were $5.7 billion. Assuming, conservatively, that 80 percent of affiliated royalties and license fees receipts were for rights related to industrial processes and products gives $31.3 billion in such receipts, and a total of $36.9 billion for unaffiliated and affiliated receipts.[8] Combining the rights related to industrial processes

[5] See appendix A for a more complete description of BEA's surveys on international trade in services and intangible assets, and for the definitions used on those surveys for the categories of trade related to R&D.

[6] Prior to 1997, these services were included in "other private services."

[7] Data from 2004, as opposed to some more recent year, are used to give a sense of the magnitude of international R&D data, as 2004 is the latest year included in the order-of-magnitude estimates presented later in the paper.

[8] The 80 percent assumption is conservative relative to shares from data collected in other (isolated) instances. Data on affiliated transactions of rights to intangible assets related to industrial processes were collected in the 1989 benchmark survey of U.S. direct investment abroad. In that year, such transactions accounted for 89 percent of affiliated royalties and license fees receipts and 93 percent of payments. In addition, preliminary indications from the 2006 survey of international trade in services are that transactions of

and products with R&D and testing services shows that R&D-related trade accounts for approximately 14 percent of total private services exports.

Imports of R&D and testing services were $5.0 billion in 2004, 1.9 percent of total private services imports. Payments in unaffiliated transactions of rights related to industrial processes and products were $2.8 billion. Assuming, again, that 80 percent of affiliated royalties and license fees payments were for rights related to industrial processes and products gives $14.4 billion in such payments, and a total of $36.9 billion for unaffiliated and affiliated payments With the $5.0 billion in R&D and testing services, R&D-related imports (broadly defined) was approximately 9 percent of total imports of private services.

**B) International investment income and position data**

This category consists of estimates included in the ITAs of receipts and payments of investment income, and outward and inward investment positions, for both portfolio and direct investment. As conventionally constructed, none of these estimates make use of information on R&D activity. Of the two, however, the direct investment estimates—where income results from a full range of firms' economic activities rather than simply from interest and dividends—require adjustment to account for changes in the measure of income to reflect the treatment of R&D as investment. The data used to estimate direct investment income and position are obtained from BEA's quarterly surveys of direct transactions between parent companies and affiliates. Lacking any information on R&D, as noted above, data from these surveys must be supplemented in order to account for the effects of treatment of R&D as investment in the income and position estimates. Fortunately, BEA does conduct other surveys of essentially the same group of companies in which information on R&D is obtained. These other surveys are the surveys on the operations of MNCs, the surveys underlying the data category discussed next. Given the extent of overlap of the two survey populations, using data from the operations surveys to

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rights related to industrial processes and products will account for the vast bulk of affiliated royalties and license fees transactions when estimates from that survey are released.

supplement data from the balance of payments surveys is, conceptually, relatively straightforward.

### C) Operations of MNCs

This category includes data on expenditures for R&D either performed by or funded by (or both) MNCs with operations in the United States. BEA collects R&D data in its surveys covering the finances and operations of U.S. MNCs and U.S. affiliates of foreign MNCs on a basis consistent with that used in NSF's surveys of Industrial Research and Development.[9] Annual series of BEA survey data on MNCs' R&D expenditures date back to 1989 for U.S. parent companies and their foreign affiliates, and to 1977 for U.S. affiliates. In benchmark surveys (currently conducted once every five years), data are collected on both R&D performance and R&D funding. Although both funding and performance data can be used as a basis for R&D investment estimates, funding data are preferred, as they more accurately identify the owners/beneficiaries of the R&D (this issue is discussed at greater length in the next section). In annual surveys (conducted in non-benchmark years), R&D data were collected on a funding basis until 1993 for outward direct investment data (i.e., for U.S. parents and foreign affiliates) and until 1996 for inward data (i.e., U.S. affiliates). Since those two respective years, annual data have been collected on a performance basis.

The MNCs' operations data are not used directly in any of the ITAs or NIPAs. However, just as physical capital investment data from the operations surveys are now used to adjust direct investment income and position data from the financial accounting basis upon which they are collected to the economic accounting basis used for BEA's published estimates, data on MNCs' R&D expenditures could be used to adjust the income and position data for the effects of treating R&D as investment. In addition, estimates of R&D investment and stocks derived from the operations data can themselves be compared to the R&D investment and stock estimates in the R&DSA. This comparison would facilitate efforts to gauge the role of MNCs in U.S. R&D, and to

[9] See appendix A for a more complete description of BEA's surveys of the operations of MNCs, and for the definitions used on those surveys for the type of activities considered R&D.

compare the extent to which U.S. parents focus their R&D activities in the United States or spread them overseas through their foreign affiliates.

In 2004, R&D expenditures, measured on a performance basis, were $152.4 billion for U.S. parents (85 percent of the U.S.-MNC total) and $27.5 billion for their majority-owned foreign affiliates (15 percent of the total). Performance expenditures were $29.9 billion for majority-owned U.S. affiliates. On a funding basis, U.S. parent expenditures were $148.2 billion and foreign affiliate expenditures were $25.9 billion. For majority-owned U.S. affiliates of foreign companies, the performance-based estimates of the cost of R&D performed by those companies in 2004 was $30.1 billion. In 2002, the latest year for which data were collected on both bases, funding-basis expenditures by U.S. affiliates were 94 percent of their performance-basis expenditures, the same percentage as for U.S. parents in 2004. Compared to R&D performance expenditures of all U.S. businesses of $208.3 billion, U.S. parents accounted for 73 percent and majority-owned U.S. affiliates accounted for 14 percent. Correcting for double counting in those instance in which a U.S. parent is also a foreign parent yields an estimate of 80 percent of all-U.S.-business R&D performance that was accounted by domestic or foreign MNCs.

Related to the MNC operations data is a project currently getting underway involving BEA, NSF, and the Census Bureau (which conducts R&D surveys on behalf of NSF). This project will link U.S. parent and U.S. affiliate R&D data from BEA's surveys of MNC operations with data from NSF's surveys of U.S. private industry R&D. The project will provide a more complete picture of R&D associated with U.S. and foreign MNCs.[10] The data link will provide information on the types of R&D conducted by MNCs (basic research, applied research, and development). For U.S. affiliates, the data link will provide state-level detail on the U.S. location of the affiliates' R&D activity.

[10] A report examining the feasibility of this data link project is available on BEA's Website at <www.bea.gov/international/pdf/FinalReportpublic.pdf>.

## II. Major conceptual questions

This section addresses a selection of conceptual issues of particular relevance in attempting to develop the most informative and accurate measure(s) of R&D capital stock for BEA's international R&D data. The first issue—who benefits from the knowledge generated by R&D?—is closely linked to the ownership of R&D-generated knowledge assets. In the national accounts, the owner of an asset is presumed to be its beneficiary, both because of an ability to use the asset in production and because of an ability to transfer ownership of the asset to another party. However, with knowledge, the link between owner and beneficiary is less clear-cut than with more tangible assets. The question of who benefits from R&D presents two conceptual problems from the perspective of economic accounting: spillovers and joint ownership. It also presents the somewhat more practical issue deciding whether to assign R&D ownership to the R&D funder or performer. The next three issues discussed are adjustment to R&D capital stocks for firm entry and exit, depreciation of R&D capital stocks, and construction of real estimates of R&D capital. For each of these, data beyond those currently collected by BEA would be very useful. The final two issues deal with consistency in translating the R&D data collected by BEA into estimates consistent with the R&D investment underlying R&D capital accumulation. Many of the issues discussed in this section are exceedingly challenging to address satisfactorily; even a full-fledged effort to treat R&D as investment in international data might have to skirt some of them. Although the list of issues considered in this section is not exhaustive, it serves to give a sense of the possibilities and limitations connected with a full-scale effort to treat international R&D as investment.

### A) Knowledge beneficiaries

The issue of who benefits from the knowledge capital created by R&D is problematic for efforts to treat R&D as investment in the same way as is done for the creation of physical capital. Like many other intangible assets, R&D-generated knowledge can be at least partly non-appropriable—that is, there often are some benefits that the owner cannot prevent others from enjoying—and at least partly non-rival in consumption—that is, one economic agent's use of the knowledge does not reduce the

amount of knowledge that is potentially available to another economic agent. These two characteristics make clear identification of the knowledge beneficiaries difficult.[11] They lead to separate difficulties in economic accounting, which is usually premised on the ability to make clear distinctions between assets and to clearly identify asset owners. To the extent that R&D-generated knowledge is non-appropriable, its creator (or subsequent owner) cannot extract some portion of the value of the knowledge from its ultimate users. As a result, the value to the owner of the R&D capital is less than its full value to society, so that the market transactions, which underlie the usual economic accounting methods, will understate the importance of R&D capital.[12] Put another way, non-appropriability results in spillovers of knowledge to others beside the legal owner(s) of the knowledge.

*i) Spillovers.* International knowledge spillovers have effects on economic accounting in the international context that are of the same nature as those that arise in a purely domestic context.[13] Specifically, the location of measured, private R&D investment capital stocks may be only tenuously connected to the location(s) of the actual beneficiaries of those stocks. Measures of R&D investment flows and the resulting capital stocks may give a misleading indication of the availability and distribution of

[11] Economic institutions and policies may mitigate the extent of non-appropriability, often purposely so. For instance, patenting is one method of limiting the unauthorized use of R&D generated knowledge. In addition, a firm often goes to great lengths to keep secret its unpatentable (or unpatented) knowledge. Modifying the size or scope of its activity is one way a firm might try to appropriate a greater share of the knowledge gleaned from R&D. For instance, the firm may become more vertically integrated to keep for itself knowledge that would otherwise become available to upstream or downstream firms. Another strategy might involve two competing firms that cannot keep their R&D knowledge from becoming known by each other merging to form a single larger firm. Finally the multinational firm itself may sometimes serve as a device for maintaining control of knowledge capital while gaining the benefits from its use around the world.

[12] Another economic outcome that often results from non-appropriability is that, if unsubsidized, the activity in question occurs less than is socially optimal. However, the fact that an activity might occur at a less-than-socially-optimal level does not, of itself, pose difficulty for the sort of economic accounting reflected in BEA's accounts.

[13] Domestically, in the 2006 R&DSA report, the issue of spillovers was deferred, other than noting its complexity and that fully accounting for spillovers would to move beyond the national accounts convention of measuring private, not public (social) values.

usable R&D capital in economic production, both domestically and internationally. Growth actually resulting from application of R&D-generated knowledge may be misattributed or unattributed.

From the U.S. perspective, even if its international accounts were adjusted to reflect the treatment of R&D as investment, they would not capture knowledge that spills over to other countries without explicit payment. Similarly, they would not capture knowledge that comes from other countries free of charge. Empirical estimates exist as to the size of certain types of R&D spillovers, but these are subject to a good deal of uncertainty and require numerous assumptions. In particular, empirical investigations typically focus on a specific mechanism through which spillovers might occur or on a specific domain in which they might operate. Further complications are that knowledge may spill over national borders at different rates than is the case within a given country; it may also spill over at different rates across different countries, or across different types of firms or industries.[14]

In this light, work on the international aspects of treating R&D as investment will follow the same route as taken for the main R&DSA. The likely existence of knowledge spillovers is acknowledged, but no attempt is made at this time to estimate them or correct the resulting distortions.

*ii) Joint ownership.* The second characteristic of knowledge—non-rivalry in use—is equally vexing. To the extent that R&D-generated knowledge is non-rival, one person's use of the knowledge does not diminish the ability of others also to use it.[15] (This is not to say that others' use of knowledge might not have consequences in the marketplace; for example, one firm could face lower demand for its product if a second, competing firm were to use knowledge belonging to the first.) One particular implication of non-rivalry is joint ownership. For instance, two or more non-affiliated firms may

[14] Although a review of the literature on spillovers is beyond the scope of this paper, the references at the end of the paper list several representative studies on R&D spillovers generally, international spillovers, and spillovers related to direct investment.

[15] A related characteristic of knowledge capital is that it does not "depreciate" due to use; it only depreciates in the sense that it diminishes in value through obsolescence.

collaborate on, and jointly own the results of, a given R&D project—a case exemplified by joint ventures among automobile manufacturers to develop and share common vehicle platforms or hybrid propulsion systems. Or, one firm may perform R&D, and transfer rights for use of the resulting knowledge to another non-competing firm without giving up its own usage rights. Perhaps most importantly for the present discussion, one entity (i.e., a parent or an affiliate) belonging to an MNC might perform R&D for use by other entities belonging to the same MNC, or for both itself and other MNC entities.[16] In all of these cases, a given firm will have the same degree of access to the knowledge derived from R&D as it would had it been the sole performer/owner/user of the R&D.

From the point of view of economic accounting, the simplest situation with respect to R&D by MNCs would be if each part of the company (parents and affiliates) performed R&D for its, and only its, needs. In practice, this not always the case. MNCs tend to centralize their R&D more than their production for reasons such as avoidance of R&D duplication (an avoidance made possible by non-rivalry in use), scale economies in research, or a desire to keep the generated knowledge secret. All else equal, R&D might naturally concentrate near company headquarters, but several other considerations (e.g., tax policy, labor or other input costs, opportunities to receive spillovers, research proficiency of the available labor force, and opportunities for collaboration with universities) affect R&D location decisions.[17]

A simple example illustrates the conceptual problem of accounting for non-rival R&D. Suppose that a U.S. company conducts research for itself that costs $3 million, generating process X—specific knowledge that it uses in production. Under the current methodology (and abstracting from depreciation), the research increases the U.S. R&D capital stock by $3 million. Later, the company acquires an affiliate in Country A, a market in which the company previously had not participated. As part of the acquisition,

[16] This case touches on both non-rivalry and non-appropriability—non-rivalry for reasons to be discussed in the paragraph that follows, non-appropriability in that the MNC itself may owe its existence, at least in part, to a desire to internalize what would otherwise become knowledge spillovers, as noted in footnote 11.

[17] See, for example, Feinberg and Gupta (2004) and Thursby and Thursby (2006a) and (2006b).

the new U.S. parent provides the affiliate—either with or without charge—the knowledge that is process X. However, due to non-rivalry, the U.S. parent retains the rights to use process X in its own production, just as it did before becoming a parent.

The problem is that it isn't clear conceptually what this new affiliation should mean for the size of R&D stocks in the United States and Country A. From one perspective, the U.S. R&D capital stock ought to remain the same, as the U.S. company has the same ability to use process X as before it took on the new affiliate. From another perspective, the R&D stock in country A should rise, as it now has access to process X. However, these two perspectives together imply an increase in the worldwide stock of R&D (and in the MNC's R&D stock) without any actual performance of R&D. Expressed differently, the problem is that the domain of measurement—the country—does not encompass the unit across which ownership of the R&D is shared—the MNC. Moreover, the non-rivalry in use means that the asset at issue can not be cleanly allocated in a way that the country parts sum to the world total.[18]

[18] One potential conceptual solution for this problem would be to assume that the value of the knowledge generated by R&D reflects all potential knowledge-sharing scenarios. In the example just presented, this would presume that the value of R&D is initially recorded such that it takes into account both its own use of process X along with the value of process X to the potential affiliate (and, for that matter, its value to any other company the R&D performer might wish to include as a shared owner or licensor). In fact, it might be reasonable to expect that the performer bears the $3 million costs of R&D taking into account all of these potential benefits, so that cost-based R&D data would largely reflect such value. Completing the example, when the performer shares the knowledge with its affiliate, part of the $3 million value of the knowledge is transferred away from the performer to the affiliate, even though the benefits which process X bestows on its own (the performer's) production is unaffected. The U.S. R&D capital stock falls and that of country A rises.

The "solution" just described is not fully satisfactory because it leads to a "sources of growth" problem. Suppose that U.S. GDP was unchanged from before the sharing of process X with the foreign affiliate to after its sharing. Suppose further that the only change to the U.S. capital stock was the decrease associated with the sharing of process X. Then there would be a decrease in the apparent use in the factors of production without a concurrent decrease in production itself. By default, measured productivity would rise, despite no actual change in productivity.

An important reason to measure capital holdings is to measure productivity and the sources of output growth. This goal would suggest that R&D stocks should be allocated to all locations where they are used for production. Allowing the affiliate in Country A to use non-rival R&D assets developed by its U.S. parent increases its productive capability (and by extension that of the host country) without diminishing the productive capability of the parent (and its country).[19] Therefore, from a theoretical standpoint, it could be argued that the affiliate's access to process X should be recorded as both an increase in its R&D capital stock and an increase in the MNC's and worldwide capital stock, on the grounds that the increase in stock represents a real increase in production possibilities and is not just an accounting anomaly.[20]

The unattractive aspect of this treatment is that R&D capital stock may vary independent of the level of current R&D activity. However, a number of forces tend to limit the likelihood of a significant quantitative disparity. As noted above, an MNC would be expected to choose its spending on R&D taking into account the fact the results may be shared. If this happened, the R&D cost would reflect the sharing arrangements. Further, the relatively high depreciation rate on R&D stocks should limit the quantitative effect of acquisitions unanticipated at the time of the original investment. When the stocks depreciate quickly, the current stock mostly reflects investment done recently.

Joint ownership also creates some practical difficulties for the measurement of R&D capital stocks using recorded payments and receipts. Two are notable: flows of knowledge that are ambiguously priced (perhaps for strategic reasons), and flows that occur without payment. For the issue of ambiguous pricing, consider another example: Two affiliated firms within an MNC face a common technological challenge and jointly finance a research venture. How much of the ownership of the R&D should be allocated to each? Both will have full access to the resulting knowledge, but one may benefit more than the other (for a variety of possible reasons), so splitting the ownership in half is not

[19] See McGrattan and Prescott (2007) for a theoretical illustration.

[20] This effect is not just an international issue. If a U.S. MNC acquires an additional establishment within the United States and allows it to use the parent's R&D, U.S. productive capability increases. The capital and labor in the new establishment is more productive with the parent's R&D than without it, just like in the international case.

the obvious solution. From the perspective of the unified MNC, however, tax or other considerations may make it advantageous to skew the costs towards one firm. Economic accounts that measure R&D ownership by funding can mislead for this reason. This is conceptually similar to transfer pricing problems with sales of tangible goods between related parties, but the scope for cost shifting is likely greater here due the nature of joint ownership and the greater uncertainties surrounding the values of intangible assets.

That at least some portion of R&D is shared without any payment at all to the R&D performer is another possibility. For instance, a U.S. parent might fund and perform all of an MNCs' research. While it may receive royalty payments for some of the more easily defined knowledge outputs, some of the resulting knowledge might be more amorphous, or *tacit*, and shared with its affiliates without charge. To the extent this occurs, the R&D capital stock of affiliates would be understated.[21]

*iii) Funder versus performer.* Aside from spillovers and joint ownership, one other aspect of the question of who benefits from R&D requires mention. Even if it is assumed that R&D can be cleanly measured and allocated, to which of the various parties associated with R&D or R&D-related transactions should R&D be connected? As observed by Moris, R&D might be connected to the R&D performer, its funder, or its user, with each different connection serving a different accounting perspective.[22] From the perspective of the relationship of R&D capital to production, it seems most reasonable to connect R&D with its user, that is, to assume that the benefits of R&D accrue to its user (whether the user is the performer, the funder, or neither). Survey data, however, usually do not identify the users of R&D capital. The MNC operations data, in particular, focus on R&D expenditures, documenting either R&D funding or R&D performance activity.

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[21] The provision without charge of intellectual property (or other failures of U.S. economic accounts to capture flows of intellectual property) is at the heart of the "dark matter" explanation of persistence in international investment position imbalances. However, the dark matter idea does not require that assets be jointly owned. For more on dark matter, see Hausmann and Sturzenegger (2006) and Kozlow (2006).

[22] Moris (2007), (p. 13).

The expenditures data collected in the MNC operations surveys underlie the entire calculation of R&D capital in the perpetual inventory method. From those expenditures data, R&D investment is calculated, allowing, in turn, for the calculation of R&D capital stocks and depreciation. The calculation of R&D investment must be based either on performance expenditures or funding expenditures. In the R&DSA, investment is estimated on funder basis, as it is the funder that is normally the legal owner of the R&D.[23] With respect to MNCs' R&D, the issues are quite similar to those that arise for domestic investment in the R&DSA. Operations data are available on either R&D funding or R&D performance (though, often only one of the two). When possible, R&D capital estimates for MNCs should be based on funding, rather than performing, expenditure data.[24]

**B) Entry and exit**

An issue particularly relevant to estimates based on the MNC operations data is firm entry and exit from the MNC universe (population).[25] Specifically, whenever a firm becomes part of an MNC—by acquiring/establishing an affiliate overseas or by being acquired/established by a parent in another country—the MNC R&D capital stock rises, apart from any R&D investment that might occur. Similarly, exit from the universe results in a drop in the capital stock unrelated to current depreciation. The issue is actually somewhat broader: acquisitions of same-country firms by entities belonging to MNCs (or divestitures to same-country buyers of parts of such entities) also change the stock of R&D capital without investment (or depreciation) *per se*. Surveys on the operations of MNCs' do not collect data on such changes in the R&D capital stock, so any estimate of changes in this stock based solely on investment and depreciation will be biased downward (assuming that entries generally exceed exits).

[23] Okubo et. al. (2006), p. 15.

[24] The order-of-magnitude estimates presented later base R&D investment estimates on funding data when possible. However, for several years, only performing data are available. In such years, R&D funding is estimated from the performing data.

[25] The definition of direct investment used for BEA's surveys of MNCs (including operations surveys) requires a parent ownership share of affiliates outside the country of the parent of 10 percent or higher.

Data that might help to estimate the effects on R&D capital of entry (as broadly construed to include the effects of entry, exit, and same-country acquisitions and divestitures) are available to varying degrees from surveys on the operations of MNCs. Information on instances of entity entry and exit is collected on MNC surveys, but it can be somewhat noisy as some cases of apparent entry/exit are actually due to reorganization or to changes within the MNC universe in the ownership of existing entities. Part, but not all, of this noise can be removed with some effort. Information on entry and exit might be combined with data on variables correlated to R&D stocks (such as physical capital stocks or R&D investment flows).[26] In addition, surveys of new investment in the United States include total assets data for entering U.S. affiliates and acquisitions of existing affiliates.[27] However, information on same-country acquisitions or divestitures is not generally available for U.S. parents or for their foreign affiliates.

Alternatively, data are available on the size of physical capital investment and depreciation flows relative to overall changes in physical capital, permitting the calculation of the entry effects on physical capital stock as a residual. To the extent that the relative sizes of R&D-capital entry effects are assumed to be similar to those of physical capital, the latter may provide the basis for producing estimates of the R&D entry effects.[28] However, the residual is quite noisy; differences in the type of stock measure used for physical capital, and the possibility of other reasons for changes in the physical capital stock make for a rather crude adjustment even at the aggregate level. At more detailed levels, such an approach may not be fruitful.

[26] But note that the correlation of industry-level physical capital with industry level R&D is *not* particularly high. Within industries (or, at least, certain industries) the correlation might be higher.

[27] These data are not netted against exits and divestitures, so are somewhat limited in their utility.

[28] The order-of-magnitude estimates presented later in this paper incorporate this methodology.

### C) Depreciation

A good deal of attention in work on the R&DSA has been, and continues be, paid to the issue of the appropriate rate and methods to use in depreciating R&D capital. As observed in the 2006 report, R&D capital depreciation results from obsolescence or leakage, not actual deterioration or loss of knowledge.[29] R&D depreciation rates generally are not objects of direct observation. Some researchers have attempted to estimate depreciation rates, but the ranges of estimated depreciation rates are large and the correct pattern of depreciation is uncertain.[30] In principle, both rate and pattern may vary widely across industries and types of R&D.

Despite the uncertainty, depreciation methods and rates applied in the R&DSA to the R&D capital stock of U.S. private industry are likely to be appropriate for the stocks of U.S. parents and U.S. affiliates, given their high share of U.S. R&D funded and performed. For foreign affiliates, the issue is less clear, for at least two reasons. First is the that the nature of R&D as performed and used outside of the United States by foreign affiliates may differ from that in the United States.[31] Particularly in less technologically advanced areas, R&D may be heavily weighted towards development and away from basic research. Affiliates may gear their own R&D towards adapting parents' existing products and processes to local conditions rather than toward creating something more unique.[32] Also particularly in less advanced areas—though this may be less of an issue

[29] Leakage (from the R&D owner to its competitors) is surely a source of depreciation from a private perspective, but is much less surely one from the perspective of the economy as a whole.

[30] The 2007 R&DSA report considers research on R&D depreciation rates at greater length.

[31] The number of studies on R&D depreciation rates in foreign countries is limited compared to studies on depreciation rates in the United States. However, see Schankerman and Pakes (1986) for a study focusing on patent rights in Europe. Estimated depreciation rates in that study vary widely over time and country. Given the wide range of rates in U.S. and foreign studies, it would be difficult to determine whether foreign rates differed fundamentally from U.S. rates, even if a greater number of studies were available on foreign depreciation rates.

[32] Feinberg and Majumdar (2001) find evidence of this in the Indian pharmaceutical industry.

for foreign affiliates than for indigenously owned firms—R&D might be geared to "imitation" as opposed to "innovation," activities that might have different life-cycle expectations.

Another reason that U.S. R&D depreciation rates may differ from those of foreign affiliates is differences in the legal, regulatory, and competitive environments. If intellectual property protection is weaker or more narrow in one country than another, or if a patent expires more quickly in one country than another, R&D capital might be expected to obsolesce or leak at a more rapid rate in the former country.[33] A similar result might occur if labor market institutions permit employees involved in the performance of R&D in one country to leave a firm and find a job at another, or to found a new firm, more easily than in another country. The quality and size of the pool of potential researchers in one country relative to that in another might also affect the rate at which a given research investment depreciates. In particular, if a country's researchers are relatively weak in a given technological area and therefore slow to generate knowledge that renders earlier ideas obsolete, any research result that is obtained in that area might depreciate relatively slowly,

This paper does not aim to provide answers to the question of how foreign affiliate depreciation rates actually do differ from U.S. rates, leaving that to a future stage in the project. In that prospective stage, the most expedient approach will likely start with industry-level rates used in the R&DSA and supplement them with evidence (or plausible arguments) for incremental differences.

### D) Construction of constant-dollar estimates

Another matter of significant ongoing import in the R&DSA work is that of finding an appropriate method to deflate R&D investment in creating real (that is,

[33] This presumes that the worldwide economy is less than fully open or fully integrated in some manner. If firms compete without frictions against all global competitors, a U.S. firm would be just as worried about British or Chinese R&D rendering its knowledge obsolete as about U.S. R&D (or as worried about knowledge leakage to competitors in those countries as to U.S. competitors). It is probably safe to assume that, at least for some industries, such a frictionless marketplace does not hold.

constant-dollar) measures from current-dollar data. To be fully satisfactory, the deflation method must be capable of revealing productivity growth in the performance of R&D. The fundamental problem is the lack of R&D prices indexes, a situation due both to the difficulty in measuring a "unit" of R&D and to the fact that only a small share of R&D performed is sold on the open market. The 2007 R&DSA uses two separate types of prices indexes to deflate prices of domestic R&D—one is based on input costs and the other on output prices in R&D-investing industries—but neither directly measures prices of R&D output itself.

Work on this stage of the international R&D capitalization project will bypass the issue of R&D price deflation. Deflation is required to convert current-cost capital stock estimates in one year to current-cost estimates in the next, but not to develop current-dollar investment estimates. These current-dollar estimates will be the only investment estimates addressed at this stage. Later-stage work—if it generates constant-dollar estimates—will draw on methods developed for the R&DSA, along with data—to the extent available—on relevant foreign prices. Because such work is potentially quite extensive given the number of countries involved and the variety in the data definitions and detail over countries, the expected benefits of the work should be assessed relative to available resources.[34] For the R&D of foreign affiliates in host countries without detailed price data, data could be deflated by broad purchasing power parity price indexes.

**E) Treating R&D as investment, consistency adjustments**

The estimates of R&D investment that feed into estimates of R&D capital are primarily based on survey data of R&D expenditures. However, R&D expenditures data collected on surveys are not necessarily entirely consistent with the relevant economic accounting definitions for R&D investment. To convert expenditures data to investment estimates, certain adjustments are necessary (or at least desirable). This section identifies several possible adjustments that might be made to R&D expenditures so that they more accurately reflect R&D investment. However, note the following caveats: 1) it may not

[34] At least initially, this work could be modeled after procedures currently used by BEA's balance of payments division to deflate capital stocks of U.S. and foreign affiliates in constructing current-cost measures of the international investment position.

be possible to make some of these adjustments given available data; 2) even if it were possible to make all of them, their effect would likely be relatively small.

For the R&DSA, international R&D data supplement the primary data on domestic R&D expenditures from NSF; imports of R&D are added into domestic investment and R&D exports are subtracted. Given the current classification system described in the previous section, the imports included in domestic R&D investment would consist of the R&D portion of R&D and testing service payments, and that part of payments for rights related to industrial processes and products involving a transfer of ownership (and, possibly, long-term leases with similar characteristics). Similar distinctions apply to exports. Neither of these parts are extractable from the larger categories to which they belong. Testing services are thought to be a minor component of R&D and testing services. Much of the value of payments for rights related to industrial products and processes may be for the short-term rental of R&D output; such transactions should not be considered to be transfers of capital. However, the exact magnitude of this material exclusion is unknown. The 2007 R&DSA report uses data on trade in R&D and testing services, but it will not use data on trade in rights related to industrial products and processes.

For the MNC operations data, several adjustments might, in principle, be made to make them more comparable to NIPA estimates and with R&D investment as defined (though not necessarily currently implemented) for the R&DSA. First, the R&D expenditures data are collected on a fiscal-year basis in the operations surveys. For consistency with the ITAs and NIPAS, these should be converted to a calendar-year basis. The adjustment would likely be relatively small as well over half of operations data are from firms whose fiscal year coincides with the calendar year. Operations surveys do request information on the ending date of the fiscal year used on each report, but the adjustment made possible by this information would be somewhat rough.

Second, the R&D (funding) expenditure data do not completely adjust for post-funding purchases and sales (or leases) of R&D output.[35] Such an adjustment would be

[35] The post-funding transactions should be accounted for in the MNC R&D expenditure estimates for the same reason that domestic R&D investment data should be

very difficult to make in practice. Although the funding data collected on BEA's surveys of MNC operations do appropriately include data on R&D performed by others on the MNC's behalf, they do not include purchases of already-completed R&D. Similarly, they do not exclude own-account R&D that is later sold to an outside party. While a portion of post-funding transactions are reportable on surveys of international trade in services, transactions that involve a domestic (or, for foreign affiliates, host country) partner are not. For foreign affiliates, transactions involving a third-country partner are also not covered.

A third adjustment that would move the operations data in the direction of consistency with the R&DSA is to remove current-year expenditures on computer software that currently are included in own-account R&D data and add back in the current-year depreciation of the stock of computer software (in essence, treating software as a capital good rather as a current expense).

Fourth, and related to the third adjustment, the depreciation of physical capital that is implicitly included in own-account R&D expenditures could be adjusted to reflect actual economic depreciation of current-cost capital stocks, rather than financial depreciation of historical-cost capital stocks. Although MNC data do not exist to make this or the third adjustment, if work on the domestic R&DSA shows that these adjustments are quantitatively important, scaling factors might be inferred and borrowed from their work.

Fifth, existing R&D capital might be used in the generation of new R&D capital. To the extent that it is, R&D capital depreciation should be added into the R&D investment measure, following the treatment used for computer software and physical capital. Again, data upon that could be used to calculate such an adjustment are not available.

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adjusted for imports and exports of R&D. That is, these post-funding transactions are another channel—besides the funding of new R&D or the depreciation of existing R&D—through which the stock of R&D capital changes

Finally, survey data should be adjusted to include R&D in the social sciences and humanities and to exclude expenditures for commercialization.[36] This last adjustment would bring R&D estimates into line with *Frascati* Manual definitions of R&D. Data are not collected in surveys of MNC operations that would allow for calculation of this final adjustment. If this adjustment, or any of the other adjustments previously mentioned for which MNC data are lacking, were to be made, they would have to be based on outside data. Where possible, and where such adjustments are made in the R&DSA, they would likely follow those adjustments to the R&DSA estimates.

As just discussed, several adjustments could, if the needed data were available or could be reliably estimated, be made to bring data on MNCs' R&D expenditures into closer agreement with the appropriate notion of investment in R&D. Whether the resulting benefits would merit the resources needed to do so is a separate question, particularly if changes to surveys are contemplated. Worth considering in this regard is how much or how little attention is given to similar issues concerning MNC physical capital data. While the details of BEA's treatment of international data on physical capital are beyond the scope of this paper, in general the approach is to collect physical capital data on the basis most readily provided by MNCs (e.g., fiscal-year data, historical-cost stocks with depreciation based on financial accounting rules). To date, adjustments generally have been made only in applications connected to ITA or IIP estimates, and only at the aggregate level or other relatively high levels of aggregation.

**F) R&D trade data consistency**

The current classification scheme used by BEA differs somewhat from the international standards recommended by the International Monetary Fund in the current *Balance of Payments Manual (BPM5)* and from the (different) scheme likely to be recommended in the next balance of payments manual (*BPM6*). In *BPM5*, outright sales of R&D-generated intangible property (such as patents) are to be excluded from the current account altogether and, instead, recorded in the capital account.[37] Only

[36] Okubo, et. al. (2006), p.16 (table A).

[37] International Monetary Fund (1993), paragraph 358 (p.84-85).

transactions related to the *use* of such intangible property, without outright transfer of ownership, are to be recorded as royalties and license fees.[38] The most recent draft of *BPM6* recommends that outright sales of intangible assets resulting from R&D be recorded as R&D services trade.[39] Under this recommendation, the distinction between the transactions of R&D capital classified as R&D services trade and those classified as royalties and license fees (renamed "fees for franchises and other proprietary rights") hinges on the ownership of the R&D results, rather than on the timing of the research relative to the transaction. That is, regardless of whether the R&D results from a purchaser entering into a specific arrangement to have the R&D performed on its behalf, or from a purchaser identifying and choosing to buy an existing R&D result, the transaction will be classified as R&D services trade as long as the ownership to the R&D result is transferred. To the extent that rentals or leases of rights to tangible assets do not increase the quantity of capital stock accounted as held by the renter/lessor, the new recommendation may lead to a cleaner measure of national holdings of R&D capital stocks, as all transactions in the R&D services trade can be included and all transactions in rights to intangible assets can be excluded for the purposes of computing the U.S. R&D capital stock.

## III. Data issues

This section moves away from conceptual issues to look at practical issues that must be confronted in constructing estimates of international R&D investment and capital stock values, as well as those of associated data items. The order-of-magnitude estimates in the next section incorporate decisions regarding several such issues, ones that are affected by considerations of both estimate precision and application simplicity. This section examines some of these issues—data series length, other related data, and level of

[38] In practice, BEA occasionally records outright sales of R&D-generated intangible assets in the capital account, as recommended by BPM5—rather than in the royalties and license fees category of the current account, as is typical practice. It does so primarily when the transactions are very large and can be definitively identified as sales.

[39] International Monetary Fund (2007), paragraphs 136 and 138 (p. 210-211).

aggregation of the estimates—at a higher level of generality than is done in that section. Compared to the order-of-magnitude estimates described there, the research plan is for estimates made in future stages of the project to treat international R&D as investment to place greater emphasis on data precision, at the expense of simplicity in application. This section also considers possible changes to BEA surveys that would enhance the ability to generate accurate international R&D capitalization estimates.

It is worth emphasizing that a number of the problems that the paper identifies are fundamental in the sense that they are not likely to be fully resolved simply by collecting more data. Some are problems conventional to many surveys, such as differing definitions across surveys, and can be resolved or mitigated in future releases by changing surveys. Others are more fundamental, stemming from an absence of market transactions or lack of an agreed accounting treatment. A number of the issues discussed in Section II are data issues of this sort.[40] Therefore, unless the market changes and R&D assets become widely traded or accounting rules change to require full capitalization of R&D, solutions to these problems are unlikely to come from survey data alone. Instead, solutions will either require significant use of imputations and other non-survey methods or will be limited by the market portion of the R&D transactions.

**A) Length of data series**

The estimates produced for the 2007 R&DSA apply to the years 1959 to 2004. International R&D data do not date back quite as far. Data on international trade in R&D date back only to 1986 for unaffiliated transactions and only to 2001 for affiliated transactions. Unaffiliated payments and receipts data on royalties and license fees for industrial processes date back to 1987.[41] For use in the domestic R&DSA, it is necessary to extend data series back to 1959 (or at least as far back as the magnitudes of the estimates remain material).

[40] For example, the entry and exit issues discussed arise not just because surveys do not ask for data on R&D stocks of acquired and divested firms. The balance sheet of an acquired affiliate does not have an entry that corresponds to current value of all R&D assets, so it will be difficult to ask questions that would elicit useful information.

[41] As noted earlier, regular data collection on this type of royalty and license fees for affiliated transactions was only initiated in 2006.

Data on MNCs' R&D expenditures extend back to different years for inward and outward investment. Data for U.S. affiliates are available annually for 1977-2004, and (separately) for 1974. Data for U.S. MNCs are available annually for 1989-2004, with single-year estimates also available for 1966, 1977, and 1982. There are two basic questions: can expenditure data for missing years be estimated with reasonable precision (and, if so, for how many missing years), and how many years of estimates of R&D capital will this support? The order-of-magnitude estimates in the next section carry both of these series back to 1966; carrying the series back this far likely has little effect on estimates for the most recent years but may be misleading for the early-year estimates. Thus, for any publicly disseminated estimates, it may be prudent to begin the series somewhat later or to flag the estimates for early years as experimental and subject to error.

**B) Related data**

Aside from the R&D capitalization estimates themselves and their effects on other key data items such as those discussed in section I and featured in the order-of-magnitude estimates, the capitalization estimates have potential implications for some other data items published by BEA. In the MNC operations data, for instance, changing the treatment of R&D might oblige a change in published estimates of income statement items (e.g., total costs and expenses, costs of goods sold) and balance sheet items (e.g., total noncurrent assets, accumulated depreciation, retained earnings). There are at least three options: 1) ignore the implications for these items, continuing to publish estimates on the present basis (that is, a financial accounting basis); 2) change the treatment of these items to fully reflect the change in the treatment of R&D; 3) publish data on both bases. In the initial efforts to quantify the effects of treating R&D as investment, adoption of the first option would probably be the most prudent course. If the treatment of R&D as investment later expands to more cover disaggregated estimates, the second option might be considered, but only if the R&D investment and capital stock estimates are put on a consistent basis with physical capital estimates; either the R&D estimates would need to remain on a financial accounting basis or the physical capital estimates

would need to be adjusted to an economic accounting basis. Resource constraints and disclosure concerns likely would make the third option infeasible.

**C) Level of aggregation**

Surveys of international trade in services collect data by industry of the U.S. transactor, and by country of the participating foreign transactor. Published estimates of this trade focus on the country dimension. Estimates of R&D trade by U.S. industry are not published externally.[42] For purposes of extending the R&DSA in the industry dimension, estimates of trade by industry are needed. Unpublished data collected on these surveys are available, but confidentiality restrictions may limit their usefulness by restricting the extent of industry disaggregation. The 2007 R&DSA will make use of these unpublished data to generate estimates for a moderate number of industries.

In the MNC operations surveys, data are collected by country of location of foreign affiliates, for outward investment, and by country of ultimate beneficial owner (UBO) for inward investment.[43] Information is also collected on the industries of U.S. parents, their foreign affiliates, and U.S. affiliates of foreign companies. For the order-of-magnitude estimates included in this paper, the estimates shown are all at the aggregate level, but future work might produce more disaggregated estimates. However, substantial resources would likely be required to produce and suppress disaggregated estimates; this presents a major obstacle to their actual production.

From a practical point of view, even if sufficient resources could be obtained, data suppression still would pose some difficulty. The problem is that each year's R&D capital stock estimate is built up as a (modified) sum of R&D investment data over prior years. For any estimate that is formed as the sum of several other estimates, suppression of one any one component requires suppression of at least one other component, or of the

[42] However, unpublished, industry-level data have been used in a limited number of research studies including Robbins (2006b) and Yuskavage, Strassner, and Medeiros (2006).

[43] For inward investment, information is also available on the country of the foreign parent (immediate owner), but data on U.S.-affiliate operations are usually presented by country of UBO.

sum itself, if the sum is not to reveal the originally suppressed component. As a result, the suppression of a single year's investment data generally would require suppression of capital stock data for the next several years.[44]

Another issue is that, compared to estimates of tangible capital investment and stocks in the NIPAs or that used to adjust the ITAs, estimates of R&D as investment are more likely to rely on assumptions that are the product of educated guesswork (as with the depreciation rates applied, for example). These assumptions might be different for different countries as well as different industries and differences in assumptions could inadvertently drive differences in results for the various data subcategories.[45]

Aside from the question of the level of aggregation at which estimates are published is the question of the level of aggregation at which data are kept in BEA's internal databases. In principle, estimates of R&D investment and R&D capital stocks could be carried down to the level of the individual affiliate or parent in the same way that value added estimates are currently constructed.[46] One particular advantage to such an approach would be relative simplicity in dealing with industry changes of MNCs, whether due to changes in the activities of the MNCs or due to industry redefinitions (e.g., the switch from SIC to NAICS). A disadvantage is that the existence of firm-level (internal) "estimates" that are not directly tied to reported data could lead to a false sense

[44] For data going forward, this might be less of a problem as one year's investment data can intentionally be suppressed to cover the previous year's suppression, without leading to several years of suppression of capital stocks. For data going back, the investment data have already been published, and thus cannot be arranged to minimize suppression in the stock series.

[45] As a concrete example, suppose that R&D held by foreign affiliates in less developed countries is, due to relatively weak protection of intellectual property, assumed to depreciate more quickly than R&D held by affiliates in developed countries, and this assumption is built into the estimation process. This built-in assumption may itself be a primary driver of differences in the measured rates of growth of R&D capital stocks in the two areas.

[46] This does not mean that value added estimates at the affiliate or parent level are publicly available; it simply means that the published estimates at any level of aggregation are constructed by summing the value added estimates for each individual affiliate or parent in the relevant population.

of precision that would not arise if the only estimates were of higher-level aggregates (and could result in estimates with too much detail being published).

### D. Data needs (potential survey changes)

This section discusses potential changes to BEA surveys that might improve the accuracy of international estimates that treat R&D as investment. Two possible changes stand out. In the surveys of trade of international services and intangible assets, collecting data on sales separately from data on rentals (or other such limited arrangements) of R&D intangible property, rather than together as is current practice, would help clarify the actual transfer of R&D capital across borders. This change would require that BEA determine how it wants to distinguish sales from rentals, that this distinction be clear to survey respondents, and that respondents be able to accurately provide the separate data. Of these, respondent ability to provide the data might be most problematic. The second change applies to MNC operations surveys. On those, collecting data on R&D funding annually rather than just in benchmark surveys, in place of (or in addition to) R&D performance would provide for greater accuracy in estimating R&D investment, an improvement that would be particularly useful in the context of disaggregated estimates.[47]

Other possible changes would lead to data requests that would either be more difficult for reporters to provide or would provide smaller incremental benefits in estimating R&D capital than the two changes just identified. In the surveys of trade in services, testing might be broken out of the research, development, and testing category. Financial and operating surveys of direct investment might (perhaps only in benchmark years) ask for a breakdown of R&D by type—basic research/applied

[47] Data on R&D funding is, as already noted, collected in benchmark years. The collection of R&D performance data has justifications of its own, unrelated to the treatment of R&D as investment, so collecting both types of expenditures might be the preferred alternative. Among these justifications, performance data can shed light on the technological capabilities of the firms involved or on shifts in comparative advantage in R&D.

research/development or some similar taxonomy.[48] This would be of potential benefit in applying depreciation rates, as basic research, for example, is often viewed as depreciating more slowly than applied research or development.

The operations surveys might also request data that would assist in understanding joint ownership of R&D by the various entities comprising MNCs. For instance, where benchmark surveys currently ask for a breakdown of

(1) own-account performance/funding,

(2) performance for others, and

(3) funding of others.

It might instead ask for a breakdown of

(1') strictly-own account performance,

(2a') performance jointly funded by self and others,

(2b') performance strictly for others,

(3a') joint funding of R&D performed by others, and

(3b') individual funding of others.[49]

Finally, in order to obtain additional information on R&D costs, the operations surveys might collect data on compensation paid to R&D employees, to go along with the data collected on the number of such employees.[50]

[48] Recall that the project linking BEA's MNC operations data with NSF's U.S. private industry data will provide information on the type of R&D conducted by U.S. parents beginning with the 2004 data.

[49] "Others" here may itself be further broken down. For example, the 2004 benchmark survey of U.S. parents requested data on R&D performed for the parent itself, for its foreign affiliates, for the federal government, and for all others.

[50] The surveys of outward direct investment collect data on numbers of R&D employees only for benchmark years. The surveys of inward direct investment collect such data annually.

## IV. Order-of-magnitude estimates

This section presents order-of-magnitude estimates that illustrate the effect of treating R&D as investment in selected international data and that complement the central 2007 R&DSA estimates. It also presents and describes the simple methodology used to generate the estimates. The effects of treating R&D as investment are carried through to several international-data annual time series estimates. Data from surveys of the operations of multinational companies (MNCs) permit the estimation of R&D investment, capital stock, and depreciation from 1966 to 2004. From these estimates, estimates are made of MNC value added for 1994-2004 and selected earlier years, of current-dollar direct investment income and related data for 1966-2004, and of the current-cost direct investment position for 1976-2004. For the most recent year, 2004, the estimates increase direct investment income and the direct investment position by approximately 4-9 percent and generate increases in MNC value added in the same range. However, they have only small effects on balances and on higher-level ITA and IIP values. The effects of the estimates are reasonably robust to differences in assumptions. The following shows the effects, measured in billions of current dollars, of treating R&D as investment on several key 2004 estimates.

| 2007 R&DSA international estimates for 2004 | With R&D as invest-ment | With R&D as an expense | Differ-ence | Percent differ-ence |
|---|---|---|---|---|
| Foreign affiliates' value added | 824.3 | 850.2 | 25.9 | 3.1 |
| U.S. parents' value added | 2,215.8 | 2,364.0 | 148.2 | 6.7 |
| U.S. affiliates' value added | 511.5 | 539.6 | 28.1 | 5.5 |
| Direct investment income (balance) | 139.4 | 140.7 | 1.3 | 0.9 |
| (+) Outward | 239.0 | 249.0 | 10.0 | 4.2 |
| (-) Inward | 99.6 | 108.3 | 8.7 | 8.7 |
| International investment income (balance) | 56.4 | 57.7 | 1.3 | 2.3 |
| (+) Outward | 401.9 | 411.9 | 10.0 | 2.5 |
| (-) Inward | 345.6 | 336.9 | 8.7 | -2.5 |
| Current account (balance) | -640.1 | -638.8 | 1.3 | -0.2 |
| (+) Exports of goods and services and income receipts | 1,559.2 | 1,569.2 | 10.0 | 0.6 |
| (-) Imports of goods and services and income payments | 2,114.9 | 2,106.2 | 8.7 | -0.4 |
| (+) Unilateral current transfers (net) | -84.4 | -84.4 | 0.0 | 0.0 |
| Rest of the world corporate profits (net) | 176.3 | 177.6 | 1.3 | 0.7 |

| 2007 R&DSA international estimates for 2004 | With R&D as investment | With R&D as an expense | Difference | Percent difference |
|---|---|---|---|---|
| Direct investment position (net) | 721.4 | 697.2 | -24.2 | -3.4 |
| (+) Outward | 2,463.6 | 2,588.7 | 125.0 | 5.1 |
| (-) Inward | 1,742.2 | 1,891.5 | 149.2 | 8.6 |
| International investment position (net) | -2,294.4 | -2,318.6 | -24.2 | 1.1 |
| (+) Outward | 9,257.1 | 9,382.1 | 125.0 | 1.4 |
| (-) Inward | 11,551.5 | 11,700.7 | 149.2 | 1.3 |

In brief, the methodology uses perpetual inventory methods to create estimates of R&D capital stocks for U.S. parent companies, their foreign affiliates, and U.S. affiliates of foreign companies. The treatment of R&D as investment does not affect the measurement of cross-border trade in goods and services, but it does affect U.S. receipts and payments of investment income in the current account of the ITAs and it affects the IIP.[51] Various measures of the operations of multinational companies also are affected. However, as those measures do not enter BEA's national accounts, changes to those measures do not affect the domestic R&DSA data. Estimates of some other international data that do affect national R&DSA estimates—specifically, estimates of R&D service imports and exports—are not presented here, as they have been separately incorporated into the domestic R&DSA.

Data on U.S. receipts and payments of investment income come from BEA's surveys of direct investment balance of payments transactions, where financial accounting rules are followed that generally treat R&D costs as current expenses. Furthermore, these surveys do not collect information on R&D that would permit BEA to generate alternative income estimates based on the assumption that R&D should be capitalized and the resulting stocks depreciated, rather than being expensed. However,

[51] Although treating R&D as investment does change the treatment of R&D stocks that have been obtained through international trade, it does not affect how the trade itself is recorded in the ITAs. Therefore, as noted previously, treating R&D as investment has no effect on the balance on goods and services trade, as the flow of R&D service transactions continues to be recorded as previously. However, its treatment as investment has an effect on the broader current-account balance through its impact on income payments and receipts.

separate, but related, BEA surveys on the operations of MNCs do collect R&D expenditure data. From these data, estimates of R&D investment and capital stocks are generated, which, in turn, are used to adjust (for purposes of this exercise) existing estimates of the rest-of-the world component of corporate profits in the NIPAs, the direct investment income items in the ITAs, and the IIP. In addition, these estimates of R&D investment and capital stocks permit the generation of modified MNC-value added estimates, which are broadly consistent with the current-dollar GDP estimates featured in the R&DSA.

A key to the approach taken is to construct—separately for U.S. affiliates of foreign MNCs, U.S. parent companies, and foreign affiliates of U.S. MNCs—annual estimates of R&D capital stocks (and other associated data items) for MNCs. As in the R&DSA, the perpetual inventory method is used to generate the stocks. Under this method, an end-of-previous-year capital stock value is adjusted with current-year data on investment flows and depreciation to generate an end-of-current-year capital stock estimate.[52] Depreciation is estimated, also as in the R&DSA, under the assumption that the value of R&D capital decays geometrically. Using a time series of investment data, a time series of capital stock estimates is constructed recursively.

The estimation of MNC operations data proceeds in three main steps: (1) conversion of R&D expenditures into R&D investment, (2) calculation of current-cost capital stocks (measured in current dollars), (3) and adjustment of value added estimates to account for treatment of R&D as a capital good. For these initial estimates, no conversion of current-dollar values into real (constant-dollar) values has been attempted.[53] Below is a discussion of the methodologies involved with each of these

[52] The term "amortization" is frequently used with intangible assets to denote a decay-in-value concept parallel to that of depreciation for tangible assets, one that, particularly for R&D, results primarily from obsolescence (rather than, for example, deterioration). This paper instead follows the convention used in the R&D satellite project of applying the term "depreciation" to both tangible assets and R&D capital.

[53] The term "current-dollar" (or "in current dollars") is used primarily in discussions of flow variables. In contrast, the related term "current-cost" is used primarily in discussions of stock variables. The flow variables derived here (e.g., R&D investment, value added, direct investment income) are presented in current dollars and,

three steps, as well as the methodology for using these operations-data estimates to adjust direct investment income receipts and payments, the rest-of-the-world component of corporate profits, and the IIP. A summary of the estimates follows the discussion.

**A) Conversion of MNC R&D expenditures into R&D investment**

The methods used elsewhere in the R&DSA to convert domestic R&D expenditures into R&D investment are taken as a model for this step. In brief, domestic R&DSA uses data from NSF surveys and adjusts them in several ways for greater consistency with NIPA definitions. The starting point of the order-of-magnitude estimates discussed here is data from BEA's financial and operating surveys of U.S. MNCs and U.S. affiliates of foreign MNCs. These data are collected on a basis consistent with that used in NSF's Survey of Industrial Research and Development. Annual series of BEA survey data on MNCs' R&D expenditures date back to 1989 for U.S. parent companies and foreign affiliates, and to 1977 for U.S. affiliates.[54] On benchmark surveys (currently conducted once every five years), data are collected on both R&D performance and R&D funding. In annual surveys (conducted for non-benchmark years), R&D data were collected on a funding basis until 1993 for outward direct investment data (i.e., for U.S. parents and foreign affiliates) and until 1996 for inward data (i.e., U.S. affiliates). Subsequently, annual data have been collected on a performance basis.

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in this sense, are consistent with existing (i.e., with R&D expensed) current-dollar estimates of these variables. Of the stock variables derived here, the direct investment position and the IIP are measured on the same basis as their existing current-cost counterparts. However, the stock variable, MNC's R&D capital, is newly constructed here and has no currently published counterpart. In addition, this capital stock measure is not directly comparable to BEA's published estimates of MNC physical capital stock, as the latter measure is based on historical cost. Additional discussion of the bases used in this exercise, and possible alternative bases, is scattered throughout this document where relevant.

[54] Data on MNCs' R&D expenditures also exist for certain other (non-contiguous) years. Data were collected for U.S. parent companies and foreign affiliates in benchmark surveys for 1982, 1977, and 1966. For U.S. affiliates, R&D data were also collected in the benchmark survey for 1974.

Data on MNCs' R&D expenditures are currently published at relatively detailed levels of industry (for U.S. parents) or country-by-industry (for foreign and U.S. affiliates) aggregation. For these initial order-of-magnitude estimates, the estimates of R&D investment, R&D capital stocks, and value added are aggregate results, not disaggregated by country or industry. However, if expansion and further development of this project occurs in the future, estimates of various industry and regional groupings, to complement those made at the aggregate level, may be feasible.[55]

This step consists of estimation of several years of missing data, along with making two minor data adjustments. For estimating missing data, simple interpolation and extrapolation methods are used. As these estimates are likely somewhat imprecise, estimates that depend heavily on early-year R&D expenditures—particularly expenditures before the mid-to-late 1970s—should be used with extra caution.

Data adjustments include conversion of performance data to funding data for the most recent years and conversion of U.S.-affiliate data from an all-affiliate basis to a majority-owned-affiliate basis for early years (for consistency with the majority-owned foreign affiliate data). For the conversion from a performance to a funding basis, funding data from benchmark survey data are used to interpolate funded-to-performed ratios for those non-benchmark years in which data were collected on a performance basis. These ratios are then multiplied by values of R&D performed. In general, this adjustment is relatively small. (For the entities in question, most R&D is both performed and funded internally.) For the conversion of U.S.-affiliate R&D data to a majority-owned basis, a ratio of 0.78 of all-affiliate data is used for years prior to 1992, a number broadly consistent with ratios for more recent years and ratios for other items.

[55] Reasons for the focus on aggregates are both statistical and practical. Statistically, the relationship between R&D expenditures and the creation of commercially viable intellectual property is likely to be increasingly variable and uncertain the greater the level of disaggregation. Practically, the amount of work required to provide estimates by industry or by country is beyond the scope of the current phase of this project. In particular, issues of data suppression and changes in industry definitions (particularly from SIC to NAICS) would require substantial effort in terms of both planning and execution.

Aside from the performing-to-funding-basis adjustment, the R&DSA makes a number of other adjustments to the domestic expenditure data (e.g., removing expenditures on tangible capital and converting data from fiscal year to calendar year).[56] No attempt has been made to perform similar adjustments for the MNC data at this stage; however, it is likely that the net effect of such adjustments would be small.

**B) Calculation of current-cost R&D capital stocks**

*i) Depreciation.* Three sorts of assumptions are required to transform R&D expenditures into R&D capital stocks. First, assumptions are required as to the nature of R&D depreciation and the rate at which it occurs. As mentioned above, it is assumed for these estimates that depreciation is geometric, with the R&D capital stock depreciating by a fixed percentage every year, regardless of the age profile of that stock.[57] For a first approximation, the rate used is that in scenario A of the 2006 R&DSA paper: 15 percent. As the proper depreciation rate is subject to some uncertainty (particularly in the context of R&D capital outside of the United States), two other depreciation rates—12 percent and 18 percent—are considered as alternatives to the 15 percent "base case" rate.

One complication is that the 15 percent depreciation rate used for the 2006 R&DSA paper is a real rate, not a nominal one. To convert this real rate to one appropriate for nominal (current-cost) stocks requires that the "depreciation factor" (equal to one minus the depreciation rate) be multiplied by one plus the rate of price change.[58] For these estimates, the price change is assumed to be similar to the price

[56] See Okubo, et. al (2006), p. 16 (Table A).

[57] In some other contexts, geometric depreciation rates are combined with service life estimates so that capital beyond a certain age is assumed to be fully depreciated. Without service life estimates, geometric depreciation rates imply that capital never fully depreciates, though its remaining value does eventually become vanishingly small. For simplicity, these order-of-magnitude estimates will not use service life estimates. Consequently, there is no need to separately account for each vintage of R&D capital, a characteristic that is particularly advantageous in the context of firm entry and exit (an issue discussed later in this section).

[58] For instance, if the real depreciation rate is 15 percent and the price change is + 5 percent, a capital investment of $100 in the current year will have a value of roughly

change in the broader economy, so the price change used is the change in the GDP implicit price deflator. (Future work could incorporate a more narrowly targeted measure of price change.)

*ii) Starting year.* The need for the second assumption stems from a choice as to what year to begin the capital stock series. One option is to begin the series as of the start of the first year for which investment data are available (1966). This, however, requires an assumption as to the value of the initial-year capital stock. The other option is to use the earliest years of investment data to build up capital stock values for a time series that would begin some years in the future. The second option does not require an initial-year capital stock assumption, but at the cost of requiring a later starting date for the series. In order to begin the R&D capital estimates in the earliest year possible—1966—the first option is chosen. For this purpose, R&D capital stocks in 1966 are assumed to be 4 times the size of R&D investment in that year. This factor of 4 times initial-year investment is, for example, approximately the factor that occurs when investment and the capital stock are growing at (common) steady-state rates of 8 percent and the depreciation rate is 15 percent.[59] Two other alternatives are also considered: capital stocks of 2.5 times, and capital stocks of 7 times, initial-year investment. The former factor corresponds to higher depreciation and/or growth rates than is consistent with the base case assumption; the latter corresponds to lower rates.

*iii) Entry.* A third assumption is required because of an issue particularly prominent for MNCs: firm entry and exit. Specifically, the MNC R&D capital stock could rise in a given year – even were no R&D investment to occur in that year – simply by virtue of more firms being added to, or subsumed into, the MNC universe. This would occur, for example, when a U.S. company with pre-existing R&D capital stock becomes a U.S. parent company as a result of a new direct investment abroad or when

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$90 in next-year dollars (90 ≈ 100 x 0.85 x 1.05). This translates into a nominal depreciation rate of roughly 10 percent.

[59] Other combinations of growth and depreciation rates also produce a factor of 4. The combinations yielding this outcome form a downward sloping line when plotted on a graph with the depreciation rate on one axis and the common steady-state growth rate of investment and capital stock on the other axis.

non-MNCs are acquired by (and subsumed into) existing MNC entities. An adjustment is included each year to account for the change in the R&D capital stock resulting from the net existing R&D stock of entering and exiting firms (as opposed to the change in the stock resulting from R&D investment and depreciation). The adjustment uses data on changes in the tangible capital stock to infer a (net) entry component for changes in the R&D capital stock.

The adjustment relies on a two-part assumption. First, the fraction of the increase in the tangible capital stock due to net entry (broadly construed, to include the above-described types of entry and exit) is assumed to be a fixed value, *EF* ("entry factor").[60] Existing data provide some information as to the magnitude of this factor, but the information is not specific or comprehensive enough to compute the factor directly; analyst judgment is also required.[61] (Section A of the appendix provides a hypothetical example motivating the use and magnitude of the entry factor.) For foreign affiliates, it is

[60] Missing data for physical capital stocks are estimated with basic interpolation/extrapolation methods.

[61] Future work may entail estimation of entry factors that vary from year to year, to more closely approximate actual fluctuations in the relative importance of entry and investment, but such refinement is beyond the scope of this phase of the project. For developing the fixed entry factor used here, data are available annually for U.S. affiliates and in benchmark surveys for foreign affiliates (but not at all for U.S. parents) that disaggregate the change in net physical capital stock into the portions due to expenditures, depreciation and depletion, sales and retirements (only for U.S. affiliates) of existing capital, and a residual category. The assumed entry factor was informed by computed values of the ratio of the residual to the change in the physical capital stock. These ratios do not give particularly accurate measures of entry effects because (1) the residual includes effects other than entry and exit (in principle, it also includes the effects of revaluations of certain physical capital and, for foreign affiliate, sales and retirements of physical capital); (2) all data used for these calculations use historical cost stock measures; and (3) the ratios computed using these data are highly variable (including both values that are negative and values that are much greater than one).

The magnitude of *EF* may appear larger than one would expect, since the share of operations, however measured, that is accounted for by firms that enter the universe in any given year will ordinarily be far smaller than its assumed values. However, it should be recalled that a new entrant's contribution to the increase in the R&D capital stock includes not only its R&D investment in that year (less depreciation), as is the case for existing MNC entities, but also capital accumulated in earlier years.

assumed that $EF = 0.4$ That is, if, hypothetically, the foreign affiliate tangible capital stock increases $100 million from one year to the next, then $40 million of the increase is presumed to be the *stock* held by entities that are new to the MNC universe, or the *stock* held by newly acquired parts of existing entities, both net of corresponding decreases (exits/divestitures). The other $60 million is presumed to be due to *investment* during the year by existing entities, net of depreciation of existing entities' stock. For U.S. parents and U.S. affiliates, the entry factor is assumed to be smaller: $EF = 0.2$ for U.S. parents, and $EF = 0.3$ for U.S. affiliates.[62]

The second part of the assumption is that the unknown R&D-capital entry component—scaled by the previous stock of R&D capital—is equal to the associated tangible-capital entry component—scaled by the previous stock of tangible capital. In combination, these two parts imply that the entry component of R&D capital as a percentage of the (prior-year) R&D capital stock is an assumed fraction, *EF*, of the percentage change in physical capital, or

$$RD_{entry} / RD_{stock(prior)} = K_{entry} / K_{stock(prior)} = EF \cdot \%\Delta K$$

where *RD* refers to R&D capital, *K* refers to physical capital, and $\%\Delta$ denotes percentage change. Equivalently, the R&D entry component itself is

$$RD_{entry} = RD_{stock(prior)} \cdot EF \cdot \%\Delta K.$$

[62] Higher entry factors were used for foreign affiliates and U.S. affiliates than for U.S. parents for two reasons. First, growth rates of the populations of the foreign affiliate and U.S. affiliate populations have typically exceeded that of the U.S. parent population. It is reasonable to postulate that the differences owe more to higher rates of entry for foreign and U.S. affiliates than to higher rates of existing-firm growth. Second, compared to U.S. companies and their potential entry into the MNC universe by acquisition of a foreign affiliate, potential foreign parents may be eager to acquire firms in a R&D-rich country such as the United States to offset the relative difficulty of generating R&D abroad.

The reason higher entry factors were used for foreign affiliates than for U.S. affiliates is more subtle; the argument relies a higher rate of R&D investment for existing U.S. affiliates than for existing foreign affiliates. Higher R&D investment, all else equal, lowers the entry factor by raising the denominator of the ratio that defines the factor (the denominator is the total change in capital). Higher investment rates for existing U.S. affiliates would be expected if the United States had a comparative advantage in R&D, as seems likely. Aside from this presumption, U.S. affiliate R&D performance is a higher as a ratio to (published) value added than the corresponding foreign affiliate performance.

The adjustment resulting from this formula is rather imprecise, as both parts of the assumption could be questioned. To address the possibility that the resulting R&D entry components are inaccurate, alternative values of *EF* are also considered. For foreign affiliates, along with the base case factor of 0.4, factors of 0.2 and 0.6 are used. For U.S. parents, factors of 0.1 and 0.3 supplement the 0.2 base case factor. For U.S. affiliates, alternative factors of 0.15 and 0.45 are used.

The estimates of R&D capital provide a measure of one sort of intangible capital that could, in principle, be compared to similar measures of tangible capital. However, due to the use of a real rate of depreciation (discussed in the second paragraph of this section), the R&D capital stock estimates are measured at current cost. BEA's surveys of MNC operations do collect data on the stock of property, plant, and equipment, but these are based on historical cost, not current cost. A direct comparison would require conversion from one basis to another. To go from current-cost to historical-cost R&D capital would rule out the use of the adjustment of depreciation rates for price changes discussed above. Alternatively, to go from historical-cost to current-cost physical capital would most easily be accomplished by substituting the results of a perpetual inventory model for the values reported on BEA's surveys.[63]

**C) Adjustment of value added estimates**

Compared to current estimation procedures, counting R&D spending as investment increases the computed value added of MNCs, by the amount of current-period R&D investment (i.e., funding expenditures). As currently estimated, MNC value added is computed as costs incurred (except those for intermediate inputs) plus profits earned in production ("profit-type return"). Because current-period spending on R&D that had previously been expensed no longer counts against profits when the R&D is treated as investment, value added increases by the amount of new reported R&D spending (funding). Depreciation of the R&D capital stock, on the other hand, now does count against profits where it previously had not, resulting in what would otherwise be a

[63] This is something that is already done, though not published, at the aggregate level in the process of constructing current-cost estimates of the direct investment position.

partly or wholly offsetting reduction in profit-type return.[64] However, this reduction is itself exactly offset by the R&D depreciation-induced rise in the capital consumption allowance (a measure of depreciation based on the book value of depreciation and one of the components of costs). Overall, therefore, the net effect is that profit-type return and value added both increase by the amount of R&D investment. A numerical example that demonstrates these changes in the calculation of value added is provided in section B of the appendix.

In the summary of the estimates that follows, value added is recomputed treating R&D as investment, and is compared to total U.S. private-industry GDP. In addition, the value added of foreign affiliates is compared to that of U.S. parents. As with the published value added estimates that treat R&D as an expense, annual estimates for majority-owned U.S. affiliates begin in 1988.[65] For foreign affiliates, annual estimates begin in 1982, with an additional estimate from the benchmark survey in 1977.[66] For U.S. parent companies, annual estimates begin in 1994, with earlier estimates from benchmark surveys in 1977, 1982, and 1989.

[64] Both of these changes to profits cause "profits as reported by firms on surveys" to be defined differently than "profits as used in the value added calculation." If one preferred not to deal with these two separate "profit" estimates, an additional component could be added to the profit-type return category of value added. This new component would equal current-year R&D investment net of current-year R&D depreciation. It, along with income taxes and depletion less (net) capital gains and losses and income from equity investments, would be added to the net income reported on surveys to equal profit-type return. In section B of the appendix, this new component is termed "R&D investment adjustment."

[65] Estimates of value added (termed "gross product" in the publications) were also published for 1977-87, but these estimates are for *all* U.S. affiliates (combining minority-owned affiliates with majority-owned affiliates). These all-affiliate estimates are not recomputed here.

[66] Estimates of foreign affiliates' value added were published for 1966 and 1970, but are not recomputed here. The former included all affiliates (not just majority-owned affiliates) and the latter estimated only value added growth for matched-samples, not the MNC universe levels of value added.

### D) Adjustment of direct investment earnings in ITA and IIP data

The final step is to apply the results of the calculations on the MNC operations data detailed in steps 1-2 to the IIP estimates and the direct investment earnings values that feed into the ITAs and NIPAs. In general, the outward investment ITA and IIP data are modified using the foreign affiliate operations data, and the inward investment ITA and IIP data are modified using the U.S. affiliate operations data. Several data series can potentially be modified in this manner. The following shows a selection of such series and describes, in broad terms, the type of modification used (the modifications themselves are subject to adjustments discussed below the table).

| Data series | Initial year | Modification |
|---|---|---|
| Current-cost direct investment income | 1966 | Add current-year R&D spending less depreciation |
| Investment income (includes income from portfolio investment) | 1966 | Add current-year R&D spending less depreciation |
| Balance on current account | 1966 | Add current-year foreign affiliate R&D spending less depreciation, subtract U.S. affiliate spending less depreciation |
| Net rest-of-world corporate profits | 1966 | Add current-year foreign affiliate R&D spending less depreciation, subtract U.S. affiliate spending less depreciation |
| Direct investment position | 1976 | Add current-year R&D capital stock |
| International investment position | 1976 | Add current-year R&D capital stock |

Differences in the scope and purpose of the MNC operations data compared to the ITA and IIP data may necessitate adjustments in order make the modifications detailed above. There are two key issues.[67] First, the MNC R&D estimates pertain to majority-owned affiliates while the ITA and IIP data pertain to all affiliates. Second, the ITA and

[67] A third issue should be noted, as well. The MNC operations estimates exclude companies classified in banking, while the balance of payments data include such companies. Ignoring this issue is likely innocuous as—given the present definition of R&D—banking MNCs probably conduct very little R&D. (NSF estimates for the entire U.S. economy combine banking with other finance, insurance, and real estate, but they show firms in this group—only a portion of which would be in banking—as accounting for only 0.8 percent of total funds for industrial R&D performance in 2004.)

IIP data, unlike the MNC R&D estimates, only include the parents' share, or interest, in its affiliates. Here it is assumed that a parent's ownership of an individual affiliate's assets is in the same proportion as its owners equity in the affiliate. (Thus, a parent holding an 80 percent interest in an affiliate is, heuristically, assumed to "own" $400 of the affiliate's $500 R&D capital stock.)

The first issue—the inclusion of only majority-owned affiliates in MNC operations estimates—implies than in translating operations estimates to a basis consistent with ITA and IIP data, the MNC data should be scaled up. The second issue—the lack of scaling by the parents' ownership shares in MNC operations estimates—implies that the MNC data should be scaled down. Although, in principle, the two issues imply separate adjustments (ones that likely vary both by year and type of investment), for simplicity, a rudimentary overall adjustment is used to approximate the net effect of the two issues.[68] The modification derived from MNC operations data (as detailed above) is multiplied by a composite scaling factor before adding it into the ITA and IIP data. In the base case, the scaling factor is 1.00 for both inward and outward data, a particular situation in which the two implicit adjustments exactly offset each other.[69] Two other alternative scaling factors are also considered, 0.85 and 1.15, cases in which one or the other of the implicit adjustments dominate. Although data that would permit direct calculation of the scaling factors are not currently collected for either foreign or U.S. affiliates, for U.S. affiliates, the necessary data were collected for R&D investment in some prior years and—along with plausible hypotheticals such as the one described in section C of the appendix—have informed the selection of the scaling factors used. In 1997, for instance, unpublished data show that R&D investment, adjusted by ownership

[68] Data are available that would allow the published values of current year R&D spending by majority-owned affiliates to be scaled for ownership shares with little trouble. However, developing a methodology to carry these shares along each year in capital stock measures and depreciation measures would require substantial upfront work. An extension that accounted for minority-owned affiliates could not be directly computed from survey data; further assumptions are needed. However, related data items that are collected on the operations survey might be used to guide year-by-year changes in estimates of minority-owned affiliates' R&D investment.

[69] For an example motivating the choice of composite scaling factors, see section C in the appendix.

shares of all affiliates, was approximately 1.03 times the unadjusted investment by majority-owned affiliates, a value close to the base case scaling factor.

**E) Estimate summary**

*i) Base case*. The figures and tables on the pages that follow give selected examples of the effects of treating R&D as investment on the MNC operations data series and on the ITA and IIP series. Figure 1 shows base-case current-cost R&D capital stocks (also see table 1), as well as R&D expenditures and depreciation for U.S. parents, foreign affiliates, and U.S. affiliates. In 2004, U.S. affiliates' R&D capital stock was 20 percent higher than the stock of foreign affiliates; U.S. parents' R&D capital stock was more than six times as high as that of foreign affiliates. From 1966-2004, U.S. affiliates' growth rates for these items were slightly higher than those for foreign affiliates. Growth rates for U.S. parents were somewhat lower. Annualized percentage growth rates of these items are shown in the tabulation below:

| | Growth rates | | |
|---|---|---|---|
| Type of firm | R&D investment | R&D capital stock | R&D depreciation |
| Foreign affiliates | 10.5 | 10.7 | 10.7 |
| U.S. parents | 7.9 | 8.5 | 8.5 |
| U.S. affiliates | 10.6 | 12.1 | 12.2 |

Figures 2 and 3 show the effects of treating R&D as investment under the base-case assumptions relative to current estimation methods (i.e, treating R&D as an expense) for several international accounts series. Figure 2 shows inward and outward data separately for three series—direct investment income, the direct investment position, and the international investment position. Figure 3 shows flow balances or net positions (outward estimates minus inward estimates) of six series—the three just named plus (all) international investment income, rest-of-world corporate profits, and the current account. In each graph in figures 2 and 3, estimates without R&D capitalization are shown with lines (solid or dashed) and estimates with R&D capitalization are shown with dots (solid or hollow). For none of these series do the with- and without-capitalization series

diverge substantially. Occasionally the changing the treatment of R&D causes the estimate to change signs, though only when the estimate itself is close to zero.

The visual information in figures 1-3 is reinforced in a series of tables, tables 1-5. Tables 1-4 provide base-case time series for four key data items. Table 1 gives R&D capital stocks and compares it to the total MNC nonfinancial capital stock. This comparison is somewhat problematic for the U.S parent estimates, as the total capital stock measure combines two estimates measured on different bases—current-cost for R&D capital and historical-cost for (net) property, plant, and equipment.[70] Nonetheless, the comparison gives a rough idea of the relative sizes of the tangible and intangible capital stocks. In 2004, under this comparison, the R&D capital stock of U.S. parents was 26 percent of total parent capital stock. For foreign and U.S. affiliates, the corresponding shares were 11 percent. Tables 2-4 compare estimates for MNC value added, direct investment income, and the direct investment position with and without R&D capitalization. Treating R&D as investment raises the 2004 value added estimates for foreign affiliates by 3 percent, for U.S. parents by 7 percent, and for U.S. affiliates by 6 percent. Outward direct investment income in 2004 increases by 4 percent and inward direct investment income increases by 9 percent; the corresponding direct investment positions increase by 5 percent and 9 percent.

Table 5 presents summary information for the time series of the items in tables 2-4 and figures 2-3, comparing estimates produced without R&D capitalization to those produced with capitalization. The first two columns compare growth rates. Treating R&D as investment slightly increases two of the three value added growth rates, but it slightly decreases the growth rates of some of the other series. Several of the growth rates are unchanged. Growth rates are not shown for the balance items, as balances may be either positive or negative.

[70] The use of an historical-cost estimate for physical capital likely results in an underestimate compared to the use a current-cost estimate. The current-cost estimates used in table 1 for foreign affiliates and U.S. parents are informed by methods used for the IIP.

The third column of table 5 shows the median over each time series of the annual percentage difference between the two estimates (with vs. without capitalization—a positive value indicates that the with-capitalization value exceeds the without-capitalization value). The largest median relative differences—21 and 9 percent, respectively—are associated with inward direct investment income and the inward direct investment position. For the income series in particular, this is due in part to small pre-R&D-capitalization values. Median differences for outward direct investment income and the outward direct investment position are smaller—4 percent and 7 percent, respectively. Other differences, particularly those for balances, are closer to 1 to 2 percent in absolute value. These smaller differences, not surprisingly, are those associated with higher-level entries in the ITAs, the NIPAs, and international investment positions.

The final two columns of table 5 show minimum and maximum annual percentage differences between the rival estimates. For several of the series—specifically, value added, outward direct investment income, and the outward and inward positions (both direct investment and international investment)—these extremes differ relatively little from the medians. For the other series, the underlying estimates can be very close to, or cross, zero, an outcome that renders measures of percentage difference somewhat misleading. As seen in figures 2 and 3, the relatively high minimum or maximum percentage differences shown in table 5 are not the result of large absolute differences.

*ii) Alternative assumptions*. Tables 6-9 are structured in a similar manner to table 5, but instead of comparing estimates treating R&D as investment to estimates treating it as an expense, they compare base-case estimates to estimates using one of the alternative assumptions detailed in the previous discussion, with R&D treated as investment in both.[71] In turn, tables 6-9 show the effects of the alternative assumptions for

[71] Compared to table 5, three of these tables add rows for the R&D capital stock and R&D depreciation. These are not shown in table 5 because these items are meaningless unless R&D is treated as investment. These tables also exclude value added rows, as value added estimates are invariant to these changes (because the alternative assumptions do not affect estimates of R&D investment). Table 9 excludes R&D capital

depreciation, the entry factors, the level of the initial capital stocks, and adjustments for converting operations data to a basis consistent with international transactions and investment position data.[72] Of these, the effects of the depreciation alternatives generate the largest changes in the estimates, with typical divergences from the base case of 10-20 percent for both R&D capital stock and R&D depreciation. For other items, however, the effects are much smaller; only inward direct investment income has a median difference of greater than 2 percent.

The effects of the alternative entry factors have only roughly half the effect of the depreciation alternatives. Of all of the alternatives, the effects of varying the initial-year capital stocks are the smallest (focusing on the medians), barely even affecting the ITA and IIP measures. The impact of the alternative adjustments in applying operations estimates to ITA and IIP data is slightly greater than the effect of the entry factor alternatives.

Overall, the order-of-magnitude estimates presented here contain no great surprises. It has long been observed that R&D is a greater relative part of MNCs' U.S. activities than for the U.S. economy as a whole, a characteristic borne out in these estimates. Compared to increases of current-dollar all-U.S. GDP due to the treatment of R&D as investment of nearly 3 percent reported in the 2007 domestic R&DSA, MNCs' U.S. value added increases were larger: 4 percent to 7 percent for U.S. parents and 5 percent to 6 percent for U.S. affiliates with the base case assumptions. Foreign affiliates'

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stock and R&D depreciation, because changing assumptions about the adjustment from operations data to balance of payments data does not affect estimates of the operations data.

[72] Of potential interest, but not shown in these tables, is the effect of combining different sets of alternatives, rather than simply combining one alternative assumption with three other base-case assumptions. Also not shown is the effect of applying different assumptions to different types of firms (foreign affiliate, U.S. parents, or U.S. affiliates). For example, it might be argued that weaker intellectual protection regimes abroad result more rapid obsolescence of foreign R&D capital than of U.S. R&D capital, justifying, for example, an 18 percent depreciation rate for foreign affiliates and a 12 percent rate for U.S. parents and U.S. affiliates. Some of the effects of this situation can be gleaned by comparing the two panels in table 6, but the effect on balance items cannot be discerned.

value added increases were more similar to those shown in the domestic portion of the R&DSA.

Changes in other variables of interest were also generally as anticipated. Direct investment income changes, although not small, did not change the nature of these series. Other items, particularly balances and higher level ITA and IIP items, saw only marginal changes. The alternative assumptions considered show that the general results are fairly robust. Although the assumptions made in order to estimate the base case scenario are somewhat arbitrary, they do have some empirical basis, and the parameters used in generating the estimates can be varied somewhat around those assigned in the base case without changing the fundamental conclusions that can be drawn from the exercise.

## V. Conclusions and recommendations

This paper has examined a number of issues associated with the treatment of R&D as investment in the international accounts. In addition, it has presented estimates of the effects of such a treatment on several key international data series. BEA's international R&D data come from two sources, surveys of international trade in services and intangible assets and surveys of the operations of MNCs. R&D data from the surveys of trade in services and intangible assets are used to adjust measures of the domestic R&D capital stock. R&D data from surveys on MNC operations can be used to adjust measures of internationally derived income, thus affecting the current account and IIP. The operations R&D data are also of independent interest, allowing calculations of MNC R&D capital stocks and related measures.

The treatment of R&D as investment is extended to account for internationally traded R&D in the main 2007 R&DSA. Although certain data for earlier years were not collected (requiring extensive imputation), their effects on aggregate measures are relatively small, and the methodology for incorporating them into the R&DSA is relatively straightforward. In contrast, the treatment of R&D as investment in data from surveys of MNC operations has yet to be incorporated into the main R&DSA. Consequently, such treatment is considered in this paper, which is a background paper

accompanying the 2007 R&DSA. In many respects, the treatment of R&D as investment in these (operations) R&D data poses issues and problems similar to those faced for domestic R&D. This paper describes a methodology for constructing MNC R&D capital stock estimates and presents results for several data series at the aggregate level up to 2004 and beginning as early as 1966. The estimates, although based in part on assumptions used to simplify the estimation procedure, show that, to a rough order of magnitude, the effects of treating R&D as investment in international data entering the ITAs and IIP are relatively minor. Changes in the current account balance are typically on the order of 1 percent; changes in the balance of the international investment position are typically on the order of 2 percent.

The order-of-magnitude estimates abstract from some important issues, however. Approaches to such issues as estimating depreciation or choosing appropriate price indexes should follow the R&DSA in structure, although practical problems may be more complex in some cases. For other issues, the treatment of international R&D as investment is particularly challenging. In measuring the R&D capital stock of MNCs, the issue of entry and exit must be confronted; this is simple conceptually, but existing data allow for only very rough estimates of entry effects. Perhaps even more problematic is the issue of joint ownership. With the boundary of MNCs overlapping the country boundaries used for economic accounting, and with non-rivalry in the use of R&D frustrating attempts to cleanly allocate the benefits of R&D among the various MNC entities, joint ownership is a conceptual hurdle without a clear answer.

The paper has demonstrated that generating estimates of the effects of treating R&D as investment is feasible. Using the order-of-magnitude estimates as a starting point, there are several actions that could increase the accuracy of R&D capital stocks. However, some of these would require substantial effort, particularly in terms of the up-front work of resolving conceptual issues, identifying data, and designing methodologies. At a more basic level, if substantial importance were attached to developing rigorous and precise estimates in international R&D capital, BEA might wish to make changes to the type of R&D data it collects. Most importantly, on the operations surveys, funding data—that are currently only collected in benchmark surveys—should be collected in

annual surveys. On the international trade surveys, data should be collected in a way that allows for international transfers of ownership of R&D capital to be distinguished from international transactions in the rights to use such capital.

# Appendix A: R&D Definitions in BEA Surveys

Annual data on trade in R&D services and intangible assets are collected on BEA's BE-120 benchmark survey, conducted once every 5 years.[73] Quarterly data are collected on BEA's BE-125 survey. Prior to 2006 for annual data and 2007 for quarterly data, data were collected separately for transactions with unaffiliated persons and for those with affiliated persons. For unaffiliated transactions, annual data were collected on the BE-22 survey and quarterly data were collected on the BE-25 survey. For affiliated transactions, quarterly data were collected on the BE-577 and BE-605 surveys and annual data were collected once every 5 years on the BE-10 and BE-12 benchmark surveys.

Survey instructions for the BE-120 and BE-125 define R&D and testing services as

> [c]ommercial and noncommercial research, product development services, and testing services. Includes fees for the conduct of experiments or performance of research and development activities aboard spacecraft. Excludes medical and dental laboratory services.

These surveys instruct respondents than in reporting transactions in rights related to industrial processes and products, they should

> [i]nclude license fees, royalties, and other fees received or paid for the use, sale, or purchase of intangible assets, including patents, trade secrets, and other proprietary rights, that are used in connection with, or related to, the production of goods. (For example, include 'maintenance' fees paid to foreign governments for the continuation of patent rights.) If the charge for the process, design, etc., is subsumed in a contract for technical or professional services, the receipt or payment generally should be reported under the proper transaction number for that service.

[73] BEA's international surveys can be accessed on BEA's Web site at <http://www.bea.gov/international/index.htm#surveys>.

Annual data on R&D expenditures of U.S. parents and foreign affiliates are collected on BEA's BE-10 benchmark (financial and operating) survey, conducted once every 5 years. For the intervening 4 years, annual data are collected on the BE-11 annual survey. Annual data on R&D expenditures of U.S. affiliates of foreign companies are collected on BEA's BE-12 benchmark survey, conducted once every 5 years. For the intervening 4 years, annual data are collected on the BE-15 annual survey. As a company might be both owned by a foreign parent company and have a foreign affiliate, there is some overlap between the U.S. parent data on the BE-10/11 surveys and the U.S. affiliate data on the BE-12/15 surveys.

Following NSF, R&D is defined as comprising three distinct activities in instructions for MNC-operations survey respondents. For example, the most recent benchmark survey of U.S. direct investment abroad defines R&D as one of the following:

> **Basic research** is the pursuit of new scientific knowledge or understanding that does not have specific immediate commercial objectives, although it may be in fields of present or potential commercial interest.
>
> **Applied research** applies the findings of basic research or other existing knowledge toward discovering new scientific knowledge that has specific commercial objectives with respect to new products, services, processes, or methods.
>
> **Development** is the systematic use of the knowledge or understanding gained from research or practical experience directed toward the production or significant improvement of useful products, services, processes, or methods, including the design and development of prototypes, materials, devices, and systems.

Despite this conceptual distinction, data are not collected separately for the three activities in BEA's surveys of MNCs, only for R&D generally.

Survey instructions direct respondents when reporting (performance) R&D expenditures to

> [i]nclude all costs incurred in performing R&D, including depreciation, amortization, wages and salaries, property taxes and other taxes (except income taxes), materials and supplies, allocated overhead, and indirect costs.

More specifically, they are instructed to

[i]nclude all costs incurred to support R&D. Include wages, salaries, and related costs; materials and supplies consumed; R&D depreciation, cost of computer software used in R&D activities; utilities, such as telephone, telex, electricity, water, and gas; travel costs and professional dues; property taxes and other taxes (except income taxes) incurred on account of the R&D organization or the facilities they use; insurance expenses; maintenance and repair, including maintenance of buildings and grounds; company overhead including: personnel, accounting, procurement and inventory, and salaries of research executives not on the payroll of the R&D organization. Exclude capital expenditures, expenditures for tests and evaluations once a prototype becomes a production model, patent expenses, and income taxes and interest.

# Appendix B: Supplementary Adjustment Information

This appendix consists of three parts, each illustrating some aspect of the adjustments used to generate the order-of-magnitude estimates. The first concerns the assumption regarding the relative contribution of the existing stock of new firms to the growth in MNC R&D capital stock versus that of the new stock of existing firms. The second shows how value added increases when R&D is capitalized rather than expensed. The third clarifies reasons for adjusting MNC operations estimates to a basis consistent with the ITAs and IIP.

### (1) Entry factor/components

The following simplified example illustrates the source of the "entry factor" assumptions used in generating the order-of-magnitude estimates. Consider a hypothetical foreign affiliate population consisting of 1,000 affiliates at the beginning of the year.

*Assumptions*: The beginning-of-year R&D capital stock is $500,000, an average of $500 of R&D capital per affiliate. The stock depreciates at a rate of 10 percent, and new investment in R&D occurs at a rate of 15 percent (of the existing stock). Over the course of the year, 60 firms are acquired or established as new foreign affiliates of U.S. parents, and 20 existing affiliates are sold to non-U.S. buyers. The R&D capital stock of each the affiliates sold is the same, on average, as that of continuing affiliates—that is, $500. New firms come into the universe with an average capital R&D stock two-thirds that of existing firms.

| | Value | Relative to beginning-of-year stock |
|---|---|---|
| **Beginning of year stock** | **500,000** | **100%** |
| **Total change** | **35,000** | **7%** |
| **Investment net of depreciation** | **25,000** | **5%** |
| Investment | 75,000 | 15% |
| Depreciation | (50,000) | -10% |
| **"Entry component"** | **10,000** | **2%** |
| Entry | 20,000 | 4% |
| Exit | (10,000) | -2% |
| **End-of-year stock** | **535,000** | **107%** |

*Implications*: The change in capital can be decomposed as resulting from the following activities: The total change in the R&D capital stock over the year is a $35,000 (7-percent) increase, of which the "entry component" accounts for $10,000, or 0.286. (Note that the 0.286 factor is the R&D-capital counterpart to the physical-capital "entry factor" (EF) used in the order-of-magnitude calculations.) Neither of these dollar increases can be computed in practice, as direct investment surveys do not collect information on the magnitude of R&D capital brought into the population for reasons other than investment. However, data are available on the change in the physical capital stock (though on a historical-cost basis rather than current-cost basis), and (much noiser) data are available on the share due to the physical capital entry component. The method used for the order-of magnitude estimates applies a rough, time-invariant estimate of the "entry factor" to data on changes in physical capital in hopes of accurately estimating the $15,000 entry component.

A second type of entry and exit can be seen by adding additional assumptions: During the year, existing affiliates acquire 100 other firms in their own countries that were not previously foreign affiliates, and that become subsumed into their respective acquirers. (In other words, the acquirees do not report separately on direct investment surveys, but their data is combined with that of their acquirers.) These 100 firms, on average, have pre-acquisition R&D capital of $200. In addition, existing affiliates sell off portions of their business 50 times during the year. On average, the sold-off portions take $300 in R&D capital out of the divesting affiliates.

| | Value | Relative to beginning-of-year stock |
|---|---|---|
| **Beginning of year stock** | **500,000** | **100%** |
| **Total change** | **40,000** | **8%** |
| **Investment net of depreciation** | **25,000** | **5%** |
| Investment | 75,000 | 15% |
| Depreciation | (50,000) | -10% |
| **"Entry component"** | **15,000** | **3%** |
| Entry | 20,000 | 4% |
| Exit | (10,000) | -2% |
| Acquisitions by continuing affiliates | 20,000 | 4% |
| Divestitures by continuing affiliates | (15,000) | -3% |
| **End-of-year stock** | **540,000** | **108%** |

The implications of this slightly more complex example are qualitatively the same as in the first example. The entry component, however, is $5,000 larger, at $20,000, with a correspondingly larger entry factor of 0.375.

**(2) Value added calculations**

This section provides a simple three-firm example of value added calculation. Under existing methods, value added is computed as the sum of costs incurred (except for intermediate inputs) and profits earned in production. Treating R&D as investment does not change this basic computation, but it does change how both costs and profits are calculated. In the example, value added rises by the value of R&D funding expenditures (R&D investment), whether due to own-account R&D or to R&D purchased from an outside source.

*Assumptions*: In year 1, firms A and B each account for $100 of R&D performance. Of the $100, $70 goes to compensate the researchers they employ and $30 is for material (intermediate) inputs. Firm A keeps its own R&D for itself, while firm B's R&D is performed under contract (for $100) for firm C. No other products are produced in year 1 and none of the firms possess any physical capital. In year 2, firms A and C each utilize the resulting R&D capital along with $50 worth of labor services to produce output that is sold for $75. No intermediate inputs or physical capital are used. When R&D is treated as investment, the depreciation rate of R&D capital is assumed to be 15 percent and, for simplicity, it is assumed that no depreciation occurs in the year in which the R&D is performed.

| R&D spending | | | | | | |
|---|---|---|---|---|---|---|
| | Year 1 | | | Year 2 | | |
| | Firm | | | Firm | | |
| | A | B | C | A | B | C |
| R&D performed | 100 | 100 | 0 | 0 | 0 | 0 |
| Own-account R&D | 100 | 0 | 0 | 0 | 0 | 0 |
| R&D performed for others | 0 | 100 | 0 | 0 | 0 | 0 |
| R&D funded | 100 | 0 | 100 | 0 | 0 | 0 |
| Own-account | 100 | 0 | 0 | 0 | 0 | 0 |
| Performed by others | 0 | 0 | 100 | 0 | 0 | 0 |

| Value added with R&D expensed | | | | | | |
|---|---|---|---|---|---|---|
| | Year 1 | | | Year 2 | | |
| | Firm | | | Firm | | |
| | A | B | C | A | B | C |
| Employee compensation | 70 | 70 | 0 | 50 | 0 | 50 |
| Profit-type return | (100) | 0 | (100) | 25 | 0 | 25 |
| Net income | (100) | 0 | (100) | 25 | 0 | 25 |
| R&D investment adjustment | N/A | N/A | N/A | N/A | N/A | N/A |
| Capital consumption allowances | 0 | 0 | 0 | 0 | 0 | 0 |
| Physical capital depreciation | 0 | 0 | 0 | 0 | 0 | 0 |
| R&D capital depreciation | 0 | 0 | 0 | 0 | 0 | 0 |
| Value added | (30) | 70 | (100) | 75 | 0 | 75 |
| MNC universe total | | | -60 | | | 150 |

| Value added with R&D treated as investment | | | | | | |
|---|---|---|---|---|---|---|
| | Year 1 | | | Year 2 | | |
| | Firm | | | Firm | | |
| | A | B | C | A | B | C |
| Employee compensation | 70 | 70 | 0 | 50 | 0 | 50 |
| Profit-type return | 0 | 0 | 0 | 10 | 0 | 10 |
| Net income | (100) | 0 | (100) | 25 | 0 | 25 |
| R&D investment adjustment | 100 | 0 | 100 | (15) | 0 | (15) |
| Capital consumption allowances | 0 | 0 | 0 | 0 | 0 | 0 |
| Physical capital depreciation | 0 | 0 | 0 | 0 | 0 | 0 |
| R&D capital depreciation | 0 | 0 | 0 | 15 | 0 | 15 |
| Value added | 70 | 70 | 0 | 75 | 0 | 75 |
| MNC universe total | | | 140 | | | 150 |

*Implications*: The second panel shows the value added calculation under the (current) expensing rules, and the third panel shows value added calculations with R&D treated as investment rather than as an expense. Compared to the expensed R&D case, when R&D is treated as investment, value added increases by the sum of R&D employee costs in year 1 (the year in which the R&D is performed) and does not change in year 2 (as depreciation of R&D capital exactly offsets lowered net income). Note that the increase in value added applies whether R&D is performed for a firm's own account or is purchased from another firm.

**(3) Operations-data to international accounts-data scaling adjustment**

This section illustrates the two-part nature of the scaling adjustment used to convert R&D investment from published MNC operations data (or, more precisely, R&D investment derived from R&D expenditures published in MNC operations data) to a basis consistent with ITA and IIP data. For MNC R&D data, estimates are currently published only for majority-owned affiliates, without adjusting for parents' ownership shares of the affiliates in this group. To convert the estimates for the operations data to the desired basis, ownership shares must be accounted for, and the estimates must be made to cover all affiliates (both majority-owned and minority-owned). Unpublished data typically are available to adjust majority-owned affiliates' estimates for ownership shares. However, data for minority-owned affiliates—whether adjusted for ownership shares or not—typically are not available.

As discussed in the main text, the two reasons for making a scaling adjustment act in opposite directions; including minority-owned affiliates increases the estimate, but adjusting for ownership shares decreases it. The following hypothetical example demonstrates these competing effects while also accounting for two empirical facts: (a) in cases where data for all affiliates are available, estimates for majority-owned affiliates tend to be roughly 75-85 percent as high as the corresponding all-affiliate estimates; (b) large portions of the published majority-owned totals are typically accounted for by wholly-owned affiliates (foreign affiliates whose U.S. parent holds a 100 percent share in

the affiliate or U.S. affiliates whose foreign parent holds a 100 percent share). In the example, the two implicit adjustments are almost exactly offsetting; the appropriate composite adjustment factor is very close to the assumed base-case factor of 1.00.

*Assumptions*: Three assumptions suffice to fully describe the data:

**(1) Majority-owned and minority-owned affiliates combine to invest $10,000 in R&D.**

**(2) Majority-owned affiliates account for 80 percent of R&D investment by affiliates.** As noted above, this percentage—although consistent with empirical fact (a)—is unknown in practice for R&D investment, as only the investment accounted for by majority-owned affiliates is reported on MNC surveys.

**(3) Parent-ownership shares (weighted by R&D investment) is uniformly distributed between 10 and 100 percent among those affiliates that are not wholly owned.** This assumption, while entirely hypothetical, is intended to be neutral—one in which R&D does not gravitate to a particular ownership structure (aside from one with complete parent ownership). It is also intended to be simple; however, almost any distribution of R&D-weighted ownership shares that is symmetric about 50 percent would generate the essentially the same result.

The following table summarizes these assumptions and some of the resulting implications.

| | Type of affiliate | | | |
|---|---|---|---|---|
| | Wholly-owned | Other majority-owned | Minority-owned | Total |
| 1. Average parent-ownership share | 100% | 75% | 30% | |
| 2. R&D investment | 5,500 | 2,500 | 2,000 | 10,000 |
| 3. Majority-owned affiliate R&D investment | 5,500 | 2,500 | - | 8,000 |
| 4. Parent-ownership-share adjusted R&D investment | 5,500 | 1,875 | 600 | 7,975 |
| 5. Difference (row 3 minus row 4) | - | 625 | (600) | 25 |

*Implications*: Assumptions (1) and (2) imply that R&D investment by majority-owned affiliates is $8,000 (the box around this value in the table indicates that this is known from the published operations data). Minority-owned affiliates, therefore, account for $2,000 of R&D investment. Assumption (3) implies that majority-owned affiliates that are not wholly owned account have an average parent-ownership share of 75 percent, and that minority-owned affiliates have an average parent-ownership share of 30 percent (given the 10-percent ownership threshold for direct investment). Applying the 30 percent share to the $2,000 of investment by minority-owned affiliates gives $600 as minority-owned affiliates' portion of R&D investment scaled for consistency with the coverage of the ITAs. Because minority-owned affiliates are not covered by the operations data, the $600 in R&D investment attributed to these affiliates in this example demonstrates the need for an upward scaling of the operations estimate.

There is one other issue. The operations data for majority-owned affiliates do not reflect parent ownership shares, as they must to be consistent with the coverage of the ITAs. Therefore, the estimates of R&D investment for these affiliates must be adjusted to reflect ownership shares. In practice, the affiliate-level operations data do permit direct computation of such an adjustment, though such an adjustment has, in the absence of R&D capitalization, not been previously needed or computed. In this example, assumptions (1)-(3) do not show the necessary adjustment, but do provide enough information to compute it. Specifically, the $8,000 operations estimate can be allocated between wholly-owned affiliates and those majority-owned affiliates that are not wholly owned. Assumption (3), in combination with the $2,000 in R&D investment by minority-owned affiliates implies that R&D investment by majority-owned affiliates that are not wholly owned is $2,500. Wholly-owned affiliates account for the remaining $5,500 of R&D investment. With the 75 percent average parent-ownership share, the $2,500 in investment by majority-owned affiliates that are not wholly owned scales to $1,875 in ownership-adjusted R&D, $625 less than their contribution to the unadjusted estimate. This $625 difference between majority-owned affiliates' adjusted and unadjusted estimates demonstrates the need for the operations-data-based estimate to be scaled downwards.

The composite adjustment, of course, should account for the $600 needed increase along with the $625 needed decrease. Together, the ideal adjustment would yield a $25 reduction compared to the original operations-data-based estimate. Applying a scaling factor of 0.997—very close to the order-of-magnitude base-case adjustment of 1.000—gives the true ownership-share adjusted total of $7,975.

In this example, the decrease resulting from adjusting the operations-data-based estimate for majority-owned-affiliates for parents' ownership shares almost exactly offsets the increase from adjusting the estimate for inclusion of minority-owned affiliates. Other hypothetical situations can be constructed that correspond to the 85 percent and the 115 percent alternative composite adjustments used in the order-of-magnitude estimates, but to get far outside this range—given that majority-owned affiliates' account for approximately 80 percent of non-adjusted activity by all affiliates—requires relatively implausible distributional assumptions.

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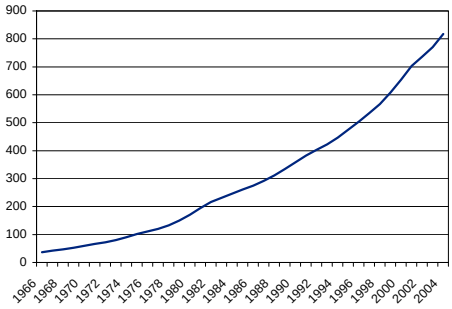
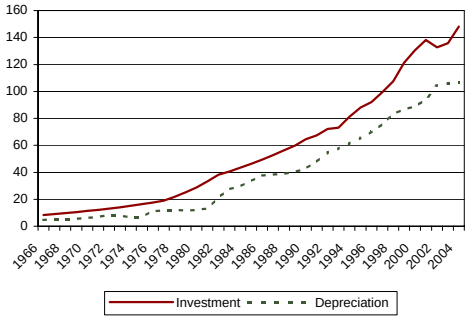
## Figure 1. Selected International R&D Data with R&D Capitalization

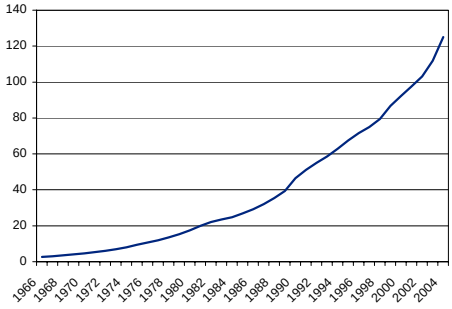
**U.S. parents' R&D capital stock**



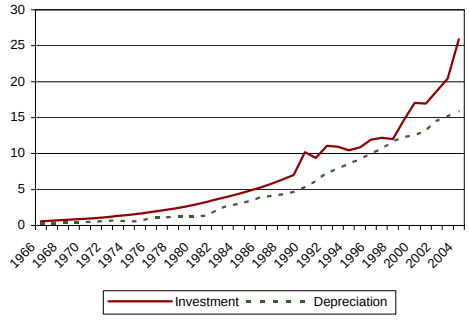

**U.S. parents' R&D**



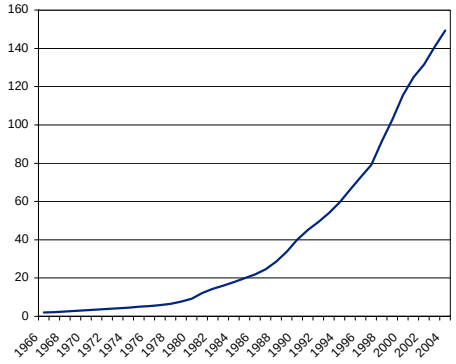

**Foreign affiliates' R&D capital stock**



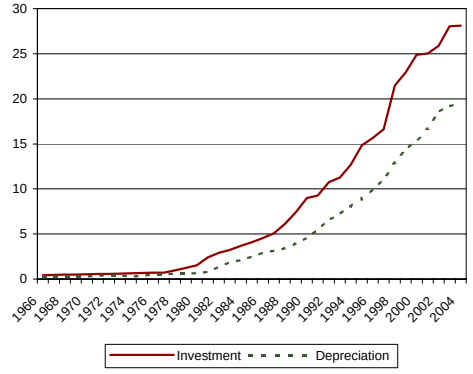

**Foreign affiliates' R&D**




**U.S. affiliates' R&D capital stock**

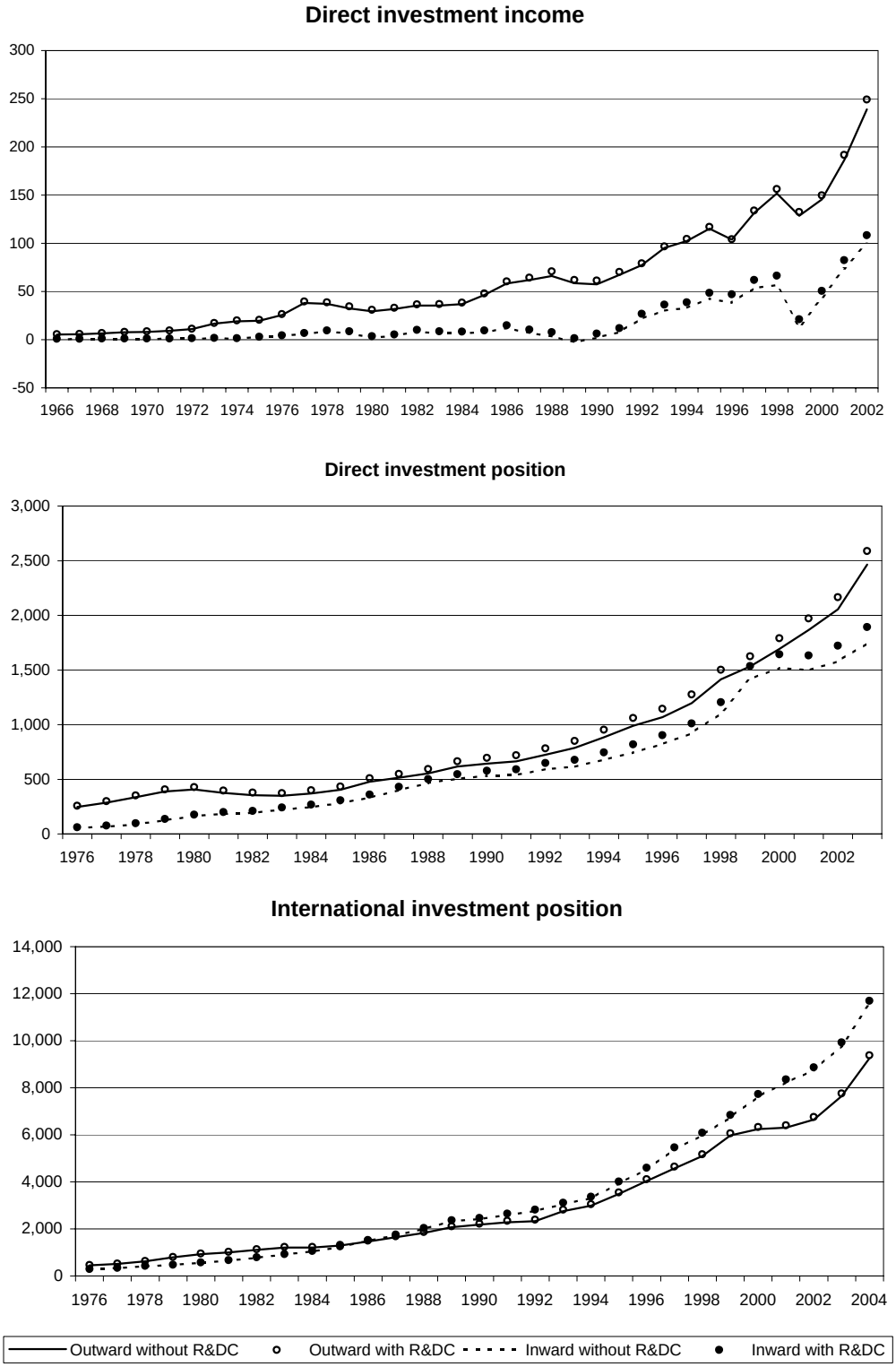



**U.S. affiliates' R&D**




Source: U.S. Bureau of Economic Analysis

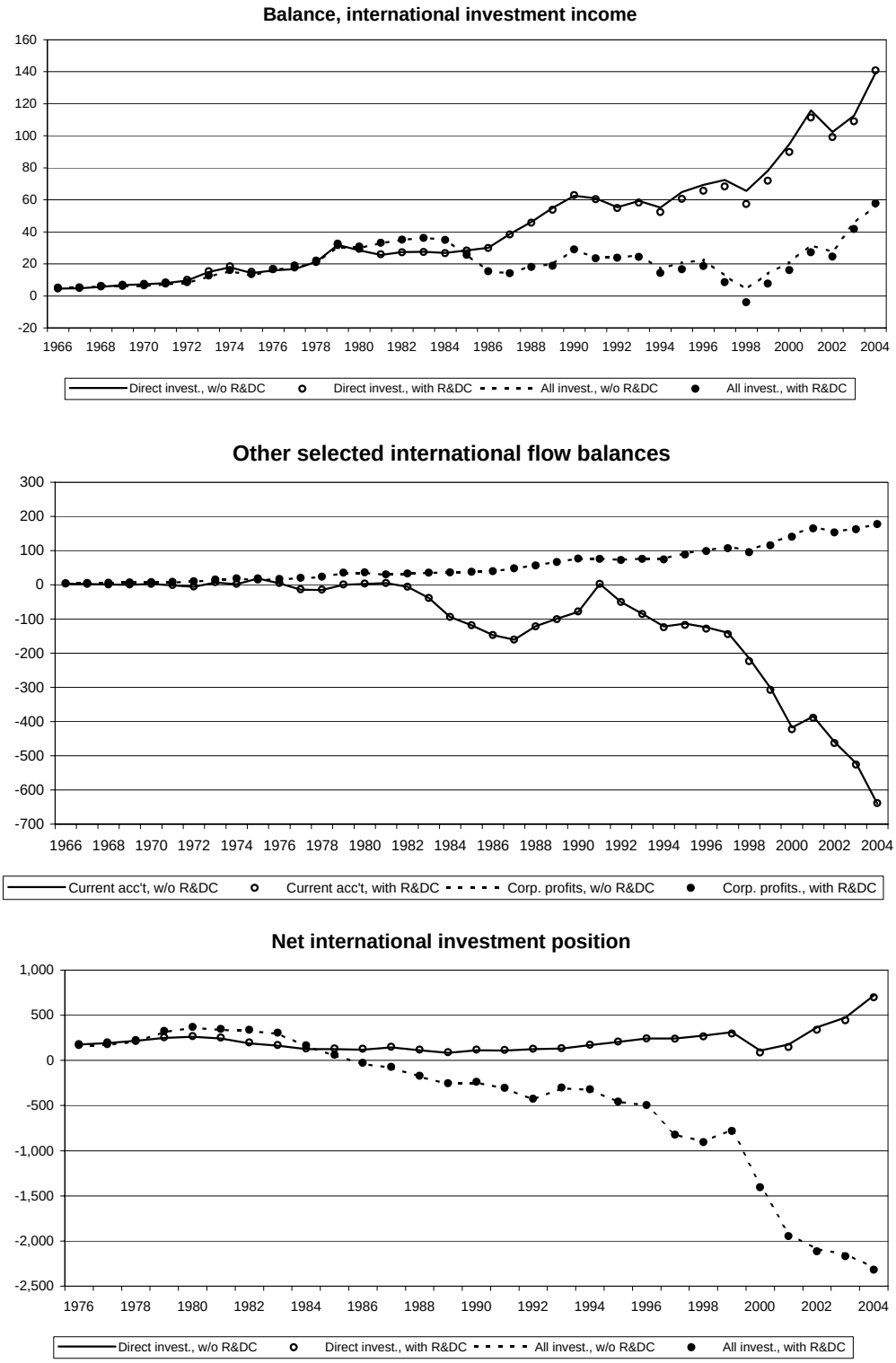
**Figure 2. Comparison of Selected Data with and without R&D Capitalization**




R&DC: R&D capitalization

Source: U.S. Bureau of Economic Analysis

**Figure 3. Comparison of Selected Flow Balances and Net Positions with and without R&D Capitalization**




R&DC: R&D capitalization

Source: U.S. Bureau of Economic Analysis

# Table 1. R&D capital

| | Estimated stock (millions of current dollars) | | | As share of total capital stock (percent) | | |
|---|---|---|---|---|---|---|
| | Foreign affiliates | U.S. parents | U.S. affiliates | Foreign affiliates[1] | U.S. parents[2] | U.S. affiliates[1] |
| 1966 | 2,617 | 37,191 | 1,948 | 7.1 | .... | .... |
| 1967 | 3,016 | 41,895 | 2,220 | .... | .... | .... |
| 1968 | 3,492 | 47,246 | 2,515 | .... | .... | .... |
| 1969 | 4,040 | 53,125 | 2,826 | .... | .... | .... |
| 1970 | 4,659 | 59,433 | 3,149 | .... | .... | .... |
| 1971 | 5,331 | 65,876 | 3,465 | .... | .... | .... |
| 1972 | 6,043 | 72,246 | 3,764 | .... | .... | .... |
| 1973 | 6,909 | 79,829 | 4,111 | .... | .... | .... |
| 1974 | 8,096 | 90,416 | 4,594 | .... | .... | .... |
| 1975 | 9,447 | 101,934 | 5,091 | .... | .... | .... |
| 1976 | 10,624 | 110,648 | 5,432 | .... | .... | .... |
| 1977 | 12,000 | 120,566 | 5,811 | 6.1 | 20.5 | 6.4 |
| 1978 | 13,510 | 133,331 | 6,582 | .... | .... | 6.0 |
| 1979 | 15,354 | 149,943 | 7,753 | .... | .... | 5.6 |
| 1980 | 17,521 | 170,352 | 9,269 | .... | .... | 5.3 |
| 1981 | 19,985 | 194,444 | 12,159 | .... | .... | 4.9 |
| 1982 | 22,114 | 216,206 | 14,398 | 6.4 | 20.5 | 4.9 |
| 1983 | 23,499 | 231,130 | 16,013 | 6.9 | .... | 5.2 |
| 1984 | 24,750 | 246,556 | 17,941 | 7.9 | .... | 5.3 |
| 1985 | 26,965 | 261,360 | 19,959 | 8.5 | .... | 5.4 |
| 1986 | 29,191 | 275,288 | 21,945 | 8.8 | .... | 5.5 |
| 1987 | 32,145 | 291,933 | 24,530 | 9.0 | .... | 5.6 |
| 1988 | 35,407 | 311,756 | 28,636 | 9.0 | .... | 5.5 |
| 1989 | 39,397 | 333,935 | 33,794 | 9.1 | 22.8 | 5.6 |
| 1990 | 46,539 | 358,768 | 40,079 | 9.6 | .... | 5.6 |
| 1991 | 51,048 | 382,266 | 45,094 | 9.8 | .... | 5.8 |
| 1992 | 55,083 | 403,315 | 49,381 | 10.5 | .... | 7.4 |
| 1993 | 58,531 | 422,881 | 53,991 | 11.3 | .... | 7.6 |
| 1994 | 62,827 | 446,848 | 59,450 | 11.3 | 23.7 | 7.7 |
| 1995 | 67,447 | 475,529 | 66,286 | 11.0 | .... | 8.2 |
| 1996 | 71,691 | 503,912 | 72,646 | 10.8 | .... | 8.5 |
| 1997 | 74,993 | 534,576 | 79,077 | 10.7 | .... | 9.0 |
| 1998 | 79,490 | 566,287 | 91,490 | 10.3 | .... | 9.2 |
| 1999 | 86,668 | 608,503 | 102,858 | 10.2 | 23.4 | 9.4 |
| 2000 | 92,346 | 654,359 | 115,583 | 10.5 | .... | 9.6 |
| 2001 | 97,545 | 702,958 | 124,942 | 10.5 | .... | 9.8 |
| 2002 | 103,117 | 736,105 | 131,528 | 10.6 | .... | 10.1 |
| 2003 | 111,772 | 770,543 | 140,778 | 10.7 | .... | 10.5 |
| 2004 | 125,047 | 817,482 | 149,248 | 10.9 | 25.8 | 10.6 |

[1]Total capital stock equals an unpublished estimate of the net stock of property, plant, and equipment plus the estimate of the net stock of R&D capital (both valued at current cost).
[2]Total capital stock equals the net stock of property, plant, and equipment (valued at historical cost) plus the estimate of the net stock of R&D capital (valued at current cost).

* Base case assumptions are used:
– Annual depreciation rate of R&D capital: 15%
– Entry factor (see text): *EF* = {40% for foreign affiliates, 20% for U.S. parents, 30% for U.S. affiliates}
– Initial-year (1966) beginning-of-year capital stock: 4 times initial (1966) R&D expenditures
– Operations data scaled by factor of 1.00 to establish matching basis when used in modifying international transactions data (net effect of scaling up to convert from a majority-owned to an all-affiliate basis and scaling down to reflects parents' onwership share)

Source: U.S. Bureau of Economic Analysis

## Table 2. Value added

| | Foreign affiliates | | U.S. parents | | U.S. affiliates | |
|---|---|---|---|---|---|---|
| | Without R&DC | With R&DC | Without R&DC | With R&DC | Without R&DC | With R&DC |
| 1977 | 161,136 | 163,211 | 490,529 | 509,482 | .... | .... |
| 1978 | .... | .... | .... | .... | .... | .... |
| 1979 | .... | .... | .... | .... | .... | .... |
| 1980 | .... | .... | .... | .... | .... | .... |
| 1981 | .... | .... | .... | .... | .... | .... |
| 1982 | 223,717 | 227,364 | 796,017 | 834,174 | .... | .... |
| 1983 | 216,683 | 220,690 | .... | .... | .... | .... |
| 1984 | 220,331 | 224,733 | .... | .... | .... | .... |
| 1985 | 220,074 | 224,911 | .... | .... | .... | .... |
| 1986 | 231,644 | 236,958 | .... | .... | .... | .... |
| 1987 | 269,734 | 275,573 | .... | .... | .... | .... |
| 1988 | 297,556 | 303,971 | .... | .... | .... | .... |
| 1989 | 319,994 | 327,042 | 1,044,884 | 1,104,809 | .... | .... |
| 1990 | 356,033 | 366,220 | .... | .... | .... | .... |
| 1991 | 356,069 | 365,465 | .... | .... | .... | .... |
| 1992 | 361,524 | 372,608 | .... | .... | 214,781 | 225,526 |
| 1993 | 359,179 | 370,130 | .... | .... | 223,008 | 234,270 |
| 1994 | 403,696 | 414,141 | 1,313,792 | 1,395,026 | 244,690 | 257,361 |
| 1995 | 465,576 | 476,456 | 1,365,470 | 1,453,551 | 254,938 | 269,784 |
| 1996 | 498,310 | 510,245 | 1,480,638 | 1,572,804 | 283,422 | 299,063 |
| 1997 | 520,867 | 533,059 | 1,573,451 | 1,672,921 | 313,655 | 330,262 |
| 1998 | 506,269 | 518,305 | 1,594,504 | 1,702,152 | 353,860 | 375,337 |
| 1999 | 566,396 | 581,022 | 1,914,343 | 2,035,695 | 397,295 | 420,244 |
| 2000 | 606,626 | 623,669 | 2,141,480 | 2,271,967 | 447,287 | 472,168 |
| 2001 | 585,657 | 602,603 | 1,892,399 | 2,030,495 | 417,122 | 442,146 |
| 2002 | 601,606 | 620,292 | 1,858,805 | 1,991,391 | 460,609 | 486,490 |
| 2003 | 697,778 | 718,189 | 1,958,125 | 2,093,853 | 475,062 | 503,103 |
| 2004 | 824,336 | 850,245 | 2,215,800 | 2,364,015 | 511,474 | 539,607 |

R&DC: R&D capitalization

Data are in millions of current dollars, base case assumptions are used.

* Base case assumptions:
  – Annual depreciation rate of R&D capital: 15%
  – Entry factor (see text): *EF* = {40% for foreign affiliates, 20% for U.S. parents, 30% for U.S. affiliates}
  – Initial-year (1966) beginning-of-year capital stock: 4 times initial (1966) R&D expenditures
  – Operations data scaled by factor of 1.00 to establish matching basis when used in modifying international transactions data (for details, see note to table 1)

Source: U.S. Bureau of Economic Analysis

## Table 3. Current-cost direct investment income

| | Outward investment | | Inward investment | | Balance (outward minus inward) | |
|---|---|---|---|---|---|---|
| | Without R&DC | With R&DC | Without R&DC | With R&DC | Without R&DC | With R&DC |
| 1966 | 5,260 | 5,517 | 711 | 902 | 4,549 | 4,615 |
| 1967 | 5,603 | 5,892 | 821 | 1,005 | 4,782 | 4,887 |
| 1968 | 6,591 | 6,939 | 876 | 1,071 | 5,715 | 5,868 |
| 1969 | 7,649 | 8,050 | 848 | 1,046 | 6,801 | 7,003 |
| 1970 | 8,169 | 8,617 | 875 | 1,070 | 7,294 | 7,547 |
| 1971 | 9,160 | 9,635 | 1,164 | 1,339 | 7,996 | 8,296 |
| 1972 | 10,949 | 11,436 | 1,284 | 1,427 | 9,665 | 10,009 |
| 1973 | 16,542 | 17,152 | 1,610 | 1,787 | 14,932 | 15,365 |
| 1974 | 19,157 | 20,053 | 1,331 | 1,629 | 17,826 | 18,424 |
| 1975 | 16,595 | 17,603 | 2,234 | 2,542 | 14,361 | 15,061 |
| 1976 | 18,999 | 19,777 | 3,110 | 3,242 | 15,889 | 16,535 |
| 1977 | 19,673 | 20,600 | 2,834 | 2,991 | 16,839 | 17,610 |
| 1978 | 25,458 | 26,569 | 4,211 | 4,575 | 21,247 | 21,995 |
| 1979 | 38,183 | 39,579 | 6,357 | 6,983 | 31,826 | 32,596 |
| 1980 | 37,146 | 38,803 | 8,635 | 9,488 | 28,511 | 29,315 |
| 1981 | 32,549 | 34,431 | 6,898 | 8,500 | 25,651 | 25,931 |
| 1982 | 29,469 | 30,934 | 2,114 | 3,652 | 27,355 | 27,283 |
| 1983 | 31,750 | 32,942 | 4,120 | 5,490 | 27,630 | 27,452 |
| 1984 | 35,325 | 36,709 | 8,443 | 10,007 | 26,882 | 26,701 |
| 1985 | 35,410 | 36,819 | 6,945 | 8,523 | 28,465 | 28,296 |
| 1986 | 36,938 | 38,304 | 6,856 | 8,440 | 30,082 | 29,864 |
| 1987 | 46,288 | 47,966 | 7,676 | 9,614 | 38,612 | 38,352 |
| 1988 | 58,445 | 60,500 | 12,150 | 14,823 | 46,295 | 45,677 |
| 1989 | 61,981 | 64,327 | 7,045 | 10,500 | 54,936 | 53,827 |
| 1990 | 65,973 | 70,787 | 3,450 | 7,820 | 62,523 | 62,967 |
| 1991 | 58,718 | 61,862 | -2,265 | 1,539 | 60,983 | 60,322 |
| 1992 | 57,539 | 61,223 | 2,190 | 6,351 | 55,349 | 54,873 |
| 1993 | 67,245 | 70,280 | 7,943 | 12,002 | 59,302 | 58,278 |
| 1994 | 77,344 | 79,203 | 22,150 | 26,812 | 55,194 | 52,391 |
| 1995 | 95,260 | 96,870 | 30,318 | 36,239 | 64,942 | 60,631 |
| 1996 | 102,505 | 104,446 | 33,093 | 38,772 | 69,412 | 65,674 |
| 1997 | 115,323 | 116,819 | 42,950 | 48,504 | 72,373 | 68,315 |
| 1998 | 103,963 | 104,304 | 38,418 | 46,990 | 65,545 | 57,314 |
| 1999 | 131,626 | 133,943 | 53,437 | 62,011 | 78,189 | 71,932 |
| 2000 | 151,839 | 156,288 | 56,910 | 66,410 | 94,929 | 89,878 |
| 2001 | 128,665 | 132,454 | 12,783 | 21,154 | 115,882 | 111,300 |
| 2002 | 145,590 | 149,734 | 43,244 | 50,561 | 102,346 | 99,173 |
| 2003 | 186,417 | 191,638 | 73,750 | 82,583 | 112,667 | 109,055 |
| 2004 | 239,008 | 249,000 | 99,600 | 108,290 | 139,408 | 140,710 |

R&DC: R&D capitalization

Data are in millions of current dollars, base case assumptions are used.

* Base case assumptions:
  – Annual depreciation rate of R&D capital: 15%
  – Entry factor (see text): *EF* = {40% for foreign affiliates, 20% for U.S. parents, 30% for U.S. affiliates}
  – Initial-year (1966) beginning-of-year capital stock: 4 times initial (1966) R&D expenditures
  – Operations data scaled by factor of 1.00 to establish matching basis when used in modifying international transactions data (for details, see note to table 1)

Source: U.S. Bureau of Economic Analysis

## Table 4. Direct investment position at current cost

| | Outward | | Inward | | Net | |
|---|---|---|---|---|---|---|
| | Without R&DC | With R&DC | Without R&DC | With R&DC | Without R&DC | With R&DC |
| 1976 | 222,283 | 232,907 | 47,528 | 52,960 | 174,755 | 179,947 |
| 1977 | 246,078 | 258,078 | 55,413 | 61,224 | 190,665 | 196,854 |
| 1978 | 285,005 | 298,515 | 68,976 | 75,558 | 216,029 | 222,956 |
| 1979 | 336,301 | 351,655 | 88,579 | 96,332 | 247,722 | 255,324 |
| 1980 | 388,072 | 405,593 | 127,105 | 136,374 | 260,967 | 269,219 |
| 1981 | 407,804 | 427,789 | 164,623 | 176,782 | 243,181 | 251,006 |
| 1982 | 374,059 | 396,173 | 184,842 | 199,240 | 189,217 | 196,932 |
| 1983 | 355,643 | 379,142 | 193,708 | 209,721 | 161,935 | 169,422 |
| 1984 | 348,342 | 373,092 | 223,538 | 241,479 | 124,804 | 131,613 |
| 1985 | 371,036 | 398,001 | 247,223 | 267,182 | 123,813 | 130,819 |
| 1986 | 404,818 | 434,009 | 284,701 | 306,646 | 120,117 | 127,363 |
| 1987 | 478,062 | 510,207 | 334,552 | 359,082 | 143,510 | 151,125 |
| 1988 | 513,761 | 549,168 | 401,766 | 430,402 | 111,995 | 118,766 |
| 1989 | 553,093 | 592,490 | 467,886 | 501,680 | 85,207 | 90,810 |
| 1990 | 616,655 | 663,194 | 505,346 | 545,425 | 111,309 | 117,768 |
| 1991 | 643,364 | 694,412 | 533,404 | 578,498 | 109,960 | 115,914 |
| 1992 | 663,830 | 718,913 | 540,270 | 589,651 | 123,560 | 129,262 |
| 1993 | 723,526 | 782,057 | 593,313 | 647,304 | 130,213 | 134,753 |
| 1994 | 786,565 | 849,392 | 617,982 | 677,432 | 168,583 | 171,960 |
| 1995 | 885,506 | 952,953 | 680,066 | 746,352 | 205,440 | 206,601 |
| 1996 | 989,810 | 1,061,501 | 745,619 | 818,265 | 244,191 | 243,236 |
| 1997 | 1,068,063 | 1,143,056 | 824,136 | 903,213 | 243,927 | 239,843 |
| 1998 | 1,196,021 | 1,275,511 | 920,044 | 1,011,534 | 275,977 | 263,976 |
| 1999 | 1,414,355 | 1,501,023 | 1,101,709 | 1,204,567 | 312,646 | 296,456 |
| 2000 | 1,531,607 | 1,623,953 | 1,421,017 | 1,536,600 | 110,590 | 87,354 |
| 2001 | 1,693,131 | 1,790,676 | 1,518,473 | 1,643,415 | 174,658 | 147,261 |
| 2002 | 1,867,043 | 1,970,160 | 1,499,952 | 1,631,480 | 367,091 | 338,680 |
| 2003 | 2,054,464 | 2,166,236 | 1,580,994 | 1,721,772 | 473,470 | 444,464 |
| 2004 | 2,463,608 | 2,588,655 | 1,742,246 | 1,891,494 | 721,362 | 697,161 |

R&DC: R&D capitalization

Data are in millions of current dollars, base case assumptions are used.

* Base case assumptions:
  – Annual depreciation rate of R&D capital: 15%
  – Entry factor (see text): *EF* = {40% for foreign affiliates, 20% for U.S. parents, 30% for U.S. affiliates}
  – Initial-year (1966) beginning-of-year capital stock: 4 times initial (1966) R&D expenditures
  – Operations data scaled by factor of 1.00 to establish matching basis when used in modifying international transactions data (for details, see note to table 1)

Source: U.S. Bureau of Economic Analysis

## Table 5. Comparisons of International Data with and without R&D Capitalization

**Base case assumptions***

| | Annualized growth rate (percent) | | Percent difference between annual estimates: With-R&DC vs. without-R&DC | | |
|---|---|---|---|---|---|
| | Without R&DC | With R&DC | Median | Minimum | Maximum |
| Value added | | | | | |
| Foreign affiliates | 7.4 | 7.5 | 2.4 | 1.3 | 3.1 |
| U.S. parents | 5.4 | 5.4 | 6.3 | 3.9 | 7.3 |
| U.S. affiliates | 7.7 | 7.7 | 5.6 | 5.0 | 6.1 |
| Current-cost direct investment income | | | | | |
| Outward investment | 10.6 | 10.5 | 4.1 | 0.3 | 7.3 |
| Inward investment | 13.9 | 13.4 | *21.0* | *-168.0* | *190.0* |
| Balance | …. | …. | *-0.6* | *-12.6* | *4.9* |
| ITA balance on investment income | …. | …. | *-0.5* | *-193.0* | *5.5* |
| ITA balance on current account | …. | …. | *1.2* | *-270.3* | *50.7* |
| Rest-of-world corporate profits (balance) | …. | …. | -0.4 | -8.0 | 4.8 |
| Direct investment position | | | | | |
| Outward investment | 9.0 | 9.0 | 6.6 | 4.5 | 8.3 |
| Inward investment | 13.7 | 13.6 | 8.6 | 7.1 | 11.4 |
| Balance | …. | …. | *3.2* | *-21.0* | *6.6* |
| International investment position | | | | | |
| Outward investment | 11.3 | 11.3 | 2.0 | 1.4 | 2.4 |
| Inward investment | 14.0 | 14.0 | 1.6 | 1.3 | 1.9 |
| Balance | …. | …. | *1.4* | *-20.0* | *12.9* |

| | Percent in 2004 | | Annual difference: With-R&DC vs. without-R&DC (percentage point) | | |
|---|---|---|---|---|---|
| Addenda: Value added shares | Without R&DC | With R&DC | Median | Minimum | Maximum |
| Foreign affiliates in U.S. MNC total | 27.1 | 26.5 | -0.70 | -0.76 | -0.54 |
| U.S. parents in U.S. private industry GDP | 25.0 | 26.7 | 1.65 | 1.52 | 1.80 |
| U.S. affiliates in U.S. private industry GDP | 5.8 | 6.1 | 0.32 | 0.22 | 0.34 |

ITA: International transactions accounts
R&DC: R&D capitalization

Notes:
-- Series switching from positive to negative values, or series with values close to zero, are subject to large percentage differences even when absolute differences are small, due to the small denominator used in the calculation. This is primarily, but not exclusively, an issue with "balance series." Percentage differences of series for which this might occur are shown in *italics*.
-- Annualized growth rate are the percent change, at annual rates, from the earliest year for which estimates are made to 2004.

* Base case assumptions:
– Annual depreciation rate of R&D capital: 15%
– Entry factor (see text): *EF* = {40% for foreign affiliates, 20% for U.S. parents, 30% for U.S. affiliates}
– Initial-year (1966) beginning-of-year capital stock: 4 times initial (1966) R&D expenditures
– Operations data scaled by factor of 1.00 to establish matching basis when used in modifying international transactions data (for details, see note to table 1)

Source: U.S. Bureau of Economic Analysis

Source: U.S. Bureau of Economic Analysis

## Table 6. Comparisons of Depreciation Alternatives to Base Case

**Base case: Depreciation rate of 15% for R&D capital stock**

**Alternative: Depreciation rate of 12% for R&D capital stock**

| | Annualized growth rate (percent) | | Annual difference from base case (percent) | | |
|---|---|---|---|---|---|
| | Base case | Alternative | Median | Minimum | Maximum |
| R&D capital stock | | | | | |
| Foreign affiliates | 10.7 | 11.2 | 21.3 | 3.1 | 23.7 |
| U.S. parents | 8.5 | 9.0 | 21.7 | 3.1 | 22.9 |
| U.S. affiliates | 11.4 | 12.5 | 18.6 | 3.1 | 23.4 |
| R&D depreciation | | | | | |
| Foreign affiliates | 10.7 | 11.3 | -11.8 | -38.4 | -4.8 |
| U.S. parents | 8.5 | 9.1 | -11.4 | -38.4 | -5.4 |
| U.S. affiliates | 11.6 | 12.6 | -13.2 | -36.9 | -8.8 |
| Current-cost direct investment income | | | | | |
| Outward investment | 10.5 | 10.5 | 1.0 | 0.5 | 1.5 |
| Inward investment | 13.3 | 13.3 | *3.6* | *2.1* | *46.9* |
| Balance | …. | …. | *0.2* | *-1.1* | *0.9* |
| ITA balance on investment income | …. | …. | *0.3* | *-9.9* | *14.6* |
| ITA balance on current account | …. | …. | *0.2* | *-3.9* | *40.9* |
| Rest-of-world corporate profits (balance) | …. | …. | 0.2 | -0.7 | 0.8 |
| Direct investment position | | | | | |
| Outward investment | 9.0 | 9.0 | 1.4 | 0.8 | 1.6 |
| Inward investment | 13.5 | 13.6 | 1.6 | 1.3 | 2.2 |
| Balance | …. | …. | *1.1* | *-0.1* | *2.4* |
| International investment position | | | | | |
| Outward investment | 11.3 | 11.3 | 0.4 | 0.3 | 0.5 |
| Inward investment | 14.0 | 14.0 | 0.3 | 0.2 | 0.4 |
| Balance | …. | …. | *-0.1* | *-6.8* | *2.9* |

**Alternative: Depreciation rate of 18% for R&D capital stock**

| | Annualized growth rate (percent) | | Annual difference from base case (percent) | | |
|---|---|---|---|---|---|
| | Base case | Alternative | Median | Minimum | Maximum |
| R&D capital stock | | | | | |
| Foreign affiliates | 10.7 | 10.3 | -15.6 | -16.8 | -3.1 |
| U.S. parents | 8.5 | 8.1 | -15.9 | -16.3 | -3.1 |
| U.S. affiliates | 11.4 | 11.7 | -13.9 | -17.6 | -3.1 |
| R&D depreciation | | | | | |
| Foreign affiliates | 10.7 | 10.2 | 8.1 | 3.0 | 28.8 |
| Source: U.S. Bureau of Economic Analysis | 8.5 | 8.1 | 7.7 | 3.9 | 28.1 |
| U.S. affiliates | 11.6 | 11.8 | 10.1 | 6.7 | 25.7 |
| Current-cost direct investment income | | | | | |
| Outward investment | 10.5 | 10.6 | -0.7 | -1.5 | -0.3 |
| Inward investment | 13.3 | 13.6 | *-2.5* | *-36.1* | *-1.4* |
| Balance | …. | …. | *-0.1* | *-0.7* | *1.0* |
| ITA balance on investment income | …. | …. | *-0.1* | *-13.4* | *9.0* |
| ITA balance on current account | …. | …. | *-0.2* | *-31.4* | *3.3* |
| Rest-of-world corporate profits (balance) | …. | …. | -0.1 | -0.6 | 0.6 |
| Direct investment position | | | | | |
| Source: U.S. Bureau of Economic Analysis | 9.0 | 9.0 | -1.0 | -1.2 | -0.6 |
| Inward investment | 13.5 | 13.6 | -1.2 | -1.7 | -0.9 |
| Balance | …. | …. | *-0.6* | *-1.7* | *0.6* |
| International investment position | | | | | |
| Outward investment | 11.3 | 11.3 | -0.3 | -0.4 | -0.2 |
| Inward investment | 14.0 | 14.0 | -0.2 | -0.3 | -0.2 |
| Balance | …. | …. | *0.0* | *-2.2* | *5.0* |

ITA: International transactions accounts

* Denotes a value greater than 0 percent, but less than 0.05 percent in absolute value.

Notes:
-- Series switching from positive to negative values, or series with values close to zero, are subject to large percentage differences even when absolute differences are small, due to the small denominator used in the calculation. This is primarily, but not exclusively, an issue with "balance series." Percentage differences of series for which this might occur are shown in *italics* .
-- Annualized growth rate are the percent change, at annual rates, from the earliest year for which estimates are made to 2004.

Source: U.S. Bureau of Economic Analysis

## Table 7. Comparisons of Entry Factor Alternatives to Base Case[1]

**Base case: Entry factors of 40% (foreign affiliates), 20% (U.S. parents), 30% (U.S. affiliates)**

**Alternative: Entry factors of 20% (foreign affiliates), 10% (U.S. parents), 15% (U.S. affiliates)**

| | Annualized growth rate (percent) | | Annual difference from base case (percent) | | |
|---|---|---|---|---|---|
| | Base case | Alternative | Median | Minimum | Maximum |
| R&D capital stock | | | | | |
| Foreign affiliates | 10.7 | 10.5 | -7.2 | -9.8 | 0.0 |
| U.S. parents | 8.5 | 8.4 | -3.0 | -5.6 | 0.0 |
| U.S. affiliates | 11.4 | 12.0 | -7.4 | -15.0 | 0.0 |
| R&D depreciation | | | | | |
| Foreign affiliates | 10.7 | 10.5 | -7.5 | -9.4 | 0.0 |
| U.S. parents | 8.5 | 8.5 | -3.1 | -6.2 | 0.0 |
| U.S. affiliates | 11.6 | 12.1 | -7.5 | -17.2 | 0.0 |
| Current-cost direct investment income | | | | | |
| Outward investment | 10.5 | 10.6 | 0.6 | 0.0 | 0.9 |
| Inward investment | 13.3 | 13.4 | *1.7* | *0.0* | *31.2* |
| Balance | .... | .... | *0.1* | *-0.2* | *0.7* |
| ITA balance on investment income | .... | .... | *0.1* | *-9.8* | *5.6* |
| ITA balance on current account | .... | .... | *0.0* | *-0.7* | *4.7* |
| Rest-of-world corporate profits (balance) | .... | .... | 0.1 | -0.1 | 0.4 |
| Direct investment position | | | | | |
| Outward investment | 9.0 | 9.0 | -0.4 | -0.6 | -0.3 |
| Inward investment | 13.5 | 13.7 | -0.6 | -1.0 | -0.2 |
| Balance | .... | .... | *-0.2* | *-2.1* | *0.4* |
| International investment position | | | | | |
| Outward investment | 11.3 | 11.3 | -0.1 | -0.2 | -0.1 |
| Inward investment | 14.0 | 14.0 | -0.1 | -0.3 | 0.0 |
| Balance | .... | .... | *0.1* | *-0.2* | *0.5* |

**Alternative: Entry factors of 60% (foreign affiliates), 30% (U.S. parents), 45% (U.S. affiliates)**

| | Annualized growth rate (percent) | | Annual difference from base case (percent) | | |
|---|---|---|---|---|---|
| | Base case | Alternative | Median | Minimum | Maximum |
| R&D capital stock | | | | | |
| Foreign affiliates | 10.7 | 10.9 | 8.3 | 0.0 | 11.5 |
| U.S. parents | 8.5 | 8.5 | 3.2 | 0.0 | 6.2 |
| U.S. affiliates | 11.4 | 12.2 | 8.3 | 0.0 | 18.9 |
| R&D depreciation | | | | | |
| Foreign affiliates | 10.7 | 10.9 | 8.8 | 0.0 | 11.1 |
| Source: U.S. Bureau of Economic Analysis | 8.5 | 8.6 | 3.4 | 0.0 | 6.8 |
| U.S. affiliates | 11.6 | 12.2 | 9.1 | 0.0 | 21.7 |
| Current-cost direct investment income | | | | | |
| Outward investment | 10.5 | 10.5 | -0.6 | -1.1 | 0.0 |
| Inward investment | 13.3 | 13.4 | *-2.0* | *-38.5* | *0.0* |
| Balance | .... | .... | *-0.1* | *-0.8* | *0.3* |
| ITA balance on investment income | .... | .... | *-0.1* | *-6.9* | *11.5* |
| ITA balance on current account | .... | .... | *0.0* | *-4.5* | *0.7* |
| Rest-of-world corporate profits (balance) | .... | .... | -0.1 | -0.5 | 0.2 |
| Direct investment position | | | | | |
| Source: U.S. Bureau of Economic Analysis | 9.0 | 9.0 | 0.5 | 0.4 | 0.7 |
| Inward investment | 13.5 | 13.6 | 0.7 | 0.2 | 1.3 |
| Balance | .... | .... | *0.2* | *-0.6* | *2.9* |
| International investment position | | | | | |
| Outward investment | 11.3 | 11.3 | 0.2 | 0.1 | 0.2 |
| Inward investment | 14.0 | 14.0 | 0.1 | 0.0 | 0.3 |
| Balance | .... | .... | *-0.2* | *-0.9* | *0.8* |

ITA: International transactions accounts

* Denotes a value greater than 0 percent, but less than 0.05 percent in absolute value.

[1]The entry factor is one part of an assumption about that portion of the change in the R&D capital stock due to entry and exit of entities plus acquisitions and divestitures by continuing entities. Specifically, the entry factor is the share of the assumed change in the stock of physical capital due to these four types of transactions. Multiplying this factor by the percentage change in the stock of physical capital and by the prior year R&D capital stock gives the entry component of the change in the R&D capital stock.

Notes:
-- Series switching from positive to negative values, or series with values close to zero, are subject to large percentage differences even when absolute differences are small, due to the small denominator used in the calculation. This is primarily, but not exclusively, a issue with "balance series." Percentage differences of series for which this might occur are shown in *italics*.
-- Annualized growth rate are the percent change, at annual rates, from the earliest year for which estimates are made to 2004.

Source: U.S. Bureau of Economic Analysis

## Table 8. Comparisons of Initial R&D Capital Stock Alternatives to Base Case

**Base case: Initial R&D capital stock of 4.0 times initial R&D expenditures**

**Alternative: Initial R&D capital stock of 2.5 times initial R&D expenditures**

| | Annualized growth rate (percent) | | Annual difference from base case (percent) | | |
|---|---|---|---|---|---|
| | Base case | Alternative | Median | Minimum | Maximum |
| R&D capital stock | | | | | |
| Foreign affiliates | 10.7 | 11.7 | -0.8 | -29.6 | 0.0 |
| U.S. parents | 8.5 | 9.5 | -0.9 | -29.6 | 0.0 |
| U.S. affiliates | 11.4 | 13.1 | -1.0 | -29.6 | 0.0 |
| R&D depreciation | | | | | |
| Foreign affiliates | 10.7 | 11.9 | -0.8 | -33.4 | 0.0 |
| U.S. parents | 8.5 | 9.7 | -1.0 | -33.4 | 0.0 |
| U.S. affiliates | 11.6 | 13.4 | -1.2 | -33.4 | 0.0 |
| Current-cost direct investment income | | | | | |
| Outward investment | 10.5 | 10.5 | 0.1 | 0.0 | 2.0 |
| Inward investment | 13.3 | 13.2 | *0.3* | *0.0* | *9.2* |
| Balance | …. | …. | *0.0* | *0.0* | *0.6* |
| ITA balance on investment income | …. | …. | *0.0* | *0.0* | *0.6* |
| ITA balance on current account | …. | …. | *0.0* | *-1.4* | *3.0* |
| Rest-of-world corporate profits (balance) | …. | …. | 0.0 | 0.0 | 0.6 |
| Direct investment position | | | | | |
| Outward investment | 9.0 | 9.0 | 0.0 | -0.2 | 0.0 |
| Inward investment | 13.5 | 13.6 | 0.0 | -0.6 | 0.0 |
| Balance | …. | …. | *0.0* | *-0.1* | *0.0* |
| International investment position | | | | | |
| Outward investment | 11.3 | 11.3 | 0.0 | -0.1 | 0.0 |
| Inward investment | 14.0 | 14.0 | 0.0 | -0.1 | 0.0 |
| Balance | …. | …. | *0.0* | *-0.1* | *0.0* |

**Alternative: Initial R&D capital stock of 7.0 times initial R&D expenditures**

| | Annualized growth rate (percent) | | Annual difference from base case (percent) | | |
|---|---|---|---|---|---|
| | Base case | Alternative | Median | Minimum | Maximum |
| R&D capital stock | | | | | |
| Foreign affiliates | 10.7 | 9.4 | 1.5 | 0.0 | 59.1 |
| U.S. parents | 8.5 | 7.2 | 1.8 | 0.0 | 59.1 |
| U.S. affiliates | 11.4 | 10.7 | 2.1 | 0.0 | 59.1 |
| R&D depreciation | | | | | |
| Foreign affiliates | 10.7 | 9.2 | 1.7 | 0.1 | 66.8 |
| Source: U.S. Bureau of Economic Analysis | 8.5 | 7.1 | 1.9 | 0.1 | 66.8 |
| U.S. affiliates | 11.6 | 10.7 | 2.3 | 0.0 | 66.8 |
| Current-cost direct investment income | | | | | |
| Outward investment | 10.5 | 10.7 | -0.1 | -4.0 | 0.0 |
| Inward investment | 13.3 | 14.0 | *-0.6* | *-18.4* | *0.0* |
| Balance | …. | …. | *0.0* | *-1.2* | *0.0* |
| ITA balance on investment income | …. | …. | *0.0* | *-1.1* | *0.0* |
| ITA balance on current account | …. | …. | *0.0* | *-6.0* | *2.7* |
| Rest-of-world corporate profits (balance) | …. | …. | 0.0 | -1.2 | 0.0 |
| Direct investment position | | | | | |
| Source: U.S. Bureau of Economic Analysis | 9.0 | 9.0 | 0.0 | 0.0 | 0.3 |
| Inward investment | 13.5 | 13.6 | 0.0 | 0.0 | 1.2 |
| Balance | …. | …. | *0.0* | *0.0* | *0.1* |
| International investment position | | | | | |
| Outward investment | 11.3 | 11.3 | 0.0 | 0.0 | 0.2 |
| Inward investment | 14.0 | 14.0 | 0.0 | 0.0 | 0.2 |
| Balance | …. | …. | *0.0* | *0.0* | *0.1* |

ITA: International transactions accounts

* Denotes a value greater than 0 percent, but less than 0.05 percent in absolute value.

Notes:
-- Series switching from positive to negative values, or series with values close to zero, are subject to large percentage differences even when absolute differences are small, due to the small denominator used in the calculation. This is primarily, but not exclusively, an issue with "balance series." Percentage differences of series for which this might occur are shown in *italics* .
-- Annualized growth rate are the percent change, at annual rates, from the earliest year for which estimates are made to 2004.

Source: U.S. Bureau of Economic Analysis

# Table 9. Comparisons of Alternatives in Modifying International Transactions Data with Operations Data

**Base case: Operations data scaled by factor of 1.00 to match basis of international transactions data**

**Alternative: Operations data scaled by factor of 0.85 to match basis of international transactions data**

| | Annualized growth rate (percent) | | Annual difference from base case (percent) | | |
|---|---|---|---|---|---|
| | Base case | Alternative | Median | Minimum | Maximum |
| Current-cost direct investment income | | | | | |
| Outward investment | 10.5 | 10.5 | -0.6 | -1.0 | 0.0 |
| Inward investment | 13.3 | 13.5 | *-2.7* | *-37.1* | *-0.6* |
| Balance | …. | …. | *0.1* | *-0.7* | *2.2* |
| ITA balance on investment income | …. | …. | *0.0* | *-31.1* | *12.3* |
| ITA balance on current account | …. | …. | *-0.2* | *-23.8* | *4.4* |
| Rest-of-world corporate profits (balance) | …. | …. | 0.1 | -0.7 | 1.3 |
| Direct investment position | | | | | |
| Outward investment | 9.0 | 9.0 | -0.9 | -1.1 | -0.6 |
| Inward investment | 13.5 | 13.6 | -1.2 | -1.5 | -1.0 |
| Balance | …. | …. | *-0.5* | *-0.9* | *4.0* |
| International investment position | | | | | |
| Outward investment | 11.3 | 11.3 | -0.3 | -0.3 | -0.2 |
| Inward investment | 14.0 | 14.0 | -0.2 | -0.3 | -0.2 |
| Balance | …. | …. | *-0.2* | *-1.7* | *3.8* |

**Alternative: Operations data scaled by factor of 1.15 to match basis of international transactions data**

| | Annualized growth rate (percent) | | Annual difference from base case (percent) | | |
|---|---|---|---|---|---|
| | Base case | Alternative | Median | Minimum | Maximum |
| Current-cost direct investment income | | | | | |
| Outward investment | 10.5 | 10.5 | 0.6 | 0.0 | 1.0 |
| Inward investment | 13.3 | 13.4 | *2.7* | *0.6* | *37.1* |
| Balance | …. | …. | *-0.1* | *-2.2* | *0.7* |
| ITA balance on investment income | …. | …. | *0.0* | *-12.3* | *31.1* |
| ITA balance on current account | …. | …. | *0.2* | *-4.4* | *23.8* |
| Rest-of-world corporate profits (balance) | …. | …. | -0.1 | -1.3 | 0.7 |
| Direct investment position | | | | | |
| Outward investment | 9.0 | 9.0 | 0.9 | 0.6 | 1.1 |
| Inward investment | 13.5 | 13.6 | 1.2 | 1.0 | 1.5 |
| Balance | …. | …. | *0.5* | *-4.0* | *0.9* |
| International investment position | | | | | |
| Outward investment | 11.3 | 11.3 | 0.3 | 0.2 | 0.3 |
| Inward investment | 14.0 | 14.0 | 0.2 | 0.2 | 0.3 |
| Source: U.S. Bureau of Economic Analysis | …. | …. | *0.2* | *-3.8* | *1.7* |

ITA: International transactions accounts

* Denotes a value greater than 0 percent, but less than 0.05 percent in absolute value.

Notes:
-- Series switching from positive to negative values, or series with values close to zero, are subject to large percentage differences even when absolute differences are small, due to the small denominator used in the calculation. This is primarily, but not exclusively, an issue with "balance series." Percentage differences of series for which this might occur are shown in *italics*.
-- Annualized growth rate are the percent change, at annual rates, from the earliest year for which estimates are made to 2004.

Source: U.S. Bureau of Economic Analysis