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Chapter Author: James R. Hines, Jr., James R. Hines Jr., R. Glenn Hubbard

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6 Taxes, Technology Transfer, and R&D by Multinational Firms

James R. Hines, Jr.

6.1 Introduction

The technology-related activities of multinational corporations generate interest among policymakers and many others who are concerned about the performance of national economies. Government opinion may be divided over the tactics to use in attracting new technologies, but there is seldom disagreement over the goals of enhancing national productivity through technological development. The statistical evidence generally supports the conclusion that the economic benefits of R&D activity extend to local firms other than those undertaking the R&D.[1] Since there are reasons to expect that externality-generating R&D activities may be underprovided by markets in which developers of new technologies do not capture all of the economic benefits that the technologies provide, various governments offer R&D-related tax subsidies.[2]

James R. Hines, Jr., is associate professor of public policy at the John F. Kennedy School of Government of Harvard University and a faculty research fellow of the National Bureau of Economic Research.

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1. See Griliches 1991 and Nadiri 1993 for surveys of empirical measures of productivity spillovers from R&D activities.

2. In theory, the welfare consequences of subsidizing R&D are ambiguous, because competitive pressures might generate too much R&D in certain industries in the absence of a subsidy, and because foreign competitors may benefit from domestic subsidies (or in other ways influence the domestic market). See Dixit 1988 and Reinganum 1989 for surveys of the theory. The United States introduced the Research and Experimentation Tax Credit, and increased the tax deductibility of the R&D expenses of certain multinational corporations, in the Economic Recovery Tax Act of 1981. This legislation appears to have been motivated by consideration of economic externalities, though the focus of congressional sentiment as described in U.S. Congress, Joint Committee on Taxation 1981 is on comparison of U.S. research intensity with the research intensities of other countries.

Governments that do not offer R&D tax subsidies are often concerned that perhaps they should. There are, however, many open questions about the impact of tax policy on the level of R&D.

Tax systems influence the level and content of R&D activity through a variety of channels. This paper focuses on R&D by multinational firms, and the impact of one particular set of taxes: withholding taxes on cross-border royalty payments. Firms that develop new technologies in their home countries and use the technologies in foreign locations are required to pay royalties from foreign affiliates to domestic parent companies. Governments tax these royalty payments. High tax rates make royalties, and the technology imports that they accompany, more expensive for the foreign affiliates that pay the taxes.

In theory, higher costs of imported technology might encourage or discourage local R&D by affiliates of multinational corporations. The difference turns on the nature of production within multinational firms. One possibility is that firms use local R&D jointly with imported technology to produce goods for sale. As an example, it may often be the case that firms need to complement imported technologies with local research efforts that tailor products and processes to local needs. A second possibility is that firms substitute local R&D for imported technologies, as is the case when a certain amount of technological development can be done either at home or abroad.

If local R&D is complementary to imported technology, then high royalty tax rates should discourage local R&D, while if local R&D is a substitute for imported technology, then high royalty tax rates should encourage local R&D.

There are two objectives of the work presented in this paper. The first is to identify the degree to which R&D activity by multinational firms is sensitive to local tax conditions. The second objective is to determine whether imported technology and local R&D are complements or substitutes.

The results suggest that R&D responds significantly to local tax rates, and that local R&D is a substitute for imported technology. These results appear both in the behavior of American investors in other countries, and in the behavior of foreign investors in the United States. Firms appear to react to high royalty tax rates by paying fewer royalties and performing additional R&D locally. To the extent that royalty payments reflect actual technology transfer (rather than adept accounting practices), the behavior of multinational firms implies that local R&D is a substitute for imported technology.

Section 6.2 briefly describes the tax treatment of multinational firms, paying particular attention to technology-related issues. Section 6.3 analyzes the R&D incentives created by international taxation, and describes the data that serve as the basis of the empirical work. Section 6.4 describes the statistical evidence on the reaction of R&D levels to royalty tax rates. Section 6.5 is the conclusion.

6.2 Multinational Firms, Taxation, and International Technology Transfer

This section examines the role of multinational firms in international technology transfer, and reviews the tax treatment of R&D expenditures and royalty receipts by multinational firms.

6.2.1 International Technology Transfer

There is considerable interest in understanding the role that multinational firms play in transferring technologies across borders. There are two methods by which multinational firms provide new technologies to the countries in which they invest. The first method is to develop new technologies locally, through R&D or other similar type of activity. The second method is to import technologies produced elsewhere.

The foreign affiliates of American firms use both methods to bring technologies to the countries in which they operate, and sufficient information exists to assess quantitatively the relative significance of each method. Direct information on the R&D activities of the foreign affiliates of U.S. firms is reported in surveys conducted by the U.S. Commerce Department. Information on technology imports by these affiliates is considerably sketchier. One can, however, infer the approximate magnitude of technology imports from royalties paid by the affiliates to U.S. parent firms and third parties in other countries, since royalty payments should, in principle, reflect the values of imported technologies.

Table 6.1 reports detailed information about the aggregate technology-

Table 6.1 **R&D and Royalty Activity of Foreign Affiliates of U.S. Multinationals**

	1982 (millions of current $)	1989 (millions of current $)
R&D expenditures, total	3,851	7,922
R&D by affiliate for itself	3,073	6,307
R&D by affiliate for others	778	1,615
Royalty receipts, total	435	1,461
From U.S. parents	36	54
From other foreign affiliates	193	656
From unaffiliated Americans	26	97
From unaffiliated foreigners	180	654
Royalty payments, total	4,308	12,472
To U.S. parents	3,663	9,839
To other foreign affiliates	354	1,488
To unaffiliated Americans	102	660
To unaffiliated foreigners	189	485

Source: U.S. Department of Commerce, Bureau of Economic Analysis 1985, 1992.
Note: Data cover majority-owned foreign affiliates of U.S. multinational firms.

related behavior of the foreign affiliates of U.S. firms in 1982 and 1989. It is noteworthy that these affiliates paid more in royalties to their parent firms ($9.8 billion in 1989) than they spent on R&D ($7.9 billion in 1989), though, as the table indicates, there was extensive use of both methods of technology acquisition. The survey distinguishes two categories of R&D expenditure: R&D by affiliates for themselves, and R&D by affiliates for others (the latter of which is R&D performed on a contract basis). R&D by affiliates for themselves constitutes roughly 80 percent of their total R&D expenditures.

American firms spend a considerable amount of money on R&D performed in foreign countries, but in recent years, foreign-owned firms have spent even more than that on R&D performed in the United States. Figure 6.1 illustrates the R&D expenditure levels of foreign affiliates of U.S. firms and foreign-owned firms in the United States over the 1977–90 period. Due to the R&D intensity of the U.S. economy relative to the rest of the world, and the strength of foreign direct investment into the United States since 1973, foreign firms have spent more on R&D inside the United States than American firms have spent on R&D outside the United States in every year since 1982, and the gap between the two expenditure levels is widening.[3]

There is considerable interest in the role of multinational firms in transferring technology across borders, and the impact that government policy can have on the rate and direction of technology transfer. Though these issues have been extensively studied,[4] one of the open questions is the degree to which imported technology is a substitute or complement for local R&D.

6.2.2 The Tax Treatment of R&D Expenditures and Royalty Receipts

The appendix to this volume describes the general features of the U.S. system of taxing the foreign incomes of American corporations. American multinational firms that perform R&D in the United States intending to use the resulting technology both in the United States and abroad face a particularly complex tax treatment of their transactions. Since passage of the Tax Reform Act of 1986, American multinationals are no longer allowed to deduct 100 percent of their U.S. R&D expenses against their U.S. tax liabilities. Instead, U.S. law requires American firms to allocate R&D expenses between U.S. and

3. Exchange rate fluctuations can confound the interpretation of figure 6.1, since changes in the value of the dollar relative to foreign currencies affect the dollar-denominated relative magnitudes of R&D performed in the United States and abroad, even if nominal expenditures are unchanged. This consideration is not significant in this case, however, since a simple adjustment for the changing value of the dollar relative to a trade-weighted average of foreign currencies produces a figure that very closely resembles figure 6.1.

4. See, for example, Teece 1976; Germidis 1977; Mansfield, Teece, and Romeo 1979; Mansfield and Romeo 1980; Davidson and McFetridge 1984; Lipsey, Blomstrom, and Kravis 1990; Zejan 1990; Blomstrom 1991; Ethier and Markusen 1991; Wang and Blomstrom 1992; and Blomstrom and Kokko 1993. These studies together consider the effect of a large number of variables on technology transfer and R&D activity, though they do not consider the effect of royalty tax rates on local R&D intensities.

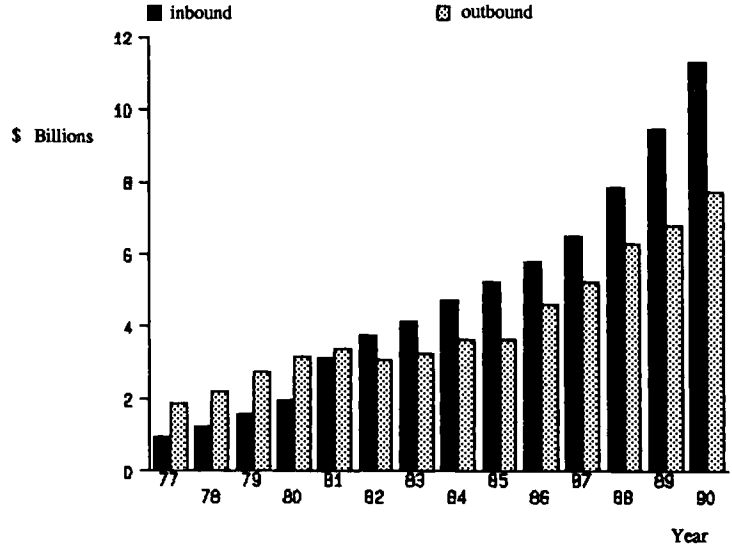

Fig. 6.1 R&D by foreign firms in the United States, and by American firms abroad, 1977–1990

Sources: U.S. Department of Commerce, Bureau of Economic Analysis, various issues; National Science Foundation 1993.

Note: The vertical scale measures billions of current dollars of annual R&D expenditures. Darkly shaded bars represent total R&D expenditures of foreign-owned firms in the United States. Lightly shaded bars represent total R&D expenditures of foreign affiliates of American firms.

foreign sources, based on the fraction of a firm's sales that are foreign.[5] The practical importance of this system is that firms with excess foreign tax credits receive usable tax deductions for only a fraction (equal to the ratio of domestic sales to total worldwide sales) of their U.S. R&D expenses. This system is based on the idea that multinational firms performing R&D in the United States use only a fraction of the output of their R&D activities to enhance their sales in the United States, and consequently, that only a fraction of their R&D costs should be deductible against U.S.-source income.

Royalties received by American parent firms for R&D used abroad represent taxable foreign-source income of the American firms. American firms with deficit foreign tax credits must pay U.S. income tax on these royalty receipts, while firms with excess foreign tax credits can apply the excess credits against U.S. taxes due on the royalties, thereby eliminating the U.S. tax liability created by the royalty receipts.

Most of the world's governments impose withholding taxes on cross-border

5. See Hines 1993, 1994 for descriptions of the precise formulas used and quantitative assessments of their impact on R&D spending levels.

royalty payments from affiliates located within their countries. These royalty tax rates are frequently reduced according to the terms of bilateral tax treaties. For example, the United States imposes a 30 percent tax on royalties paid to foreign corporations, but this tax rate is often reduced, in some cases to zero, when recipients of royalty payments are located in countries with whom the United States has a tax treaty in force.

6.3 Framework and Data

This section analyzes the R&D incentives created by systems of international taxation, and describes the data that serve as the basis of the statistical work.

6.3.1 R&D Incentives

Consider a multinational firm that establishes a foreign affiliate to produce and sell goods in the foreign country in which the affiliate is located.[6] The affiliate generates sales using local inputs of capital, labor, and intermediate products; in addition, the affiliate uses technology from its parent and the technology it generates on its own to produce goods for sale.

American tax law and the tax laws of most other countries require that foreign affiliates pay rents or royalties to their parent firms for the fair market value of technologies transferred from the parent firms to the affiliates.[7] In practice, of course, it is frequently difficult to establish the fair market value of technology transferred from one party to another within a controlled group, since there may exist no market prices for the types of technology in question. In such circumstances, tax-avoiding firms that transfer technology from the parent to its foreign affiliates often have incentives to select royalty payments that transfer taxable income out of high-tax jurisdictions and into low-tax jurisdictions. Governments are aware of this incentive, and try to use their enforcement power to prevent royalties from deviating too greatly from reasonable values.[8]

One way to describe government enforcement efforts is to consider the additional costs that firms bear when royalties deviate from market values. These include costs that firms incur in justifying their royalty declarations to tax authorities. If these adjustment costs rise sufficiently with the deviations of re-

6. This analysis abstracts from the possibility that the activities of foreign affiliates directly enhance the sales of their domestic parent firm. One of the practical difficulties that American firms encounter in such situations is that royalties paid by U.S. parents to their foreign affiliates are severely tax-disadvantaged. See Hines 1994 for a discussion of this issue.

7. Of the twenty-five industrialized countries surveyed by Lawlor (1985), twenty-four apply the arm's-length principle to the taxation of related-party transactions; Hong Kong is the lone exception.

8. For evidence on the overall effectiveness of transfer price enforcement, see Kopits 1976; Grubert and Mutti 1991; Harris et al. 1993; and Hines and Rice 1994.

ported royalties from market values, then they will ultimately limit the degrees to which firms modify royalty payments simply for tax purposes.

Enforcement efforts that require firms to pay royalties equal to market values of technology transfers also mean that taxes on royalty payments should affect the volume of technology transfers. As long as there is a positive relationship between royalty payments and technology transfers, higher royalty taxes raise the cost of transferred technology, and may encourage local firms to undertake their own R&D as a substitute for imported technology.

6.3.2 Data

There are two available sources of detailed information on the R&D activities of multinational firms located in a large number of countries. The first source is the 1989 Benchmark Survey of the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. This survey, the results of which are reported in U.S. Department of Commerce 1992, is the most recent comprehensive survey of the activities of the foreign affiliates of American multinational firms. The survey covers activities during 1989. In order to protect the confidentiality of survey respondents, BEA does not divulge the responses of individual firms, and reports country aggregates only for those countries in which there are sufficient numbers of U.S. firms with sizable activities so that aggregate figures do not reveal information about individual firms. Useful R&D and royalty data are available for affiliates in forty-three foreign countries for 1989.

The second source of information is the 1987 survey of foreign direct investment in the United States, reported in U.S. Department of Commerce 1990. This survey describes the activities of foreign-owned firms in the United States during 1987. Due to data suppressions and other limitations, useful data are available on investors from twenty-seven countries during 1987.

The goal of the statistical work is to examine the relationship between royalty tax rates and levels of R&D activity, both for American firms investing in foreign countries and for foreign firms investing in the United States. The difficulty that such a study encounters is that R&D levels differ for reasons that have nothing to do with tax rates. One nontax factor that is clearly associated with R&D spending is the degree of R&D intensity in the countries in which multinational firms have operations. The foreign affiliates of American multinationals located in countries whose economies are R&D-intensive tend to perform more R&D than do affiliates located in other countries. Similarly, foreign-owned affiliates in the United States tend to invest more in R&D if their parent firms are located in technology-intensive countries.

Information is available from the National Science Foundation (1991) on the R&D intensities of a large number of countries. The National Science Foundation constructs indices that reflect national R&D/GNP ratios; due to data limitations, these ratios are not all calculated using data for the same year,

Table 6.2 **R&D Expenditure as a Percentage of GNP, 1961–1989**

	France	West Germany	Japan	United Kingdom	United States
1961	1.4	—	1.4	2.5	2.7
1962	1.5	1.2	1.5	—	2.7
1963	1.6	1.4	1.5	—	2.8
1964	1.8	1.6	1.5	2.3	2.9
1965	2.0	1.7	1.6	—	2.8
1966	2.1	1.8	1.5	2.3	2.8
1967	2.2	2.0	1.6	2.3	2.8
1968	2.1	2.0	1.7	2.2	2.8
1969	2.0	1.8	1.7	2.3	2.7
1970	1.9	2.1	1.9	—	2.6
1971	1.9	2.2	1.9	—	2.4
1972	1.9	2.2	1.9	2.1	2.4
1973	1.8	2.1	2.0	—	2.3
1974	1.8	2.1	2.0	—	2.2
1975	1.8	2.2	2.0	2.1	2.2
1976	1.8	2.1	2.0	—	2.2
1977	1.8	2.1	2.0	—	2.2
1978	1.8	2.2	2.0	2.2	2.1
1979	1.8	2.4	2.1	—	2.2
1980	1.8	2.4	2.2	—	2.3
1981	2.0	2.5	2.3	2.4	2.4
1982	2.1	2.6	2.4	—	2.5
1983	2.1	2.6	2.6	2.2	2.6
1984	2.2	2.6	2.6	—	2.7
1985	2.3	2.8	2.8	2.3	2.8
1986	2.3	2.8	2.8	2.4	2.8
1987	2.3	2.9	2.8	2.3	2.8
1988	2.3	2.9	2.9	2.2	2.7
1989	2.3	2.9	3.0	2.0	2.7

Source: National Science Foundation 1991.

Note: French data are based on gross domestic product (GDP); consequently, percentages may be slightly overstated compared to GNP. Omissions (—) indicate that R&D data are unavailable.

though most observations represent the period 1986–88.[9] In the empirical investigations, the variables that influence R&D demand are interacted with these country-level measures of R&D intensity. This procedure represents a simple, if rather unsubtle, adjustment for differences among countries in the extent to which their firms undertake R&D. Local R&D intensity can have an important impact on the demand for imported technology as well, so the R&D intensity variable appears in the royalty equations.

9. R&D/GNP ratios change little from year to year, as evidenced by the time-series data on France, Germany, Japan, the United Kingdom, and the United States presented in table 6.2 These economies, which are among the most R&D-intensive in the world, exhibit only gradual movements in R&D intensity relative to each other.

Information on tax systems and tax rates is reported by Price Waterhouse (various issues). In the empirical investigations, firms are assumed to face effective tax rates on their technology-related activities equal to statutory corporate tax rates in host countries.

6.4 Responsiveness of R&D Activity to Tax Rates

This section describes the evidence on the responsiveness of R&D activity to royalty tax rates. Two sources of information are considered: information on the behavior of American-owned affiliates in foreign countries, and information on the behavior of foreign-owned affiliates in the United States.

6.4.1 Foreign Affiliates of American Multinational Corporations

Evidence reported in Hines 1995 indicates that American-owned affiliates in foreign countries that tax royalties heavily tend to pay fewer royalties (measured as a fraction of total sales) to their parent firms than do other affiliates. These results control for the technological intensity of host countries in which affiliates are located. The implied elasticity of royalty payments with respect to the royalty tax rate, evaluated at the sample mean, is approximately -0.4. This figure implies that, when royalty tax rates double,[10] royalty payments fall (relative to sales) by 40 percent.

At least part of the responsiveness of royalty payments to local tax rates corresponds to changes in the use of imported technology. The complexity of determining appropriate royalty payments for a variety of intangible property that firms transfer across borders, along with taxpayers' natural incentives to minimize their own tax liabilities, makes reported royalties a somewhat noisy measure of the amount of technology that firms import. Nevertheless, royalty payments should correspond, even if only loosely, to the value of technology imports; the evidence suggests that they respond negatively to higher tax rates.

There are two ways to assess the impact of royalty tax rates on the R&D activities of the foreign affiliates of American multinationals. The first way is to examine the degree to which the ratio of R&D expenses by American-owned affiliates to their labor expenses appears to respond to royalty tax rates.[11] The evidence, reported in Hines 1995, indicates that higher royalty tax

10. The mean royalty tax rate facing the foreign affiliates of American multinationals is 20 percent; hence, doubling the tax rate implies a change from 20 percent to 40 percent.

11. R&D expenditures are scaled by labor compensation in manufacturing. Manufacturing affiliates account for about 90 percent of the foreign R&D activity of multinational firms. Labor compensation is chosen as the denominator because both labor and R&D expenses share the feature of immediate deductibility for tax purposes. Of course, some countries (including the United States) offer tax credits and other inducements to firms that perform R&D (and in some cases to firms that hire labor). A brief survey of country practices indicates, however, that sizable R&D subsidies are rare (for example, see Hall 1993 for an analysis of the magnitude of the marginal subsidy provided R&D in the United States by the Research and Experimentation Tax Credit), and that the primary subsidy comes from the immediate deductibility of R&D expenses that almost all industrialized countries provide.

rates are associated with greater R&D intensities. The estimated elasticity of responsiveness is 0.16, which implies that doubling the royalty tax rate is associated with 16 percent higher R&D expenditures, controlling for other factors (such as the technological intensity of the local economy). Local R&D appears to be a substitute for imported technology.

There is a second way to measure the impact of royalty tax rates on the R&D activities of the foreign affiliates of American multinationals, one that exploits the distinction between total R&D performed by foreign affiliates of U.S. firms and that part of R&D performed by foreign affiliates of U.S. firms for their own use. The latter differs from the former because foreign affiliates of U.S. firms do some R&D on contract for others. Under the assumption that imported technology does not influence R&D performed for other parties, it is possible to compare R&D performed for an affiliate's own use to R&D performed for other parties, in order to infer the impact of royalty tax rates on R&D for own use. The advantage of this technique is that the level of R&D performed for other parties reflects and controls for nontax factors that might otherwise threaten to confound the analysis. The results, reported in Hines 1995, indicate that, once again, local R&D is a substitute for imported technology. The estimated elasticity of responsiveness is now 0.11, which implies that doubling the royalty tax rate is associated with 11 percent higher R&D expenditures, controlling for R&D performed for other parties. This estimated elasticity differs little from the 0.16 elasticity estimated using the first method.

6.4.2 Foreign-Owned Affiliates in the United States

The behavior of foreign-owned affiliates in the United States offers additional evidence on the responsiveness of R&D activity to royalty tax rates. This evidence must, however, be interpreted with caution, owing to heterogeneous circumstances of foreign firms that invest in the United States and the small sample size of twenty-seven foreign countries for which sufficient data are available.

Evidence on the behavior of foreign-owned affiliates in the United States yields conclusions that are very similar to those that emerge from the behavior of the foreign affiliates of American corporations. Foreign investors in the United States pay fewer royalties, and use more R&D-intensive operations, when they face higher tax rates on royalties paid to their home countries. The small number of countries that constitute major foreign investors makes statistical inference difficult, but the estimated coefficients are statistically significant at usual levels of confidence, and in fact, the estimated responsiveness (reported in Hines 1995) is somewhat larger than that for the foreign affiliates of American corporations.

6.5 Conclusion

This paper describes information on the behavior of the foreign affiliates of U.S. firms and foreign-owned affiliates in the United States to estimate the

relationship between technology imports and local R&D. The idea is to use the tax treatment of royalty payments to identify the degree of substitutability between these sources of technology. The evidence from the actions of American and foreign firms indicates that R&D responds to local tax rates, and that technology imports and local R&D are substitutes. The substitutability of these technologies carries numerous implications for the design of tax policy toward R&D, particularly when contrasted with the complementarity that is sometimes thought to characterize their relationship.

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