

From the
Office of Tax Policy Research

WORKING PAPER SERIES

International Taxation and the Location of Inventive Activity

by

James R. Hines Jr.

University of Michigan and NBER

Adam B. Jaffe

Brandeis University and NBER

The Office of Tax Policy Research, established in 1987, promotes policy-oriented research in taxation, and serves as a liaison between the academic, business, and policy making communities. We are committed to using state-of-the-art methods to analyze tax policy issues, and to disseminate our findings, and those of a broader academic community, to people in the policy making community.

LEADING IN THOUGHT AND ACTION

International Taxation and the Location of Inventive Activity

James R. Hines Jr.
University of Michigan and NBER

Adam B. Jaffe
Brandeis University and NBER

May 2000

We thank Austin Nichols for excellent research assistance, Austan Goolsbee for helpful comments on an earlier draft, and the NBER for financial support.

©2000 by James R. Hines Jr. and Adam B. Jaffe. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

International Taxation and the Location of Inventive Activity

ABSTRACT

This paper considers the effect of tax rules on the distribution of inventive activity between the United States and foreign countries. The empirical work analyzes the effect of U.S. tax changes on international patenting by a panel of American multinational firms. American firms differ in the extent to which they were affected by the R&D provisions of the Tax Reform Act of 1986. The evidence indicates that firms for which the after-tax cost of performing R&D in the United States for use abroad rose most rapidly after 1986 exhibit the slowest growth of foreign patenting in subsequent years. This pattern suggests that tax incentives influence subsequent patenting patterns of individual firms, and that foreign and domestic innovative activities are complements at the firm level.

JEL Classification: H25, H87, F23, O31.

James R. Hines Jr.
University of Michigan Business School
701 Tappan Street
Ann Arbor, MI 48109-1234
jrhines@umich.edu

Adam B. Jaffe
Department of Economics
Brandeis University
Waltham, MA 02254
ajaffe@stanley.feldberg.brandeis.edu

1. Introduction.

Tax systems often encourage certain activities at the expense of others. Governments typically offer investments in research and development (R&D) very attractive tax treatment, since R&D is thought to be associated with large positive economic spillovers.¹ One of the factors contributing to the generosity of tax benefits for R&D is competition between governments to attract R&D-intensive investments by multinational firms. Since a multinational firm typically has the option of performing its R&D in any of several countries, the volume of its R&D activity in one country is likely to be affected by the attractiveness of opportunities elsewhere. In spite of the frequency with which R&D receives generous tax subsidies, and the widespread belief that these subsidies encourage the discovery and development of new technologies, very little of a quantitative nature is known about the impact of tax rules on the international location of innovative activity.

The purpose of this paper is to examine the effect of taxation on the distribution of inventive activity between the United States and foreign countries. The paper analyzes the effect of U.S. tax changes, particularly those introduced by the Tax Reform Act of 1986, on the international pattern of subsequent patenting by American multinational firms. Due to the specifics of U.S. tax law, American firms differ in the extent to which tax changes affect the after-tax cost of performing R&D in the United States. Firms also differ in the extent to which tax changes affect the returns to using the results of R&D performed in the United States to generate sales abroad. The same U.S. tax changes do not directly influence the return to R&D performed abroad by American multinational firms, so any induced international relocation of

¹ Griliches (1992) surveys the econometric evidence of economic spillovers from innovative activity.

innovative activity in the years following tax changes reflect the ways in which domestic and foreign patenting activity are related.

There is extensive interest in understanding the role that multinational firms play in transferring technologies across borders. There are two methods by which multinational firms provide technology to the countries in which they invest. The first method is to develop new technologies locally, through R&D or other similar types 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 invest, and there exists sufficient information to assess quantitatively the relative significance of each method. Direct information on the R&D activities of the foreign affiliates of American 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 affiliates to American parent firms and third parties in other countries, since royalty payments should, in principle, reflect the values of imported technologies.

Table 1 reports detailed information on the aggregate technology-related behavior of the foreign affiliates of American firms in 1982, 1989, and 1994. It is noteworthy that affiliates paid more in royalties to their parent firms (\$16.7 billion in 1994) than they spent on R&D (\$11.9 billion in 1994), 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. R&D by affiliates for themselves

constitutes roughly 80 percent of their total R&D expenditures.

In spite of extensive consideration in the literature of the role that multinational firms play in facilitating international technology transfer,² there is very little in the way of quantitative evidence of the complementarity or substitutability of foreign and domestic technology. Hines (1995) offers evidence that domestic and foreign R&D are substitutes, but to the extent that firms establish foreign R&D to exploit the core competencies that they have developed at home by adapting the firms' technology to foreign markets, we would expect that foreign and domestic R&D would be complementary. The evidence reported in Hines (1995) is based on an analysis of aggregate data concerning the R&D activities of American multinational firms abroad and the R&D activities of foreign investors in the United States. The purpose of the current investigation is to examine whether similar patterns appear at a firm level.

The empirical results in this paper suggest that foreign and domestic innovative activities are complements rather than substitutes. Specifically, firms with rising after-tax costs of performing R&D *in the United States* that is directed at generating technology for use abroad are those that exhibit the slowest growth of *foreign* patenting. This pattern is sensible if the willingness to undertake foreign R&D is a function of the propensity to perform related domestic R&D, and the latter is a function of domestic tax incentives. What the results indicate is that domestic tax incentives can significantly influence not only the rate of domestic innovation, but also the rate of foreign innovation by American multinational firms. Since complementarity is a

² See, for example, Teece (1976), Mansfield, Teece, and Romeo (1979), Mansfield and Romeo (1980), Davidson and McFetridge (1984), Lipsey, Blomstrom, and Kravis (1990), Zejan (1990), Blomstrom (1991), Wang and Blomstrom (1992), Blomstrom and Kokko (1995), and Ethier and Markusen (1996). 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

symmetric relationship, the results also imply that foreign tax incentives should influence the rate at which American multinational firms innovate in their domestic markets.

Evidence of the complementarity of innovative activity comes from an analysis of the behavior of a panel of American multinational firms over the 1982-1992 period. There were several important U.S. tax changes over this time period, notable among them the changes introduced by the Tax Reform Act of 1986. Using international patent data that specify the inventor's country of residence, it is possible to trace the effect of U.S. tax changes on subsequent patenting patterns, and thereby to identify any effects of U.S. tax changes on foreign innovative activity (as reflected by patents).

Section 2 of the paper reviews the U.S. tax treatment of foreign-source income, with an emphasis on the tax treatment of R&D expenses and foreign royalty receipts. Section 3 presents a model of firm behavior and describes the data used in the empirical analysis. Section 4 presents the regression results and analyzes their implications. Section 5 is the conclusion.

2. Tax incentives.

The United States taxes income on a residence basis, meaning that American corporations and individuals owe taxes to the U.S. government on all of their worldwide income.³ The top U.S. corporate tax rate is now 35 percent. Since profits earned in foreign countries are usually taxed by host governments, U.S. law permits taxpayers to claim tax credits for foreign income taxes and related tax obligations, in order not to subject American multinationals to double

potential complementarity of domestic and foreign innovation.

taxation. The foreign tax credit mechanism implies that a U.S. corporation earning \$100 in a foreign country with a 12 percent tax rate (and a foreign tax obligation of \$12) pays only \$23 to the U.S. government, since its U.S. corporate tax liability of \$35 (35 percent of \$100) is reduced to \$23 by the foreign tax credit of \$12. The foreign tax credit is, however, limited to U.S. tax liability on foreign income; if, in the example, the foreign tax rate were 50 percent, then the firm pays \$50 to the foreign government but its U.S. foreign tax credit is limited to \$35. Hence an American firm receives full tax credits for its foreign taxes paid only when it is in a deficit credit position, i.e., when its average foreign tax rate is less than its tax rate on domestic operations. A firm has excess credits if its available foreign tax credits exceed U.S. tax liability on its foreign income. Firms average together their taxable incomes and taxes paid in all of their foreign operations in calculating their foreign tax credits and the foreign tax credit limit.⁴

Deferral of U.S. taxation of certain foreign earnings is another important feature of the U.S. international tax system. An American parent firm is taxed on its subsidiaries' foreign income only when repatriated to the parent corporation. This type of deferral is available only to foreign operations that are separately incorporated in foreign countries (subsidiaries of the parent) and not to consolidated (branch) operations. The U.S. government taxes branch profits as they are earned, just as it would profits earned within the United States.

³ Portions of this brief description of U.S. law are excerpted from Hines (1991, 1994, 1997).

⁴In order to qualify for the foreign tax credit, firms must own at least 10% of a foreign affiliate, and only those taxes that qualify as income taxes are creditable. Furthermore, income is broken into different functional "baskets" in the calculation of applicable credits and limits. Income earned and taxes paid in the conduct of most types of active foreign business operations are grouped in one "basket;" petroleum industry income is grouped in a separate "basket;" and there are separate "baskets" for items such as passive income earned abroad. The "basket" distinctions imply that a firm might simultaneously have excess foreign tax credits in the petroleum "basket" (which is common, since foreign tax rates on oil income are typically quite high) and deficit foreign tax credits in the active income "basket." Such a firm would have to pay some U.S. tax on its active foreign income, even though it has excess foreign tax credits on its petroleum income.

The deferral of U.S. taxation may create incentives for firms with lightly-taxed foreign earnings to delay repatriating dividends from their foreign subsidiaries.⁵ This incentive arises in those cases in which firms expect never to repatriate their foreign earnings, or if they anticipate that future years will be more attractive for repatriation (either because domestic tax rates will be lower, or because future sources of foreign income will generate excess foreign tax credits that can be used to offset US tax liability on the dividends).⁶ It appears that, in practice, U.S. multinationals choose their dividend repatriations selectively, generally paying dividends out of their more heavily taxed foreign earnings first.⁷ Consequently, the average tax rate that firms face on their foreign income need not exactly equal the average foreign tax rate faced by their branches and subsidiaries abroad.

Branch earnings and dividends from subsidiaries represent only two forms of foreign income for U.S. income tax purposes. Interest received from foreign sources also represents foreign income, though foreign interest receipts are often classified within their own "basket" and hence are not averaged with other income in calculating the foreign tax credit. Royalty income received from foreigners, including foreign affiliates of U.S. firms, is also foreign source income. Foreign governments often impose moderate taxes on dividend, interest, and royalty payments

⁵The incentive to defer repatriation of lightly taxed subsidiary earnings is attenuated by the Subpart F provisions, introduced in U.S. law in 1962, that treat a subsidiary's passive income, and income invested in U.S. property, as if it were distributed to its American owners, thereby subjecting it to immediate U.S. taxation. The Subpart F rules apply to controlled foreign corporations, which are foreign corporations owned at least 50% by U.S. persons holding stakes of at least 10% each. Controlled foreign corporations that reinvest their foreign earnings in active businesses can continue to defer their U.S. tax liability on those earnings. See Hines and Rice (1994) and Scholes and Wolfson (1991) for the behavioral implications of these rules.

⁶It is interesting to note that the deferral of U.S. tax liability does not itself create an incentive to delay paying dividends from foreign subsidiaries, since the U.S. tax must be paid eventually. See Hartman (1985).

⁷See the evidence presented in Hines and Hubbard (1990), Altshuler and Newlon (1993), and Altshuler et al. (1995).

from foreign affiliates to their American parent companies; these withholding⁸ taxes are fully creditable against an American taxpayer's U.S. tax liability on foreign 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 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.

Interaction of R&D and Foreign Income Rules

American firms with foreign income are generally not permitted to deduct all of their R&D expenditures in the United States against their domestic taxable incomes. Instead, the law provides for various methods of allocating R&D expenses between domestic and foreign income. The intention of the law is to retain the relatively generous treatment of R&D, but only for that

⁸Taxes on cross-border flows, such as dividends, interest, and royalties, are known as "withholding" taxes due to some of the niceties of their administration. Strictly speaking, these taxes represent obligations of the recipients and not the payors; this arrangement permits immediate crediting of withholding taxes by recipients who are eligible to claim foreign tax credits. The taxes are called "withholding" taxes because the local payor is the withholding agent for the tax,

part of a firm's R&D expenditures that is devoted to production for domestic markets. R&D-performing firms with foreign sales and foreign income are presumed to be doing at least some of their R&D to enhance their foreign profitability.

From the standpoint of taxpaying firms, the U.S. tax law's distinction between domestic and foreign R&D deductions is potentially quite important. If an R&D expense is deemed to be domestic, then it is deductible against the taxpayer's U.S. taxable income. Alternatively, if it is deemed to be foreign, then the R&D expense reduces foreign taxable income *for the purposes of U.S. income taxation only*. Foreign governments do not use U.S. methods of calculating R&D deductions, and generally do not permit American firms to reduce their taxable incomes in foreign countries on the basis of R&D undertaken in the United States. Consequently, an R&D expense deduction allocated against foreign income is valuable to an American firm only if the firm has deficit foreign tax credits. If the firm has deficit credits, then the firm pays some U.S. tax on its foreign income, and any additional dollar of R&D deduction allocated against foreign income reduces the firm's US taxable income by a dollar. Hence, firms with deficit foreign tax credits are indifferent between allocating R&D expenses against foreign income and allocating them against domestic income.⁹ By contrast, firms with excess foreign tax credits pay no U.S. tax on their foreign income, and therefore have no use for R&D deductions allocated against foreign income. Consequently, firms with excess foreign tax credits lose the value of any R&D

and is therefore liable to ensure that the taxes are paid.

⁹This statement, along with much of the subsequent analysis, abstracts from the ability of firms to carry excess foreign tax credits backward two years and forward five years. Firms that can exploit carryforwards or carrybacks may (depending on specific circumstances) face incentives that are intermediate between those of deficit credit and excess credit firms.

deductions allocated against foreign income.

The tax law governing the allocation of R&D expenses was for years rather vague, but was codified by U.S. Treasury Regulation section 1.861-8 in 1977. The 1977 rules provide for several stages in allocating R&D expenditures for tax purposes. R&D in the United States that is undertaken to meet certain legal requirements (such as R&D devoted to meeting pollution standards) can be 100% allocated against domestic income. Firms that perform more than half of their [other than legally required] R&D in the United States are permitted to allocate 30% of that R&D against U.S. income. The remaining 70% is then to be allocated between domestic and foreign sources on the basis of sales (including the sales of controlled foreign corporations). R&D is generally allocated according to activities within product lines (defined similarly to two-digit SIC codes), so that a corporation need not allocate part of its chemical R&D against foreign income simply because the electronics part of its business has foreign sales.

There are several options available to taxpayers who are unsatisfied with the outcome of the R&D allocation method just described. Firms are permitted to apportion more than 30% of their domestic R&D against U.S. income if they can establish that it is reasonable to expect the R&D so apportioned to have very limited application outside of the country; the remaining portion of its R&D expenses are then allocated on the basis of sales. Alternatively, firms are permitted to allocate their R&D on the basis of total foreign and domestic income (though without the 30% initial allocation to U.S. source), so that firms with foreign operations that generate sales but not income (relative to domestic operations) might prefer the income allocation method. There is, however, a limit to the income allocation method: firms are not

permitted to reduce their foreign source R&D expense allocation to less than 50% of the allocation that would have been produced by the sales method (including the 30% initial apportionment).

The Economic Recovery Tax Act in 1981 changed these rules by permitting American firms to allocate 100% of the expense of R&D performed in the United States against U.S. taxable income. This change was intended to be temporary (two years), in order to offer strong R&D incentives while affording Congress the opportunity to rethink its R&D policy. At the end of that time, the U.S. Department of the Treasury produced a study (1983) concluding that the tax change offered a small R&D incentive to U.S. firms, and was desirable on that basis.¹⁰ In 1984 and 1985 the Congress extended the temporary change permitting 100% deductibility of U.S. R&D expenses against U.S. income, so these rules remained in place until the end of the 1986 tax year.

The Tax Reform Act of 1986 removed the 100% deductibility of U.S. R&D expenses, replacing it with a new, and again temporary, system of R&D expense allocation.¹¹ Under the 1986 Act, 50% of U.S. R&D expense (other than R&D to meet regulations, which was 100% allocated to domestic source) was allocated to domestic source, with the remaining 50% allocated on the basis of sales or of income, at the taxpayer's choice. There was no limit imposed

¹⁰The Treasury study (1983) based its conclusions on a range of assumed elasticities of R&D with respect to price changes; there was no attempt made to ascertain how firms responded to the changes introduced in 1981.

¹¹The Tax Reform Act of 1986 also introduced a number of other changes relevant to R&D investment decisions, including reducing the statutory corporate tax rate from 46% (the tax rate from 1979-1986) to 40% in 1987 and 34% for 1988 and subsequent years. The 1986 Act also removed a number of investment incentives such as accelerated depreciation of capital assets and the investment tax credit for new equipment purchases.

on the degree to which allocation on the basis of gross income could reduce foreign allocation relative to the sales method. These rules, it turned out, were in effect only for 1987.

The Technical and Miscellaneous Revenue Act of 1988 changed the R&D expense allocation rules for the first part of 1988. For the first four months of the year firms were permitted to allocate 64% of U.S. R&D expense against U.S. domestic income, with the remaining 36% allocated between foreign and domestic sources on the basis of either sales or income (at the taxpayer's choice). The 1988 Act further provides that if the 36% were allocated on the basis of income, then the R&D allocation against foreign income must equal at least 30% of the foreign allocation that would have been produced by the sales method. For the remaining eight months of the year, taxpayers were required to use the allocation method described in section 1.861-8 as of 1977 (and described above).

The Omnibus Budget Reconciliation Act of 1989 again changed the R&D allocation rules, this time reintroducing the same rules that applied for the first four months of 1988. The Omnibus Budget Reconciliation Act of 1990 and the Tax Extension Act of 1991 extended this treatment of R&D expenses until a date that depends on a taxpayer's choice of fiscal year, but in no case later than 1 August 1992. Consequently, 64% of domestically-performed R&D in 1989-1992 could be allocated against domestic income, with the remaining 36% allocated either on the basis of sales or of income (though use of the income method could not reduce foreign source allocation to less than 30% of the foreign source allocation that would have been produced by the sales method).

The expiration of the R&D expense allocation legislation in the summer of 1992

motivated an extensive reconsideration of the issue of the appropriate tax treatment of R&D expenditures by multinational firms. In June 1992, the Treasury temporarily suspended its section 1.861-8 allocation rules (the 1977 regulations), replacing them with an 18-month moratorium in which taxpayers could continue to use the system embodied in the legislation covering the years 1989-1992 (64% place-of-performance allocation, with the remaining deductions allocated on the basis of sales). The idea was that the Treasury would reexamine its section 1.861-8 regulations during the 18-month period. The rationale for the moratorium was "to provide taxpayers with transition relief and to minimize audit controversy and facilitate business planning during the conduct of the regulatory review."¹² Some contemporaneous observers noted that the extension of the R&D allocation rules through Treasury moratorium instead of Congressional legislation made the rules less costly from the standpoint of federal budget targets, since regulatory changes are exempt from the budget agreement limits. What role, if any, such considerations played in the decision to suspend the section 1.861-8 rules is not clear. In any case, the Treasury moratorium did not run its full course, being supplanted in 1993 by new legislation.

President Clinton's budget proposal of February 1993 recommended a major change in the allocation of R&D expenditures and treatment of royalty receipts by U.S.-based multinational corporations. The President proposed that American firms deduct 100% of their U.S. R&D expenditures against U.S. income, but that the same firms no longer be permitted to use foreign tax credits generated by their active foreign operations to reduce U.S. tax liabilities on royalty

¹²United States Congress, Joint Committee on Taxation (1993), p. 55.

income from foreign sources. Instead, firms would be required to allocate foreign-source royalty income to the "passive basket" in determining their foreign tax credit limits. The idea behind the change was to limit severely the ability of American firms to use excess foreign tax credits to wipe out their U.S. tax liabilities on foreign-source royalty income. Very few firms have excess foreign tax credits in the "passive basket." Consequently, the overall effect of the proposal would have been to raise the deductions that firms with excess foreign tax credits receive for R&D performed in the United States, but to include - as income fully taxed by the United States - the royalties they receive from foreign sources. Congress chose not to include this proposal in the legislation passed in August 1993.

Instead, the Omnibus Budget Reconciliation Act of 1993 (OBRA 93) continued the pattern of allowing U.S.-based multinational firms to deduct only a fraction of their U.S. R&D expenses against U.S. income, and, at the same time, permits firms to use excess foreign tax credits to eliminate U.S. tax liabilities on foreign-source royalty income. OBRA 93 permitted firms to allocate 50% of U.S.-based R&D expenses to domestic source, with the remaining 50% allocated between domestic and foreign source based either on sales or on income, at the taxpayer's option (subject to the restriction that income-based allocation not reduce foreign source allocation to less than 30% of that produced by the sales method). The allocation rules under OBRA 93 were temporary, expiring one year after they took effect. As in earlier years, many observers attributed the temporary nature of the allocation rules to the mechanics of compliance with federal budget targets: if Congress were to pass permanent legislation covering the R&D allocation rules, then the "cost," to the current-year budget, of any treatment more

generous than the 1977 regulations, must include "costs" incurred in future years. By instead passing temporary legislation, Congress incurs budgetary "costs" only for the current year. Of course, budgetary "costs" need not bear any relation to the economic consequences of permanent legislation covering the allocation of R&D expenses.¹³

During 1995 the Treasury reconsidered the appropriateness of its 1977 R&D expense regulations. Based on newer analysis (U.S. Department of the Treasury, 1995), the regulations were amended roughly along the lines of recent legislative developments. Specifically, the 1995 regulations permit firms to select one of two allocation methods, one in which firms allocate 50% of U.S.-based R&D expenses to domestic source, with the remaining 50% allocated between domestic and foreign source based on sales, and a second in which firms allocate 25% of U.S.-based R&D expenses to domestic source, with the remaining 75% allocated between domestic and foreign source based on gross income. Under these regulations, income-based allocation is not permitted to reduce foreign source allocation to less than 50% of that produced by the sales method. The new regulations amend the previous rules in certain, more minor, ways as well.¹⁴ Since the OBRA 93 R&D allocation rules have now expired, the 1995 Treasury regulations now govern the allocation of U.S. R&D expenses.¹⁵

¹³There are some with strong feelings that permanent legislation creates a more predictable environment for businesses, thereby making the United States a more attractive location for R&D. Turro (1993, p. 436) quotes one tax practitioner, who describes the Congress's decision to make the OBRA 93 R&D allocation rules temporary an "absurd tax policy decision."

¹⁴Specifically, firms are required to make their elections permanent, so it is not possible to use the sales method in one year and the income method in the next. In addition, the new regulations specify that firms allocate R&D expenses based on 3-digit SIC activities, rather than the 2-digit SIC activities provided in the previous regulations.

¹⁵It is noteworthy that the 1995 revisions to the R&D cost allocation regulations were not "costly" from the standpoint of federal budget targets, since regulatory changes are not budgeted.

3. Framework for analysis.

Changes in the U.S. tax treatment of R&D expenses affect some firms more than others, due to differences in excess foreign tax credit status and in the extent to which sales and income have foreign sources. Consequently, these changes can be used to identify differences between firms in costs of performing R&D in the United States in years before and after tax changes. The idea behind the empirical work that follows is to draw appropriate inferences from correlations between tax-driven cost changes and subsequent propensities to take out patents on the basis of U.S. and foreign research activities.

3.1 A model.

It is useful to distinguish three types of R&D undertaken by multinational firms. The first type is R&D performed in the United States and intended to produce innovative output for the American market. The second type is R&D performed in the United States and intended to generate foreign sales. The third type is R&D performed abroad. Tax incentives differ for each of these types, and as a result, the incentives that firms face to undertake R&D in domestic and foreign locations will differ. Of course, to a certain degree these distinctions may be more pronounced *ex post* than they are *ex ante*, since, in the early stages of industrial research, the location of ultimate sales may be more than a little bit uncertain. For the purpose of this analysis, firms are assumed to be able to distinguish the ultimate location of the uses of their innovative output at the time that they perform the initial R&D.

The R&D expense allocation rules imply that multinational firms performing R&D in the United States are unable to deduct all of their R&D expenses in years after 1986. Instead, they can deduct a fraction α of such expenses, in which the value of α depends on the firm's foreign tax credit status, its ratio of foreign to domestic sales, and the tax rules in place at the time. U.S. tax rules in effect between 1981-1986 imply that $\alpha = 1$, while those in effect after 1986 imply that $1 \geq \alpha \geq 0$.

An American firm that contemplates committing funds to an R&D project that is expected to generate innovative output, and therefore sales in the domestic market, maximizes:

$$(1) \quad \pi_i = Q(R_i, \theta_i)(1-\tau) - R_i(1-\alpha_i\tau),$$

in which π_i denotes firm i 's after-tax profits, R_i is firm i 's expenditures on R&D, $Q(\cdot)$ is net sales generated by firm i 's R&D activity, α_i is the fraction of firm i 's R&D expenses that are deductible for tax purposes, and τ is the statutory tax rate. The variable θ_i is an unobservable parameter (assumed to be known to firms) that affects the productivity of firm i 's research activity and thereby influences its desired R&D spending. The function $Q(\cdot)$ is assumed to be twice continuously differentiable and concave in R . The first-order condition corresponding to an interior maximum of (1) is $\partial\pi_i/\partial R_i = 0$, which implies:

$$(2) \quad \frac{\partial Q(R_i, \theta_i)}{\partial R_i} = \frac{1-\alpha_i\tau}{1-\tau}.$$

Equation (2) expresses the simple point that reduced deductibility of domestic R&D expenses, which is captured by lower values of α_i , are associated with higher required marginal products of R&D expenditures by profit-maximizing firms. Since the function $Q(\cdot)$ is assumed to exhibit decreasing returns to R, it follows that lower values of α_i reduce desired spending on R&D.

The incentives facing an American multinational firm performing R&D in the United States for use abroad are potentially quite different. Returns to the innovating firm come in the form of foreign-source royalties that are effectively untaxed by the United States if the firm has excess foreign tax credits, and are fully taxed otherwise. Denoting firm i 's R&D undertaken for this purpose by R_i^* , and the relevant sales function by $Q^*(R_i^*, \theta_i)$,¹⁶ the firm's profits from this source (π_i^*) equal:

$$(3) \quad \pi_i^* = Q^*(R_i^*, \theta_i)(1 - \beta_i \tau) - R_i^*(1 - \alpha_i \tau),$$

in which β_i reflects the extent to which firm i 's foreign-source royalties are taxed, so that $\beta_i = 0$ for firms with excess foreign tax credits and $\beta_i = 1$ for firms with deficit foreign tax credits.

The first-order condition corresponding to an interior maximum of (3) with respect to R_i^* is $\partial \pi_i^* / \partial R_i^* = 0$, implying:

¹⁶ Strictly speaking, it is necessary for the analysis that follows to include as an argument of the $Q^*(\cdot)$ function R&D undertaken by foreign affiliates; this argument is omitted, since including it complicates the notation without changing the interpretation of the results.

$$(4) \quad \frac{\partial Q^*(R_i^*, \theta_i)}{\partial R_i^*} = \frac{1 - \alpha_i \tau}{1 - \beta_i \tau}.$$

Equation (4) expresses in a simple way that the incentive to perform R&D in the United States for use abroad is a function of the deductibility of R&D expenses as well as the tax treatment of foreign-source royalty receipts. Assuming the $Q^*(\cdot)$ function to exhibit decreasing returns to R^* , it follows that the desired level of R^* is an increasing function of α and a decreasing function of β .

The third type of R&D that multinational firms undertake is foreign R&D. The foreign innovative activity of American multinational firms is a decreasing function of R&D performed in the United States and intended for foreign use (R^*) if foreign and domestic research are substitutes, and an increasing function of R^* if they are complements.¹⁷ Since R_i^* is not directly observable, it is necessary to infer its value from the tax incentives that firm i faces. This inference is greatly complicated by the likely importance of firm-specific technology shocks. Firms differ greatly in their abilities and willingness to patent new technologies, and these differences may change over time. It is convenient to introduce the variable ϕ_{it} , which denotes a firm-specific shock to the patenting proclivity of firm i in period t . The firm-specific shock ϕ_{it} differs from θ_{it} , in that θ_{it} affects the marginal product of additional R&D spending, while ϕ_{it} affects the proclivity to obtain patents conditional on research activity.

It is helpful to define foreign and domestic patenting functions:

¹⁷ This discussion takes the returns to foreign R&D to be unaffected by domestic R&D intended for the domestic market. This is a reasonable assumption, given the very limited domestic use of technology produced by foreign

$$(5a) \quad P_{it}^* = \psi^*(R_{it}^f, \phi_{it})$$

$$(5b) \quad P_{it} = \psi(R_{it}, \phi_{it})$$

in which R_{it}^f is the foreign R&D spending of firm i in year t , P_{it}^* is the number of foreign patents taken out by firm i in year t , and P_{it} is the corresponding number of domestic patents.¹⁸

From (4) it is clear that the after-tax cost of domestic R&D directed at producing sales in foreign markets is a function of the firm's domestic tax situation. The extent, therefore, to which these domestic tax considerations affect R_{it}^f (and thereby affect P_{it}^*) depends on the complementarity or substitutability of foreign and domestic technology. The firm's derived demand for foreign R&D can be written:

$$(6) \quad R_{it}^f = g^* \{ [(1-\alpha_{it}\tau_t)/(1-\beta_{it}\tau_t)], \theta_{it} \},$$

in which the first argument of the g^* function is simply the after-tax cost of performing R&D at home to generate sales abroad, and other considerations, such as firm and economy characteristics in year t , are captured by θ_{it} .

Combining (5a) and (6) yields a function that expresses foreign patenting as it is affected

affiliates, as reflected by royalty payments reported in Table 1.

¹⁸ It is noteworthy that this specification assumes that any technology spillovers between domestic and foreign innovation are fully credited to proper sources and therefore reflected in royalty payments. The functional forms of (5a) and (5b) also require that patenting be affected only by R&D performed contemporaneously, a testable

by the price of domestic R&D:

$$(7) \quad P^*_{it} = h^* \left\{ \left[\frac{(1-\alpha_{it}\tau_t)}{(1-\beta_{it}\tau_t)} \right], \theta_{it}, \phi_{it} \right\}.$$

By a similar reasoning, the demand for domestic R&D directed at producing sales in the domestic market is a function of the implied after-tax cost indicated by (2):

$$(8) \quad R_{it} = g \left\{ \left[\frac{(1-\alpha_{it}\tau_t)}{(1-\tau_t)} \right], \theta_{it} \right\},$$

which, combined with (5b), implies:

$$(9) \quad P_{it} = h \left\{ \left[\frac{(1-\alpha_{it}\tau_t)}{(1-\tau_t)} \right], \theta_{it}, \phi_{it} \right\}.$$

Linearizing the effect of θ and ϕ yields:

$$(10) \quad P^*_{it} = f^* \left[\frac{(1-\alpha_{it}\tau_t)}{(1-\beta_{it}\tau_t)} \right] + c^*(\theta_{it} + \phi_{it})$$

and

$$(11) \quad P_{it} = f \left[\frac{(1-\alpha_{it}\tau_t)}{(1-\tau_t)} \right] + c(\theta_{it} + \phi_{it}).$$

proposition examined in the next section.

Combining (10) and (11), and taking first differences, yields:

$$(12) \quad P^*_{it} - P^*_{it-1} = \delta_{1it} - (c^*/c)\delta_{2it} + (c^*/c)(P_{it} - P_{it-1}),$$

$$\delta_{1it} \equiv f^*[(1-\alpha_{it}\tau_t)/(1-\beta_{it}\tau_t)] - f^*[(1-\alpha_{it-1}\tau_{t-1})/(1-\beta_{it-1}\tau_{t-1})]$$

$$\delta_{2it} \equiv f[(1-\alpha_{it}\tau_t)/(1-\tau_t)] - f[(1-\alpha_{it-1}\tau_{t-1})/(1-\tau_{t-1})].$$

Equation (12) expresses the change in foreign patenting as a function of three variables: the change in home-country tax incentives for home R&D directed at foreign markets, the change in tax incentives for home R&D directed at domestic markets, and the change in domestic patenting. Estimates of the propensity to develop foreign patents as a function of these variables implicitly estimate the degree of complementarity or substitutability of foreign and domestic R&D, since this connection is embedded in the $f^*(\cdot)$ function. It is this specification that provides the framework used in the empirical analysis.

3.2 *Data.*

The empirical work that follows analyzes the behavior of publicly-traded firms whose annual report information is collected by Compustat. Starting from a universe of somewhat over 7,500 companies, firms are included in the sample if they are multinationals incorporated in the United States, and if their reported foreign assets equal one percent or more of reported total

assets for each year during 1986-1990. This criterion is satisfied by 422 firms.

Foreign tax rate information is central to the analysis, since the hypothesis that firms maximize after-tax profits implies that deficit foreign tax credit firms will react very differently than excess foreign tax credit firms to the changes introduced by the Tax Reform Act of 1986. Compustat reports foreign pretax incomes and foreign taxes paid by the firms in the sample, from which it is possible to use simple division to obtain an estimate of effective foreign tax rates.¹⁹ These average foreign tax rates for firms in 1985 are the basis of the tax calculations that follow. Data for 1985 are used because this was the last full year before passage of the Tax Reform Act of 1986, which introduced incentives to relocate foreign operations and tax liabilities. Average foreign tax rates are truncated at zero and 100% for purposes of this construction.

During the 1983-1986 period, U.S. tax law permitted American firms to deduct 100% of their domestic R&D expenses against domestic taxable income. In the years after 1986, deductibility is based on excess foreign tax credit status and on shares of total sales in foreign markets. For the purposes of constructing regression variables, α_{it} is assigned a value of one for all firms until 1986. In the period after 1986, firms are assigned $\alpha_{it} = 1$ if the 1985 foreign average tax rate is below the (year t) U.S. statutory tax rate, and otherwise $\alpha_{it} = [1 - 0.36(\text{foreign sales fraction})]$, corresponding to the expense allocation rules in place in 1991. Since the value of β_{it} depends critically on foreign tax credit status about which only imprecise information is

¹⁹ Average foreign tax rates are used in place of actual foreign tax credit status (i.e., excess or deficit credit) for two reasons. The first reason is that actual foreign tax status is endogenous to a host of decision variables related to the financing, investment, repatriation, transfer pricing, and other activities of multinational firms. While average foreign tax rates are, by the same reasoning, also endogenous, the endogeneity problem is generally regarded to be more severe with excess foreign tax credit status than it is with average foreign tax rates. The second reason is that tax return data at the firm level are unavailable, so the actual foreign tax credit situations of firms in the sample

available, a more continuous tax specification is used in defining β_{it} : β_{it} is defined to equal one minus the average foreign tax rate a firm faced in 1985.

To determine the international distribution of patenting, the 422 sample firms were matched to the database of U.S. patents created by the NBER and Case-Western Reserve University.²⁰ The NBER/CWRU database contains all patents granted by the U.S. government between 1963 and 1996. This database, based on the public patent records, identifies for every patent the inventors, the geographic location of the inventors, and a corporate “assignee” (if any) to whom the patent right is transferred by the inventor.^{21,22} To utilize these data for the current purpose, it was necessary to identify all U.S. patents that were taken out by the sample firms or their affiliates, as well as the countries in which the patents originated.

The task of identifying the patents of the sample firms is complicated by two problems. First, the patent office does not utilize an external code or identifier that permits patenting assignees to be linked electronically to data such as the Compustat. Rather, assignees are indicated by name, and the spelling and punctuation of the names are not completely standardized, e.g., there may be patent records for “IBM” and others for “I.B.M.” Secondly, and more fundamentally, companies choose the corporate entity to which the patent will be assigned, and this could be a subsidiary or an affiliated company rather than the parent company. As described further in Hall, Jaffe and Trajtenberg (2000), the NBER/CWRU database contains a

cannot be determined.

²⁰ For more information on this database, see the description in Trajtenberg, Jaffe and Hall (2000).

²¹ Patents must be taken out by the individual or individuals who created the invention. About three-fourths of all patents are “assigned” at the time of the patent application to an institution, typically the inventors’ employer.

²² The NBER/CWRU database contains additional information not used in this paper, including a technological classification of the patent and information about citations between patents. See Jaffe and Trajtenberg (1999) and

match between the corporate assignees in the patent office data and Compustat firms; the match attempts to deal with both of these problems. First, spelling and punctuation variations were standardized by removing all spaces, punctuation, generic words (e.g. “Inc.” and “Co.”) and searching for apparent multiple versions of the same entities based on these compressed names. All potential matches of this sort were checked by hand to ensure that they were real. Second, approximately 30,000 subsidiaries and affiliates of the Compustat universe as indicated in Who Owns Whom Directory of Corporate Affiliations in 1989 were matched to the patent database to identify patents taken out by these affiliates, and these affiliated patents were assigned to the parent companies for the purpose of this paper.

The geographic location of the patent is based on the location of the first inventor listed on the patent.²³ The inventor locations in the patent data are domestic residences (not citizenships or nationalities) of inventors as indicated on patent applications. Hence, it is reasonable to expect that a patent based on an invention from an IBM laboratory in Japan would be coded as a “Japanese” patent. The patent might be assigned to IBM, Inc. or it might be assigned to an affiliate or subsidiary organized in Japan. Either way, in principle, it would be treated as if it were an IBM patent, so long as the Who Owns Whom directory includes the ownership link. Certainly, it is possible for some subsidiaries and affiliates to be omitted in this classification, which would mean that the foreign patent counts of their parent firms are systematically biased downward. Further, to the extent that the creation of such foreign affiliates

Trajtenberg, Jaffe and Hall (2000).

²³ Jaffe, Henderson and Trajtenberg (1993) investigated the extent of geographic dispersion among the inventors on a given patent. They found that all inventors on a given patent listed the same country of residence on 98% of all patents (including those with a single inventor).

or the assignment of patents to them has changed over time, the *change* in foreign patents for these firms might be systematically biased. There is no obvious reason, however, why such an undercount of foreign patents would be correlated with the other variables of interest.

For purposes of estimation the data are combined to form two observations for each firm, one corresponding to the 1983-1986 period, and a second corresponding to the 1988-1991 period. Foreign and domestic patents are summed over the four years that constitute each period. The specification of (12) that is then estimated is one in which the dependent variable is the difference between the number of foreign patents taken during the 1988-1991 period and the number taken during the 1983-1986 period. Similarly, the change in domestic patents variable that appears on the right side of (12) equals the difference between the number of domestic patents taken during the 1988-1991 period and the number taken during the 1983-1986 period.

Table 2 presents country-level information on foreign patents by firms in the sample, along with other indicators of activity by the foreign affiliates of American multinational firms. Foreign patenting is concentrated in a relatively small number of technologically advanced countries, which is not surprising; nor is it surprising that R&D spending by the foreign affiliates of American multinational firms is concentrated in roughly the same countries. Indeed, the five foreign countries with the most patents over the period 1988-1991 attributed to resident inventors (the United Kingdom, Japan, Germany, Canada, and France) lead all others in R&D spending by American multinational firms in 1989. To be sure, there is important variation between countries, and most importantly, the vast majority of American patents taken out by sample firms have inventors that are residents of the United States. But the foreign data presented in Table 2

serves to confirm the reasonableness of the patent attribution method on which is based the empirical work that follows.

4. Results.

As a prelude to estimating the model implied by Equation (12), the regressions reported in Table 3 look simply at the firm-level relationship between R&D and patents as it is evident in the data. Columns one and two of Table 3 present estimates in which the dependent variable is the log of total (worldwide) firm patents over the 1982-1985 period, and the independent variables include the log of R&D spending in 1986 and log of total firm assets in 1986. The sample analyzed in these regressions is limited to firms with nonzero patents over 1982-1985, and those with positive R&D spending and total assets in 1986.

Consistent with other work,²⁴ the results indicate a strong correlation between patenting and R&D activity, one that is not simply a function of firm size (as measured by assets). The regression of log of patents on log R&D (reported in column one) shows slightly less than constant returns of patents to R&D, although this result is somewhat sensitive to how the observations with no patents are treated. When log of total assets is added to the regression, as it is in the regression reported in column two, log assets absorbs part of the explanatory power of log R&D, but the results continue to imply a patent production function with approximately constant returns to scale. Columns three and four of Table 3 report regressions using a larger sample of firms that includes those with no patents over the 1982-1985 period. The dependent

²⁴ See, e.g., Bound et al. (1984).

variable in these regressions is now the log of one plus patents, and the right-hand side variables now include a dummy variable that takes the value one if a firm has nonzero patents over this time period. The results reported in columns three and four are qualitatively similar to those reported in columns one and two, in that there is a strong positive relationship between patents and R&D spending that exhibits decreasing returns.

The consistency of the firm-level patent data with country and firm characteristics (as evidenced in Tables 2 and 3) offers the prospect of informative estimation of variants of (12) using these data. Table 4 presents means and standard deviations of the regression variables, and the initial regression results are presented in Table 5. The specification estimated in these regressions is:

$$(13) \quad P^*_{it} - P^*_{it-1} = \beta_1 (P_{it} - P_{it-1}) + \beta_2 \alpha_{it} + \beta_3 \lambda_{it} + \beta_4 X_{it} + \epsilon_{it},$$

$$\lambda_{it} \equiv [(1 - \alpha_{it}\tau_t)/(1 - \beta_{it}\tau_t)] - [(1 - \alpha_{it-1}\tau_{t-1})/(1 - \beta_{it-1}\tau_{t-1})].$$

Comparing (13) to (12), it follows that the regression coefficients can be interpreted as $\beta_1 = (c^*/c)$, β_2 equals the product of (c^*/c) and a linearization of the $f(\cdot)$ function, and β_3 captures a different linearization of the $f^*(\cdot)$ function. The reason that the first difference of the $f(\cdot)$ function may be represented in (13) simply by α_{it} is that all firms were entitled to deduct their full R&D expenses in the period before 1986, and all faced the same statutory taxes after 1986, so this term differs between firms only in α_{it} . The variable X_{it} represents firm-specific characteristics (including a constant term).

Column one of Table 5 reports estimates of (13) without including firm-specific characteristics (other than constants). The estimated coefficients are consistent with the evidence reported in other tables and with a generally complementary relationship between domestic and foreign innovative activity. The estimated value of β_1 is approximately 0.06, which means that shocks to domestic patenting translate rather little into changes in foreign patents – reflecting the much larger share of U.S. inventors than foreign inventors among the patents taken out by American firms. The estimated value of β_2 is positive but not significant; though this is not of great consequence, since α_{it} is included in (13) merely in order to control for changes in domestic patenting due to tax changes rather than firm-specific shocks.

The negative and significant estimated value of β_3 implies that greater deductibility of R&D expenses in 1991 is associated with increased foreign patenting. Specifically, lower tax costs of performing R&D in the United States for use abroad are associated with greater foreign patents in the second (1988-1991) period relative to the first (1983-1986). In order to interpret the magnitude of the estimated value of β_3 , it is important to bear in mind the construction of the R&D tax incentive variable, and specifically, the use of average foreign tax rates in place of β_{it} . Since a ten percent difference in average foreign tax rates is generally sufficient to move firms between excess and deficit foreign tax credit status, it follows that the estimated value of β_3 (without this correction) overstates by a factor of ten the impact of changes in the tax treatment of royalties. The estimated coefficient of -30.8 in column one therefore implies that changing the domestic taxation of foreign-source royalties from taxable to not taxable, would, for a firm with the mean value of $\alpha_{it} = 0.88$, be responsible for 1.1 additional foreign patents over the 1988-

1991 period. Given the sample mean value of 5.4 foreign patents over the 1983-1986 period, this estimate implies that the cross elasticity of foreign patents with respect to the after-tax cost of domestic R&D directed at foreign markets is between 0.2 and 0.4. This estimate is of the same order of magnitude, though of a different sign, as estimates of international R&D and royalty substitutability reported by Hines (1995). These behavioral elasticities are considerably smaller than an own-price R&D demand elasticity of unity or greater, as reported by Hall (1993) and Hines (1993).

Column two of Table 5 presents estimated coefficients from a regression that adds as an independent variable the 1991 ratio of foreign to total sales. The purpose of this somewhat ad hoc addition is to control for a form of unobserved heterogeneity, in which firms that differ in their degrees of multinationality also differ in other unobserved dimensions that affect changes in foreign patenting. Firms with greater foreign sales in 1991 show faster growth of foreign patenting, though in other ways the results presented in column two differ little from those presented in column one. The estimated tax effects in the column two regression are somewhat smaller than those in the first specification of the equation, but remain significant and of the same sign.

Table 6 reports results from a different specification of (12):

$$(14) \quad P^*_{it} - P^*_{it-1} = \beta_1 (P_{it} - P_{it-1}) + \beta_2 P^*_{it-1} + \beta_3 P^*_{it-1} \alpha_{it} + \beta_4 X_{it} + u_{it},$$

$$\lambda_{it} \equiv [(1 - \alpha_{it}\tau_t)/(1 - \beta_{it}\tau_t)] - [(1 - \alpha_{it-1}\tau_{t-1})/(1 - \beta_{it-1}\tau_{t-1})].$$

The specification (14) is a close variant of (13), with the difference that the independent variables are now interacted with numbers of foreign patents over 1983-1986. The specification in (14) is intended to provide a natural scaling for the price-type variables that appear on the right side of (12).

The results reported in Table 6 are quite consistent with those reported in Table 5. Firms with rapidly growing domestic patenting exhibit faster than average growth of foreign patenting. Of particular interest is the estimated -14.6 value of β_3 in the regression reported in column one. Again taking a ten percent change in the average foreign tax rate to be sufficient to change foreign tax credit status, it follows that the -14.6 coefficient implies roughly a 0.5 cross-price elasticity of foreign R&D with respect to the cost of domestic R&D directed at foreign markets. As is evident from the results reported in columns two through four of Table 6, minor specification changes affect this estimated behavioral elasticity very little.

5. Conclusions.

This study considers the effect of changes in the after-tax cost of R&D on subsequent patenting by American firms in the United States and abroad. The purpose is to estimate the impact of tax policy on the location of successful inventive activity. Tax policy affects patent location by influencing the location of R&D and therefore the likelihood of producing patentable inventions. Recent U.S. tax changes affect some American firms more strongly than others, making it possible to estimate the effect of tax policies on innovation by comparing reactions to the changes.

The results indicate that firms for which after-tax costs of performing R&D in the United States for use abroad rose most rapidly after 1986 exhibit the slowest growth of foreign patenting in subsequent years. Estimated cross-price elasticities of foreign patenting with respect to the cost of domestic R&D directed at foreign markets vary between 0.2 and 0.5. This suggests not only that tax incentives influence subsequent patenting patterns, but that foreign and domestic innovative activities are complements at the firm level. While this is an intuitively appealing finding, it is inconsistent with available evidence of the international substitutability of R&D activity as measured at the aggregate level. This raises the interesting possibility that domestic and foreign innovation, while complements for individual firms, become substitutes between economies due to induced effects on the composition of industry or for other reasons.

References

- Altshuler, Rosanne and T. Scott Newlon, 1993, "The effects of U.S. tax policy on the income repatriation patterns of U.S. multinational corporations," in Alberto Giovannini, R. Glenn Hubbard, and Joel Slemrod eds., *Studies in international taxation* (Chicago: University of Chicago Press).
- Altshuler, Rosanne, T. Scott Newlon, and William C. Randolph, 1995, "Do repatriation taxes matter? Evidence from the tax returns of U.S. multinationals," in Martin Feldstein, James R. Hines Jr., and R. Glenn Hubbard eds., *The effects of taxation on multinational corporations* (Chicago: University of Chicago Press).
- Blomstrom, Magnus, 1991, "Host country benefits of foreign investment," in Donald McFetridge ed., *Foreign investment, technology and economic growth* (Calgary: University of Calgary Press).
- Blomstrom, Magnus and Ari Kokko, 1995, "Policies to encourage inflows of technology through foreign multinationals," *World Development*, 23, 1-10.
- Bound, John, Clint Cummins, Zvi Griliches, Bronwyn Hall and Adam Jaffe, 1984, "Who does R&D and who patents?" in Zvi Griliches ed., *R&D, Patents and Productivity* (Chicago: University of Chicago Press).
- Davidson, W.H. and Donald G. McFetridge, 1984, "International technology transactions and the theory of the firm," *Journal of Industrial Economics*, 32, 253-264.
- Ethier, Wilfred J. and James R. Markusen, 1996, "Multinational firms, technology diffusion and trade," *Journal of International Economics*, 41, 1-28.
- Griliches, Zvi, 1992, "The search for R&D spillovers," *Scandinavian Journal of Economics*, 94, 29-47.
- Hall, Bronwyn H., 1993, "R&D tax policy during the 1980s: Success or failure?" in James M. Poterba ed., *Tax Policy and the Economy*, Vol. 7 (Cambridge, MA: MIT Press).
- Hall, Bronwyn H., Adam B. Jaffe and Manuel Trajtenberg, 2000, "Market value and citations: A first look," NBER Working Paper.
- Hartman, David G., 1985, "Tax policy and foreign direct investment," *Journal of Public Economics*, 26, 107-121.

Hines, James R., Jr., 1991, "The flight paths of migratory corporations," *Journal of Accounting, Auditing, and Finance*, 6, 447-479.

Hines, James R., Jr., 1993, "On the sensitivity of R&D to delicate tax changes: The behavior of US multinationals in the 1980s," in Alberto Giovannini, R. Glenn Hubbard, and Joel Slemrod eds., *Studies in international taxation* (Chicago: University of Chicago Press).

Hines, James R., Jr., 1994, "No place like home: Tax incentives and the location of R&D by American multinationals," in James M. Poterba ed., *Tax Policy and the Economy*, Vol. 8 (Cambridge, MA: MIT Press).

Hines, James R., Jr., 1995, "Taxes, technology transfer, and the R&D activities of multinational firms," in Martin Feldstein, James R. Hines Jr., and R. Glenn Hubbard eds., *The effects of taxation on multinational corporations* (Chicago: University of Chicago Press).

Hines, James R., Jr., 1997, "International taxation and corporate R&D: Evidence and implications," in James M. Poterba ed., *Borderline case: International tax policy, corporate research and development, and investment* (Washington, DC: National Academy Press).

Hines, James R., Jr. and R. Glenn Hubbard, 1990, "Coming home to America: Dividend repatriations by U.S. multinationals," in Assaf Razin and Joel Slemrod eds. *Taxation in the global economy* (Chicago: University of Chicago Press).

Hines, James R., Jr. and Eric M. Rice, 1994, "Fiscal paradise: Foreign tax havens and American business," *Quarterly Journal of Economics*, 109, 149-182.

Jaffe, Adam B., Rebecca Henderson and Manuel Trajtenberg, 1993, "Geographic localization of knowledge spillovers as evidenced by patent citations," *Quarterly Journal of Economics*, 108, 577-598.

Jaffe, Adam B. and Manuel Trajtenberg, 1999, "International knowledge flows: Evidence from patent citations," *Economics of Innovation and New Technology*, 8, 105-136.

Lipsey, Robert E., Magnus Blomstrom, and Irving B. Kravis, 1990, "R&D by multinational firms and host country exports," in Robert E. Evenson and Gustav Ranis eds., *Science and technology: Lessons for development policy* (Boulder, CO: Westview Press).

Mansfield, Edwin, and Anthony Romeo, 1980, "Technology transfer to overseas subsidiaries by U.S.-based firms," *Quarterly Journal of Economics*, 95, 737-750.

Mansfield, Edwin, David Teece, and Anthony Romeo, 1979, "Overseas research and development by U.S.-based firms," *Economica*, 46, 187-196.

Scholes, Myron S. and Mark A. Wolfson, 1992, *Taxes and business strategy: A planning approach* (Englewood Cliffs, NJ: Prentice Hall).

Teece, David J., 1976, *The multinational corporation and the resource cost of international technology transfer* (Cambridge, MA: Ballinger).

Trajtenberg, Manuel, Adam B. Jaffe and Bronwyn H. Hall, 2000, "The NBER/Case Western Reserve patent data – a guided tour," NBER Working Paper.

Turro, John, 1993, "U.S. enacts controversial budget legislation," *Tax Notes International*, August 16, 7, 435-438.

United States Congress, Joint Committee on Taxation, 1993, *Summary of the President's revenue proposals* (Washington, DC: US Government Printing Office).

United States Department of Commerce, Bureau of Economic Analysis, 1985, *U.S. direct investment abroad: 1982 benchmark survey data* (Washington, DC: U.S. Government Printing Office).

United States Department of Commerce, Bureau of Economic Analysis, 1992, *U.S. direct investment abroad: 1989 benchmark survey, final results* (Washington, DC: U.S. Government Printing Office).

United States Department of Commerce, Bureau of Economic Analysis, 1996, *U.S. direct investment abroad: 1994 benchmark survey, final results* (Washington, DC: U.S. Government Printing Office).

United States Department of the Treasury, 1983, *The impact of the section 861-8 regulation on U.S. research and development* (Washington, DC: US Government Printing Office).

United States Department of the Treasury, 1995, *The relationship between U.S. research and development and foreign income* (Washington, DC: U.S. Department of the Treasury).

Wang, Jian-Ye and Magnus Blomstrom, 1992, "Foreign investment and technology transfer: A simple model," *European Economic Review*, 36, 137-155.

Zejan, Mario C., 1990, "R&D activities in affiliates of Swedish multinational enterprises," *Scandinavian Journal of Economics*, 92, 487-500.

Table 1
R&D and royalty activity of foreign affiliates of American multinationals

	Year	1982	1989	1994
R&D expenditures of affiliates	Total	3, 851	7, 922	11, 877
	By affiliate for itself	3, 073	6, 307	8, 901
	By affiliate for others	778	1, 615	2, 976
Royalty receipts of affiliates	Total	435	1, 461	2, 581
	From U.S. parents	36	54	368
	From other foreign affiliates	193	656	1, 096
	From unaffiliated Americans	26	97	387
	From unaffiliated foreigners	180	654	730
Royalty payments by affiliates	Total	4, 308	12, 472	22, 039
	To U.S. parents	3, 663	9, 839	16, 744
	To other foreign affiliates	354	1, 488	2, 615
	To unaffiliated Americans	102	660	2, 138
	To unaffiliated foreigners	189	485	543

Source: U.S. Department of Commerce (1985, 1992, 1996).

Note to table 1: Amounts are millions of current dollars. Data cover majority-owned foreign affiliates of American multinational firms.

Table 2
Foreign patent and R&D activity of American firms

	Patents 1983- 1986	Patents 1988- 1991	Net PPE 1989	Sales 1989	R&D Spending 1989
Australia	14	17	12113	37745	191
Austria	2	1	919	5550	16
Bahamas	0	1	616	1529	*
Belgium	109	106	4811	30085	317
Brazil	4	6	9223	30588	90
Canada	152	305	63636	173251	914
Chile	1	1	718	1981	1
Colombia	0	1	1959	3895	2
Denmark	3	10	923	4119	d
Dominican Republic	0	0	281	578	*
Ecuador	1	0	196	578	*
Egypt	1	0	1313	1871	*
France	148	214	11093	70761	545
Germany	360	418	21066	106366	1496
Greece	3	1	174	1932	1
Guatemala	1	0	133	672	*
Hong Kong	4	7	3174	16408	9
India	1	10	76	323	2
Indonesia	1	0	4644	6120	2
Ireland	7	37	1874	11415	134
Israel	11	53	326	1042	29
Italy	35	50	6386	45265	294
Japan	174	483	7830	58420	488
Luxembourg	26	21	633	1443	d
Malaysia	3	10	2212	5419	3
Mexico	1	1	3929	16437	37
Netherlands	52	84	8182	45408	360
New Zealand	1	1	775	3153	4
Nigeria	0	0	706	2250	*
Norway	4	4	5865	7616	27
Philippines	2	2	531	2905	5
Singapore	1	26	2153	15102	25
South Africa	2	4	449	2653	9
South Korea	6	4	641	2463	5
Spain	6	8	4514	23712	115

Sweden	13	12	732	7703	33
Switzerland	93	88	1977	36231	67
Taiwan	0	4	1047	6773	23
United Kingdom	540	749	42418	167186	1673
Venezuela	0	3	461	2677	9
United States	28516	39143			

Note to Table 2: Columns one and two report total numbers of U.S. patents granted to the 378 American firms in the sample and assigned to inventors located in designated countries. Column 3 reports aggregate dollar values (in \$ millions) of the local property, plant, and equipment of majority owned nonbank affiliates of nonbank American parent firms in 1989. Column 4 reports aggregate sales (in \$ millions) of majority owned nonbank affiliates of nonbank American parent firms in 1989. Column 5 reports aggregate R&D expenditures (in \$ millions) on behalf of majority owned nonbank affiliates of nonbank American parent firms in 1989. The “d” entry in column 5 indicates that data are suppressed to protect the identity of individual survey respondents, while the “*” entry indicates R&D spending of less than \$500,000. Data reported in columns 3-5 are drawn from United States Department of Commerce (1992).

Table 3
R&D activity and patenting behavior

Dependent variable	ln (total patents,1982-1985)		ln (1+total patents,1982-1985)	
	Constant	0.8714 (0.1478)	-0.9037 (0.3452)	-1.0570 (0.1797)
ln(R&D, 1986)	0.8376 (0.0371)	0.4726 (0.0735)	0.7317 (0.0369)	0.5569 (0.0740)
Patents dummy			3.1103 (0.2063)	3.0377 (0.2178)
ln(Assets, 1986)		0.4470 (0.0787)		0.2151 (0.0857)
R-squared	.690	.728	.782	.788
Number of obs.	231	231	292	292

Note to Table 3: The table reports estimated coefficients from OLS regressions. The dependent variable in the regressions reported in the first two columns is the log of the number of new patents (domestic plus foreign) taken out between 1982 and 1985. Observations are included in the samples analyzed in these regressions only if they have nonzero and nonmissing patent and R&D data. The dependent variable in the regressions reported in columns three and four is the log of one plus the number of new patents (domestic plus foreign) taken out between 1982 and 1985. Observations are included in the samples analyzed in these regressions only if they have nonzero and nonmissing R&D data. “ln(R&D, 1986)” is the log of total R&D expenditures in 1986. “Patents dummy” is a dummy variable that equals one if a firm took out nonzero patents between 1982 and 1985, and equals zero otherwise. “ln(Assets, 1986)” is the log of total firm assets in 1986. number of new domestic patents taken out between 1988 and 1992. Heteroskedasticity-consistent standard errors are in parentheses.

Table 4
Means and Standard Deviations of Regression Variables

	Variable	Mean	Standard deviation	Number of obs.
R&D Sample (Table 3)	ln (total patents, 1982-1985)	3.5225	1.9805	231
	ln (1+total patents, 1982-1985)	3.5571	2.4662	292
	ln(R&D, 1986)	2.8121	2.0368	292
	Patents dummy	0.8219	0.3832	292
	ln(Assets, 1986)	6.5559	1.8240	231
Foreign patents sample (Tables 5 & 6)	Change in foreign patents	3.0317	14.8684	378
	Change in domestic patents	35.2116	178.7609	378
	R&D expense deductibility, 1991	0.8806	0.1315	378
	Change in R&D tax incentives (foreign)	-0.1126	0.0713	378
	Percent foreign sales, 1991	0.3242	0.1946	378
	First-period foreign patents	5.3810	21.1604	378
	Foreign patents * R&D expense deductibility	4.6951	18.4840	378
	Foreign patents *R&D incentives (foreign)	-0.6773	2.8683	378

Note to table 4: The table presents means and standard deviations of variables used in the regressions.

Table 5
Foreign patents and domestic tax incentives

Dependent variable: Change in number of foreign patents

Constant	-14.4802 (7.4138)	-11.9398 (7.3321)	
Change in domestic patents	0.0590 (0.0144)	0.0587 (0.0143)	
R&D expense deductibility, 1991	13.5946 (7.1326)	9.5607 (7.1384)	
Change in R&D tax incentives (foreign)	-30.7697 (12.8296)	-26.4124 (12.3228)	
Percent foreign sales, 1991		4.6708 (2.4622)	
R-squared	.513	.516	
Number of obs.	378	378	

Note to Table 5: The table reports estimated coefficients from OLS regressions. The dependent variable is the difference between the number of new foreign patents taken out during 1988-1991 (inclusive) and the number taken out during 1983-1986 (inclusive). "Change in domestic patents" is the difference between the number of new domestic patents taken out during 1988-1991 (inclusive) and the number taken out during 1983-1986 (inclusive). "R&D expense deductibility, 1991" equals the fraction of domestic R&D expenses that firms can deduct against their domestic tax liabilities in 1991. "Change in R&D tax incentives (foreign)" equals the change in the required cost of capital for a \$1 investment in domestic R&D intended to enhance foreign profitability. "Percent foreign sales, 1991" equals the fraction of a firm's sales that are foreign in 1991. Heteroskedasticity-consistent standard errors are in parentheses.

Table 6
Foreign patents and domestic tax incentives

Dependent variable: Change in number of foreign patents

Constant	0.4650 (0.3300)		-0.3125 (0.0094)	
Change in domestic patents	0.0441 (0.0094)	0.0443 (0.0093)	0.0441 (0.0094)	0.0441 (0.0094)
First-period foreign patents	-7.0090 (2.9126)	-6.9122 (2.8834)	-6.9873 (2.9001)	-7.0120 (2.9079)
Foreign patents * R&D expense deductibility	6.1417 (2.2333)	6.0594 (2.5081)	6.1158 (2.5218)	6.1389 (2.5281)
Foreign patents *R&D incentives (foreign)	-14.6054 (5.8364)	-14.4423 (5.7862)	-14.5892 (5.8173)	-14.6249 (5.8309)
Percent foreign sales, 1991			2.4524 (1.9554)	1.7459 (1.1536)
R-squared	.640	.654	.641	.656
Number of obs.	378	378	378	378

Note to Table 6: The table reports estimated coefficients from OLS regressions. The dependent variable is the difference between the number of new foreign patents taken out during 1988-1991 (inclusive) and the number taken out during 1983-1986 (inclusive). "Change in domestic patents" is the difference between the number of new domestic patents taken out during 1988-1991 (inclusive) and the number taken out during 1983-1986 (inclusive). "First-period foreign patents" is the number of foreign patents taken out between 1983 and 1986. "Foreign patents*R&D expense deductibility" equals the product of foreign patents taken out between 1983 and 1986 *and* the fraction of domestic R&D expenses that firms can deduct against their domestic tax liabilities in 1991. "Foreign patents*R&D incentives (foreign)" equals the product of foreign patents taken out between 1983 and 1986 *and* the change in the required cost of capital for a \$1 investment in domestic R&D intended to enhance foreign profitability. "Percent foreign sales, 1991" equals the fraction of a firm's sales that are foreign in 1991. Heteroskedasticity-consistent standard errors are in parentheses.

OFFICE OF TAX POLICY RESEARCH

Working Paper Series

- No. 2000-11 William G. Gale and Joel Slemrod, "We Tax Dead People," June 2000.
- No. 2000-10 David Joulfaian, "Charitable Giving in Life and Death," July 2000.
- No. 2000-9 Barry W. Johnson, Jacob M. Mikow, and Martha Britton Eller, "Elements of Federal Estate Taxation," July 2000.
- No. 2000-8 Richard Schmalbeck, "Avoiding Federal Wealth Transfer Taxes," July 2000.
- No. 2000-7 Jonathan S. Feinstein and Chih-Chin Ho, "Elderly Asset Management and Health: An Empirical Analysis," June 2000.
- No. 2000-6 Martha Britton Eller, Brian Erard, and Chih-Chin Ho, "The Magnitude and Determinants of Federal Estate Tax Noncompliance," June 2000.
- No. 2000-5 Wojciech Kopczuk and Joel Slemrod, "The Impact of the Estate Tax on the Wealth Accumulation and Avoidance Behavior of Donors," June 2000.
- No. 2000-4 James M. Poterba and Scott Weisbenner, "The Distributional Burden of Taxing Estates and Unrealized Capital Gains at the Time of Death," June 2000.
- No. 2000-3 John Laitner, "Simulating the Effects on Inequality and Wealth Accumulation of Eliminating the Federal Gift and Estate Tax," June 2000.
- No. 2000-2 Louis Kaplow, "A Framework for Assessing Estate and Gift Taxation," June 2000.
- No. 2000-1 James R. Hines Jr. and Adam B. Jaffe, "International Taxation and the Location of Inventive Activity," May 2000.
- No. 99-6 Joel Slemrod and Shlomo Yitzhaki, "Tax Avoidance, Evasion, and Administration," November 1999.
- No. 99-5 Julie Berry Cullen, "The Impact of Fiscal Incentives on Student Disability Rates," May 1999.
- No. 99-4 James R. Hines Jr., "The Case against Deferral: A Deferral Reconsideration," May 1999.

- No. 99-3 Joel Slemrod and Jon Bakija, "Does Growing Inequality Reduce Tax Progressivity? Should It?" February 1999.
- No. 99-2 Joel Slemrod and Wojciech Kopczuk, "The Optimal Elasticity of Taxable Income," November 1998.
- No. 99-1 James R. Hines Jr., "Lessons from Behavioral Responses to International Taxation," February 1999.
- No. 98-22 Eduardo M. R. A. Engel and James R. Hines Jr., "Understanding Tax Evasion Dynamics," December 1998.
- No. 98-21 James R. Hines Jr., "Three Sides of Harberger Triangles," November 1998.
- No. 98-20 Joel Slemrod, "Methodological Issues in Measuring and Interpreting Taxable Income Elasticities," August 1998.
- No. 98-19 James R. Hines Jr., "Nonprofit Business Activity and the Unrelated Business Income Tax," October 1998.
- No. 98-18 James R. Hines Jr., "'Tax Sparing' and Direct Investment in Developing Countries," August 1998.
- No. 98-17 James R. Hines Jr., "Investment Ramifications of Distortionary Tax Subsidies," May 1998.
- No. 98-16 Robert Carroll, Douglas Holtz-Eakin, Mark Rider, and Harvey S. Rosen, "Entrepreneurs, Income Taxes, and Investment," December 1997.
- No. 98-15 Gerald E. Auten, Charles T. Clotfelter, and Richard L. Schmalbeck, "Taxes and Philanthropy Among the Wealthy," December 1997
- No. 98-14 James Alm and Sally Wallace, "Are the Rich Different?" October 1997.
- No. 98-13 Alan J. Auerbach, Leonard E. Burman, and Jonathan M. Siegel, "Capital Gains Taxation and Tax Avoidance: New Evidence from Panel Data," December 1997.
- No. 98-12 Christopher D. Carroll, "Why Do the Rich Save So Much?" December 1997.
- No. 98-11 James Poterba, "The Estate Tax and After-Tax Investment Returns," December 1997.
- No. 98-10 Andrew Samwick, "Portfolio Responses to Taxation: Evidence from the End of the Rainbow," December 1997.

- No. 98-9 Roger H. Gordon and Joel Slemrod, "Are 'Real' Responses to Taxes Simply Income Shifting Between Corporate and Personal Tax Bases?" December 1997.
- No. 98-8 Robert Moffitt and Mark Wilhelm, "Labor Supply Decisions of the Affluent," March 1998.
- No. 98-7 Austan Goolsbee, "It's Not About the Money: Why Natural Experiments Don't Work on the Rich," December 1997.
- No. 98-6 Edward N. Wolff, "Who Are the Rich? A Demographic Profile of High-Income and High-Wealth Americans," September 1997.
- No. 98-5 Douglas A. Shackelford, "The Tax Environment Facing the Wealthy," September 1997.
- No. 98-4 Robert H. Frank, "Progressive Taxation and the Incentive Problem," September 1997.
- No. 98-3 W. Elliot Brownlee, "Historical Perspective on U.S. Tax Policy Toward the Rich," December 1997.
- No. 98-2 Joel Slemrod, "The Economics of Taxing the Rich," February 1998.
- No. 98-1 James R. Hines Jr., "What Is Benefit Taxation?" February 1998.
- No. 97-4 Mihir A. Desai and James R. Hines Jr., "'Basket' Cases: International Joint Ventures After the Tax Reform Act of 1986," July 1997.
- No. 97-3 James R. Hines Jr., "Taxed Avoidance: American Participation in Unsanctioned International Boycotts," October 1997.
- No. 97-2 Mihir A. Desai and James R. Hines Jr., "Excess Capital Flows and the Burden of Inflation in Open Economies," July 1997.
- No. 97-1 Joel Slemrod, "Measuring Taxpayer Burden and Attitudes for Large Corporations: 1996 and 1992 Survey Results," March 1997.
- No. 95-3 Harry Grubert and T. Scott Newlon, "The International Implications of Consumption Tax Proposals," September 1995.
- No. 95-2 Alan L. Feld, "Living with the Flat Tax," September 1995.
- No. 95-1 Martin D. Ginsburg, "Life Under a Personal Consumption Tax, Some Thoughts on Working, Saving, and Consuming in Nunn-Domenici's Tax World," September 1995.

- No. 94-1 Joel Slemrod, Carl Hansen and Roger Procter, "The Seesaw Principle in International Tax Policy," April 1994.
- No. 93-11 Joel Slemrod and Marsha Blumenthal, "The Income Tax Compliance Cost of Business," July 1993.
- No. 93-10 Joel Slemrod, *Tax Progressivity and Income Inequality*: Introduction, May 1993.
- No. 93-9 Richard A. Musgrave, "Progressive Taxation, Equity and Tax Design," January 1993.
- No. 93-8 Steven M. Sheffrin, "Perceptions of Fairness in the Crucible of Tax Policy," October 1992.
- No. 93-7 Michael Haliassos and Andrew B. Lyon, "Progressivity of Capital Gains Taxation with Optimal Portfolio Selection," March 1993.
- No. 93-6 John Karl Scholz, "Tax Progressivity and Household Portfolios: Descriptive Evidence from the Surveys of Consumer Finances," May 1993.
- No. 93-5 Joel Slemrod, "On the High-Income Laffer Curve," March 1993.
- No. 93-4 Robert K. Triest, "The Efficiency Cost of Increased Progressivity," January 1993.
- No. 93-3 Lynn A. Karoly, "Trends in Income Inequality: The Impact of, and Implications for, Tax Policy," January 1993.
- No. 93-2 Gilbert E. Metcalf, "The Lifetime Incidence of State and Local Taxes: Measuring Changes During the 1980s," January 1993.
- No. 93-1 Richard Kasten, Frank Sammartino, and Eric Toder, "Trends in Federal Tax Progressivity: 1980-1993," January 1993.
- No. 90-18 Charles H. Berry, David F. Bradford, and James R. Hines, Jr., "Arm's Length Pricing -- Some Economic Perspectives," September 1991.
- No. 90-17 Stanley Langbein, "A Modified Fractional Apportionment Proposal For Tax Transfer Pricing," September 1991.
- No. 90-16 Bibliography on Tax Compliance and Tax Law Enforcement, December 1990.
- No. 90-15 Michelle J. White, "Why Are Taxes So Complex and Who Benefits?" December 1989.

- No. 90-14 Susan Chaplinsky and Greg Niehaus, "The Tax and Distributional Effects of Leverages ESOPs," October 1989.
- No. 90-13 Jeffrey K. MacKie-Mason, "Do Firms Care Who Provides Their Financing?" February 1990.
- No. 90-12 Jeffrey K. MacKie-Mason, "Some Nonlinear Tax Effects on Asset Values and Investment Decisions Under Uncertainty," December 1989.
- No. 90-11 Jeffrey K. MacKie-Mason, "Do Taxes Affect Corporate Financing Decisions?" November 1989.
- No. 90-10 Henry J. Aaron, "Lessons for Tax Reform," November 1989.
- No. 90-9 John Whalley, "Foreign Responses to U.S. Tax Reform," December 1989.
- No. 90-8 Paul N. Courant and Edward M. Gramlich, "The Impact of TRA on State and Local Fiscal Behavior," November 1989.
- No. 90-7 Charles T. Clotfelter, "The Impact of Tax Reform on Charitable Giving: A 1989 Perspective," December 1989.
- No. 90-6 Joel Slemrod, "The Impact of the Tax Reform Act of 1986 on Foreign Direct Investment to and from the United States," December 1989.
- No. 90-5 James M. Poterba, "Taxation and Housing Markets: Preliminary Evidence on the Effects of Recent Tax Reforms," December 1989.
- No. 90-4 Roger H. Gordon and Jeffrey K. MacKie-Mason, "Effects of the Tax Reform Act of 1986 on Corporate Financial Policy and Organizational Form," December 1989.
- No. 90-3 Jonathan Skinner and Daniel Feenberg, "The Impact of the 1986 Tax Reform Act on Personal Saving," November 1989.
- No. 90-2 Alan J. Auerbach and Kevin Hassett, "Investment, Tax Policy and the Tax Reform Act of 1986," December 1989.
- No. 90-1 Joel Slemrod, "Do Taxes Matter?: The Economic Impact of the Tax Reform Act of 1986," January 1990.

Office of Tax Policy Research Working Papers can be obtained by sending \$5 per paper to the address below. Limited quantities are free to academics, journalists, and government staff.

Office of Tax Policy Research
University of Michigan Business School
701 Tappan Street, Room A2120D
Ann Arbor, MI 48109-1234

Checks should be made out to the University of Michigan.