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The tax treatment of R&D expenditures of multinational enterprises

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This paper investigates the tax treatment by national governments of R&D expenditures of multinational enterprises. In a noncooperative world, the international tax system is generally shown to discourage R&D investments by multinational firms. For the special case of symmetric corporate tax rates, the multinational is allowed to expense less than the total of its R&D expenses worldwide. Internationalization of the firm's operations and ownership is demonstrated to lead to less generous expensing rules within individual countries, and may even eliminate R&D tax deductions altogether.

1. Introduction

Several countries have adopted R&D incentives, including subsidies, tax credits, and more generous expensing of research outlays, to enhance the ability of domestic forms to compete in international markets. Spencer and Brander (1983) and Bagwell and Staiger (1989) have examined strategic R&D subsidies in an international setting. R&D subsidies are found to enable the government to shift profits from a foreign competitor to the domestic firm. Many markets, however, do not consist of easily identifiable domestic and foreign firms, but instead are dominated by multinational firms that operate worldwide and are owned by investors in many countries. In an article on the stateless corporation, *Business Week* recently demonstrated the extent to which key firms in many markets now are truly international in terms of sales, assets, and ownership.[1] This paper analyzes the tax treatment by national governments of the R&D expenditures of essentially nationless multinational firms.

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[1] *Business Week*, 14 May 1990. Several multinationals from the smaller European countries, such as the Netherlands, Sweden, and Switzerland, are shown to have more than 80 percent of 1989 sales and assets abroad. For Bayer, Philips and Smithkline Beecham, 48, 46, and 46 percent of shares are held abroad, respectively.

Investment in R&D and other intangible assets are at the heart of the modern theory of the multinational firm [see, for instance, Helpman (1984), Markusen (1984), and Horstmann and Markusen (1987a, b)]. Empirical studies have also shown that U.S. companies expand abroad not because the United States is a capital-abundant country, but because these companies possess intangible assets in the form of superior products or management that allow them to compete effectively with foreign producers.[2] The theory of the tax treatment of the multinational thus has to address the multinational's intangible investment decision in addition to, as is traditionally done, its international capital allocation decision.[3]

The R&D performed by the multinational typically enhances the multinational's productivity and profitability wherever the multinational operates. Consequently, there is no obvious rule for how individual countries should treat the multinational's R&D expenses for tax purposes regardless of whether the issue is tax rates, subsidies, or rules for allowing R&D expensing. Since a favorable tax treatment of R&D by one country enhances the firm's profitability and tax payments worldwide, it is clear that the deductibility of R&D expenses amounts to providing an international public good. This paper specifically addresses how the national tax treatment of the multinational's R&D is affected by increasing internationalization of the firm, both in terms of operations and ownership. The analysis is to some extent analogous to Andreoni (1988), who examines how the volume of privately provided public goods in a closed economy changes with the number of individuals.

Countries are free to individually determine rules for apportioning the multinational's R&D expenses to taxable income in the various tax jurisdictions where the multinational firm operates. This independence implies that country A's rules for apportioning R&D expenses to corporate income in country B do not have to be recognized by country B. In essence, each country thus decides for itself to what extent the multinational can expense R&D outlays against corporate income within the country.

Rules for apportioning a multinational's R&D expenses internationally are analogous to rules for apportioning an American company's taxable income for state corporate income tax purposes in the United States [see McClure (1981) and Gordon and Wilson (1986)]. Corporate income is generally apportioned to individual states on the basis of the shares of a company's property, payroll, or sales in the various states. The rules are set by the individual states and do not have to be consistent in the sense that the shares of corporate income apportioned to the states sum to one. The

[2]See Hufbauer (1975) and Caves (1982).

[3]Huizinga (1991) analyzes home and foreign country tax policies towards a multinational that engages in product innovation.

obvious difference is that state apportionment rules determine the share of a company's income that is to be taxed by the state, while in the case of international R&D apportionment rules what is at issue is the share of company-wide expenses that is to be deducted from a company's national income. Also, while the states in principle have all of the company's U.S. income as their tax base, in practice many countries limit themselves to taxing a company's income generated within the country.

The model of this paper assumes that national governments are interested in maximizing national income, which includes tax revenues and dividend income distributed by the multinational to domestic residents. Naturally, the optimal R&D apportionment rule, from a national perspective, depends on the degree of internationalization of the firm, both in terms of its operations and in terms of ownership. In particular, the model shows that a country that has full ownership of the firm optimally allows a more generous deduction of R&D expenses from taxable income than countries that have no ownership share in the firm. Under certain conditions, a country's tax authority is shown to allow more generous R&D deductions the larger the country's ownership stake in the company. At the same time, countries are shown to allow an ever decreasing share of the company's worldwide R&D expenditures to be expensed domestically as the multinational expands into more and more countries. Generally, the international tax system is shown to discourage the R&D undertaken by multinational firms. For the special case of symmetric corporate tax rates, a multinational can only expense a fraction of its R&D outlays worldwide. As a corollary, the volume of R&D carried out by the multinationals will be inefficiently low. Under certain conditions, the share of R&D expenses that can be expensed worldwide approaches zero as the multinational becomes more global.

The remainder of the paper is organized as follows. Section 2 outlines the model. Section 3 examines optimal national tax policies toward the multinational's R&D. Section 4 provides some information on the tax treatment of R&D expenses in several countries, and in particular on the U.S. rules for apportioning the R&D expenses of multinationals to U.S. and foreign source income. Section 5 discusses possible extensions and concludes.

2. The model

The model describes a single multinational firm that operates $n \geqq 2$ plants in n countries.[4] The firm is assumed to be able to internalize all the benefits

[4]The number of plants, n, is assumed to be exogenous. By introducing a fixed cost of setting up additional plants, one could endogenously derive the firm's optimal number of plants for a given output objective or level of demand and its relationship to the tax system. With a sufficient number of countries and tax precommitment on the part of the countries, tax competition will drive down taxes to zero, and the firm will set up the technologically efficient number of plants. Without tax precommitment, however, firms have to take into account how

of its R&D. Thus the model abstracts from technological or pecuniary spillovers between firms. Some extensions to the basic model are discussed in section 5.

Output at plant i is related to the plant's employment, denoted L_i, and to the firm's worldwide expenditure on an intangible, denoted R, according to the production function $f(L_i, R)$, where $f'_1 > 0$, $f'_r > 0$, $f''_{11} < 0$, $f''_{rr} < 0$, $f'_1(0, R) = \infty$, $f'_1(\infty, R) = 0$, $f'_r(L_i, 0) = \infty$, $f'_r(L_i, \infty) = 0$, $f''_{1r} > 0$, and $f''_{rr} f''_{11} - (f''_{r1})^2 > 0$.[5] The price of output is set at unity. The variable R stands for the research and development that makes the firm more productive at all its production sites, either by lowering production costs or by covering company-wide fixed costs such as overall management or advertising.[6]

The tax system is assumed to be territorial so that countries only tax the multinational's income generated within their borders. Country i taxes the multinational's local taxable income at a rate τ_i, where $0 \leqq \tau_i \leqq 1$. Taxable income is defined as output net of the wage bill and of a deduction for research and development. Let θ_i, with $\theta_i \geqq 0$, denote the share of the multinational's worldwide R&D expenses that can be deducted from taxable income in country i.[7] Each country determines its deduction policy taking into account that research benefits domestic as well as foreign treasuries and shareholders. Hence, the main purpose of the tax system is to capture profits that would otherwise go to foreign treasuries and shareholders.[8]

The firm chooses the employment levels L_i at plants in country i and the

the number of plants n affects R&D expensing as derived in Propositions 2 and 3. As R&D deductibility is shown to decrease with n, the number of plants is biased downward by the tax system. After n is determined by the firm, however, tax parameters are set as analyzed in the paper. In a different context, Huizinga (1990) shows that international tax competition can bias the number of plants upward, if the firm can induce more intense international tax competition by establishing additional plants.

[5]The function $f(L_i, R)$ reflects various types of R&D investments for a single firm. The set-up of a single multinational firm can be extended by interpreting $f(L_i, R)$ as equilibrium revenues of all firms in a single country in a market where several identical multinational firms compete in some fashion. This extension requires a careful description of the market structure, which is not presented here.

[6]Since the model is static, it does not distinguish between the time of research outlays and the time of research as a productive input. Thus, the model collapses the productive as well as the tax benefits of research into the present. At the same time it abstracts from the reality that ordinary capital depreciates over time, while technological knowledge does not. However, it does capture the fact that technological knowledge, unlike labor or capital, can be used at many different locales at the same time.

[7]Since the model abstracts from the employment effects of R&D, it is immaterial where the R&D is undertaken, and the tax deductibility of R&D applies to the firm's worldwide R&D effort. A tax credit for R&D is a special case of a deduction where θ_i equals $1/(1-\tau_i)$. Also, a deductibility rate of θ_i is equivalent to a subsidy equal to $\theta_i \tau_i$ and no deduction of R&D expenses.

[8]In this regard the model differs from real-world corporate taxation, which mainly taxes the return to capital. To introduce this aspect, the model could include capital that is less than completely expensed in the period of investment.

overall R&D effort R so as to maximize worldwide after-tax profits, denoted π, given by

$$\pi=\sum_{i=1}^{n}(1-\tau_i)\,[f(L_i,R)-wL_i]-\left(1-\sum_{i=1}^{n}\tau_i\theta_i\right)R, \tag{1}$$

where w is the wage in all plant locations.[9]

The optimality conditions for the firm's problem with respect to L_i and R are given as follows:

$$f'_1(L_i,R)-w=0, \quad i=1,\dots,n, \tag{2}$$

$$\sum_{i=1}^{n}(1-\tau_i)f'_r(L_i,R)-\left(1-\sum_{i=1}^{n}\tau_i\theta_i\right)=0. \tag{3}$$

Expression (2) states that employment L_i is chosen so as to equalize the marginal product of labor to the wage. According to (3), R&D is carried out to the point where the net-of-tax worldwide marginal product of the intangible resource equals its cost net of the value of the worldwide R&D tax deductions. Since employment L_i only depends on the wage w and on the worldwide research effort R, we can define output at plant i net of the wage bill, denoted $g(R)$, as a function of worldwide R&D spending only:

$$g(R)=\max_{L_i}\,[f(L_i,R)-wL_i], \tag{4}$$

where

$$g'(R)=f'_r(L_i,R)>0,$$

$$g''(R)=f''_{rr}-(f''_{1r})^2/f''_{11}<0.$$

The firm's worldwide net-of-tax income is shown to depend only on its overall research expenditure, R, and on the tax variables, τ_i and θ_i, in the countries where the multinational operates. This enables us to write (1) as

$$\pi=\sum_{i=1}^{n}(1-\tau_i)g(R)-\left(1-\sum_{i=1}^{n}\tau_i\theta_i\right)R. \tag{1'}$$

[9]The wage is assumed to be exogenously given to the firm, which makes the model partial equilibrium.

The firm's optimality condition with respect to R in expression (3) can be similarly condensed as follows:

$$\sum_{i=1}^{n}(1-\tau_i)g'(R)-\left(1-\sum_{i=1}^{n}\tau_i\theta_i\right)=0. \tag{3'}$$

At this point we can see how the tax parameters τ_i and θ_i in each of the countries affect the firm's employment and research decisions. Straightforward total differentiation of (2) and (3') shows that the employment levels L_i and research effort R are related to the tax variables as follows:

$$\frac{\mathrm{d}R}{\mathrm{d}\tau_i}=\frac{g'(R)-\theta_i}{\sum_{i=1}^{n}(1-\tau_i)g''(R)}\gtrless 0, \tag{5}$$

$$\frac{\mathrm{d}L_j}{\mathrm{d}\tau_i}=-\frac{f''_{1r}}{f''_{11}}\cdot\frac{\mathrm{d}R}{\mathrm{d}\tau_i}\gtrless 0, \quad i,j=1,\dots,n, \tag{6}$$

$$\frac{\mathrm{d}R}{\mathrm{d}\theta_i}=\frac{-\tau_i}{\sum_{i=1}^{n}(1-\tau_i)g''(R)}>0, \tag{7}$$

$$\frac{\mathrm{d}L_j}{\mathrm{d}\theta_i}=-\frac{f''_{1r}}{f''_{11}}\cdot\frac{\mathrm{d}R}{\mathrm{d}\theta_i}>0, \quad i,j=1,\dots,n. \tag{8}$$

According to (5), a higher tax rate, τ_i, leads to more worldwide R&D if $g'(R)<\theta_i$, i.e. the share of research expenditures that is deductible from taxable income in country i exceeds the marginal product of the intangible (inclusive of the triggered change in employment) at plant i. Employment at each of the plants is positively related to worldwide R&D. Thus (6) shows that with $g'(R)<\theta_i$ an increase in country i's tax rate can lead to more employment at the firm's plant in country i as well as at other plants.[10] Finally, according to (7) and (8) a more generous expensing of R&D in country i unambiguously leads to a larger research effort and larger employment at all of the multinational's plants worldwide.

[10] A sufficient condition for this to occur is that country i allows that the full deductibility of R&D expenses and tax rates in countries other than country i are not all equal to one, i.e. $\theta_i=1$ and $\tau_j<1$ for at least one $j\neq i$, since in that case

$$g'(R)=\frac{1-\tau_i-\sum_{j\neq i}^{n}\tau_j\theta_j}{\sum_{i=1}^{n}(1-\tau_i)}<1, \quad \text{from (3')}.$$

While actual tax statutes may be such that $g'(R)<\theta_i$, it is shown below that this is inconsistent with country i's maximization of national income.

3. National tax policies

In a cooperative world, countries will choose their tax parameters so as to avoid distorting the firm's overal R&D decision. This requires $ng'(R)=1$, which from (3′) implies that the tax parameters are set such that $(1/n)\sum_{i=1}^{n}\tau_i=\sum_{i=1}^{n}\tau_i\theta_i$. In the case of a symmetric tax rate, τ_i, this simplifies to $\theta_i=1/n$ or $\sum_{i=1}^{n}\theta_i=1$, which means full global expensing. If $(1/n)\sum_{i=1}^{n}\tau_i> \sum_{i=1}^{n}\tau_i\theta_i$, then the tax system provides a net tax on research, while the reverse inequality implies a net R&D subsidy. This section shows that in a noncooperative world the deductability parameters are set such that the tax system implies a net tax on research.

To start, let T_i denote tax revenues in country i. Tax revenues are related to the tax variables, τ_i and θ_i, and to the firm's research effort, R, as follows:

$$T_i=\tau_i g(R)-\tau_i\theta_i R. \tag{9}$$

National income in country i consists of the government's tax revenues, any profits of the multinational firm distributed to the country's residents, and wage income. The residents of country i are assumed to own a share, ρ_i, of the firm, where $0\leqq\rho_i\leqq 1$ and $\sum_{i=1}^{n}\rho_i=1$. The ownership shares, ρ_i, can be taken to be exogenous if there are many different owners of the firm that individually cannot influence ρ_i.[11] Let $\hat{L}_i$ be the size of country i's overall employed labor force.[12] In symbols, national income, denoted N_i, can be written as

$$N_i=\rho_i\pi+T_i+w\hat{L}_i. \tag{10}$$

Substituting for the firm's net-of-tax profits, π, from (1′) and for tax revenues, T_i, from (9) into (8), we find the following expression for national income, N_i:

$$N_i=[\rho_i(1-\tau_i)+\tau_i]g(R)+\sum_{j\neq i}^{n}\rho_i(1-\tau_j)g(R)$$

$$-R\left[\rho_i+\tau_i\theta_i-\sum_{j=1}^{n}\rho_i\tau_j\theta_j\right]+w\hat{L}_i. \tag{11}$$

[11] If there are individual investors with large stock holdings, then shareholders have the incentive to choose international ownership shares so as to minimize the world-wide tax liability of the firm given the relationship between ownership shares and national tax policies. In this regard, national firms with only domestic plants are optimally wholly domestically owned. However, the optimal ownership pattern of the multinational appears generally more complex.

[12] It is assumed that $L_i<\hat{L}_i$, and that $w\hat{L}_i$ in (8) is exogenous to the tax variables τ_i and θ_i.

Country i's tax authority is assumed to set the tax rate, τ_i, and the deduction rate, θ_i, so as to maximize national income, N_i. In Cournot–Nash fashion, each country is assumed to set its tax parameters on the assumption that the foreign countries' tax parameters are fixed. From (11), this implies that a country's optimal tax variables, τ_i and θ_i, are set such that

$$(1-\rho_i)\,[g(R)-\theta_i R]+\tau_i[g'(R)-\theta_i]\,\frac{\mathrm{d}R}{\mathrm{d}\tau_i}=0, \tag{12}$$

$$(1-\rho_i)R-(g'(R)-\theta_i)\,\frac{\mathrm{d}R}{\mathrm{d}\theta_i}=0, \tag{13}$$

where use is made of (3′).

Eqs. (12) and (13) implicitly define the optimal tax parameters, τ_i and θ_i, from country i's perspective, as functions of the ownership and foreign tax parameters ρ_i, τ_j, and θ_j. The international Nash equilibrium in the tax parameters is given by (12) and (13) for each of the n countries. Eqs. (12) and (13) have a number of implications for the optimal values of τ_i and θ_i that are now examined.

Governments have an incentive to levy a tax, τ_i, on the firm's national income, since part of the tax is borne by foreign shareholders. However, the tax also distorts the firm's R&D decision according to (5), which may prevent the institution of a very high tax. The implications of (12) and (13) for the optimal value of τ_i are:

Proposition 1
(i) *If $\rho_i=1$, then a change in τ_i does not affect national income in country i.*
(ii) *If $\rho_i<1$, then optimally $\tau_i>0$.*

Proof. See the appendix.

Part (i) of Proposition 1 states that the tax rate, τ_i, does not affect national income, since an increase in τ_i simply increases tax revenues by the same amount that it decreases after-tax profits distributed to domestic shareholders. Note from (5) and (13) that with $\rho_i=1$ and $g'(R)=\theta_i$ a change in the tax rate, τ_i, leaves the firm's research allocation (and employment levels) unchanged. Part (ii) states that each country levies a positive tax rate, τ_i, if none of the countries wholly owns the multinational. The proposition does not exclude countries with small ownership rates, ρ_i, from instituting a tax rate, τ_i, equal to one.

For the remainder of this section we focus on the determination of the apportionment rules, with particular emphasis on how deduction parameters are affected by globalization as represented by increases in n for given tax rates τ_i. The assumption of fixed tax rates appears reasonable, since tax reform is often piecemeal in that a single tax regulation is changed within the larger tax code. We can now distinguish the two cases where (i) the firm is wholly owned by the residents of a single country (which is the traditional assumption in the literature on international taxation), and alternatively where (ii) the firm's ownership is diffused among several countries. The two cases are examined in turn.

Starting with the case of $\rho_k=1$ and $\rho_j=0$ $(j\neq k)$, we can derive the following results on how the optimal deduction parameters, θ_k and θ_j, are related to the number of plants, n, as well as to each other.

Proposition 2

(i) $0<\theta_k, \quad \theta_j<\theta_k;$

(ii) $\sum_{i=1}^{n} \tau_i\theta_i<\frac{1}{n}\sum_{i=1}^{n} \tau_i;$

(iii) $\lim_{n\to\infty} \theta_k=0, \qquad \lim_{n\to\infty} \theta_j=0;$

(iv) *if* $g'''(R)<0$, *then* $\lim_{n\to\infty} \sum_{i=1}^{n} \theta_i=0;$

(v) $-1<\frac{d\theta_k}{d\theta_j}<0.$

Proof. See the appendix.

Part (i) states that a country k that fully owns the multinational will always be allowing some R&D expensing, and that the share of worldwide R&D expensable in country k exceeds the share of expenses that can be deducted in country j. The optimal share, θ_j, may well be zero if the ownership share, ρ_j, is very small. Part (ii) is the condition that the tax system imposes a net tax on R&D. Again, for a common tax rate, τ_i, the condition collapses to $\sum_{i=1}^{n}\theta_i<1$, which means less than full global expensing. As a result, the independent determination of national R&D apportionment rules causes the multinational to make inefficiently low R&D investments from a global perspective. Part (iii) states that, as the multinational expands into an ever larger number of locales, the share of the firm's R&D expenditures that can be expensed in any one jurisdiction approaches zero. Part (iv) says that if we assume $g'''(R)<0$ [which can be interpreted as increasingly decreasing returns to R&D at any one plant and is equivalent to $d^2R/d\theta_i^2<0$ in (7)], then the stronger result obtains that the share of R&D

expenditures that the firm can expense worldwide approaches zero. Part (v) means that country k adjusts its deduction parameter, θ_k, so as to partly undo a change in R&D deduction rules in another (or several other) countries. Thus, a reapportioning of R&D expenses by a tax authority j to income in country k will be only partly recognized by country k. The combined impact of a reduction in country j's deduction parameter in a two-country world, taking into account the change in θ_k, is to reduce the global deductibility of R&D expenses.

Turning to the case where the firm's ownership is spread over a number of countries and $\rho_i < 1$ for all i, we can again show that in a noncooperative setting the international tax system discourages R&D, and that worldwide R&D deductibility declines with the number of countries, n. The results are summarized as follows:

Proposition 3

(i) $$\sum_{i=1}^{n} \tau_i \theta_i < \frac{1}{n} \sum_{i=1}^{n} \tau_i;$$

(ii) $$\lim_{n \to \infty} \theta_i = 0;$$

(iii) $$\textit{if } g'''(R) < 0, \textit{ then } \sum_{i=1}^{n} \theta_i = 0, \quad \textit{for } n > n^*, \; n^* < \infty;$$

(iv) $$\textit{if } g'''(R) < 0, \textit{ then } -1 < \frac{\mathrm{d}\theta_i}{\mathrm{d}\theta_j} < 0;$$

(v) $$\textit{if } g'''(R) < 0, \textit{ then } \frac{\mathrm{d}\theta_i}{\mathrm{d}\rho_i} > 0.$$

Proof. See the appendix.

Parts (i) and (ii) of Proposition 3 again point out that the tax system discourages R&D, and that as the multinational expands into an increasing number of countries, the share of worldwide R&D that can be expensed in any one country approaches zero. Part (iii) states that provided $g'''(R) < 0$, the multinational loses the ability to expense any R&D outlays anywhere as it expands into more than a finite number of countries. This general result of course holds for the special case where ownership is equally divided internationally, i.e. $\rho_i = 1/n$. The finding that the multinational loses its ability to deduct research expenses entirely as the number of identical countries increases contrasts with Andreoni (1988, theorem 1) who shows that overall donations to a public good approach a positive constant amount as the number of individuals with identical preferences and wealth approaches infinity. Part (iv) generalizes (v) of Proposition 2 and states that for any ownership share, $\rho_i < 1$, country i adjusts θ_i partially and in the opposite direction following a change in θ_j. Finally, (v) states that the share of R&D expensing allowed in a country is positively related to the country's ownership stake in the firm. Overall, the results indicate that increasing globalization of the firm makes the worldwide tax treatment of R&D less favorable, and thus discourages R&D.

4. Some evidence on actual international R&D apportionment

The share of a multinational's R&D that can be expensed worldwide depends on whether countries allow deductions for R&D expenses at all and on their apportionment rules. Most countries at this point allow a current deduction for R&D expenditures for resident companies. The United States in particular has allowed a current deduction for R&D expenditures since 1954. Some countries, such as Brazil, Singapore, and Spain, however, generally require research expenses to be capitalized and subsequently depreciated over time, which implies a less generous tax treatment even if eventually all expenses are deductible.[13]

The international tax treatment of R&D is most favorable in cases where countries allow formal cost-sharing agreements that allocate R&D expenditures between national and foreign firms or subsidiaries of multinational enterprises. Countries that allow such cost-sharing agreements are primarily industrial nations such as Ireland, the Netherlands, Singapore, Spain, and Switzerland.[14] In these instances all costs are currently deductible worldwide. Generally, no withholding taxes are imposed on payments between the international parties of the cost-sharing agreement. Spain, however, does impose a 25 percent (non-treaty) withholding tax on the fully deductible contributions by Spanish firms to their foreign partners in the cost-sharing agreement.

Where cost-sharing agreements are not available, overall R&D deductibility depends on the interplay between the written and sometimes unwritten allocation rules of the various countries in which the multinational firm operates. As an example, let us consider the tax treatment of R&D expenses of an American multinational, since the U.S. apportionment rules have been explicitly formalized since 1977. The current U.S. apportionment rule, enacted as part of the Omnibus Budget Reconciliation Act of 1989, is as follows.[15] First, any research undertaken to meet legal requirements regarding the product itself or its production or marketing imposed within a

[13]This information is from *The Tax Treatment of Research and Development Expenses* (1990).
[14]See *The Tax Treatment of Research and Development Expenses* (1990).
[15]The information in this paragraph is from *A Complete Guide to the Omnibus Budget Reconciliation Act of 1989* (1989, pp. 36–38, and 54–56).

specific jurisdiction can be entirely allocated to the geographic source where the costs are incurred. Of the remaining expenses, 64 percent of U.S.-based research should be allocated to U.S. source income, and similarly 64 percent of foreign-based research should be allocated to income in the foreign country.[16] Finally, any remaining research expenses are apportioned to domestic and foreign income sources on the basis of the international distribution of sales or gross income.[17] U.S. tax rules thus favor U.S.-based research, which is to be expected if research creates important employment effects or technological spillovers to other domestic firms.

Developing countries that harbor subsidiaries of U.S. multinational firms generally do not provide for cost-sharing between these subsidiaries and the parent company. The tax treatment by Latin American countries of the U.S. multinationals' overall R&D expenditures is probably typical. Among these, Colombia, the Dominican Republic, Peru, and Venezuela do not allow any expensing of payments by the subsidiary to the parent company for technological intangibles, as defined by the various countries.[18] Subsidiaries in Ecuador, however, may deduct general managing expenses paid to the parent company under contracts authorized by the Ministry of Industry, Commerce, etc. provided the deduction does not exceed 5 percent of the annual taxable income of the subsidiary prior to the deduction of such expenses. Uruguay specifically limits the deductibility of expenses to those incurred to maintain the Uruguayan-source income of the subsidiary. Hence, it appears that U.S. firms with substantial foreign operations, especially in developing countries, cannot fully deduct their U.S.-based research undertaken to maintain their worldwide operations.[19]

5. Conclusions and possible extensions

This paper has analyzed the tax treatment by national governments of the R&D expenditures of multinational firms. A main result is that the international tax system that results from uncoordinated national tax policies discourages the R&D undertaken by national firms. Consequently, the multinational makes inefficiently low investments in R&D.

[16]The previous rules adopted in 1977 stipulated that a taxpayer could automatically allocate 30 percent of research expense, after adjusting for research to meet legal requirements, exclusively to income from the geographic source where over half of the taxpayer's research had been undertaken. The newest rules thus provide additional incentives for firms to do research in the United States if the aim is to reduce the U.S. tax liability.

[17]However, if the income-based method of apportionment is chosen, the amount apportioned to foreign-source income can be no less than 30 percent of the amount that would be apportioned to foreign-source income had the sales method been used.

[18]The information in this paragraph is from *Taxation in Latin America*, various years.

[19]Hence, investment in R&D is discouraged. However, it is not clear whether R&D is discouraged relative to capital accumulation since the expensing of capital investments is generally far from complete as well.

The model has abstracted from possible pecuniary or technological spillovers among different firms that, as analyzed in Dixit (1988) and Bagwell and Staiger (1989), have implications for national tax policies towards corporate research activities. The model of this paper can be changed in rather straightforward directions to allow for several multinationals or for purely domestic or foreign firms that compete with a single multinational. These modifications could affect the optimal deductibility parameters in either direction. Also, the introduction of positive technological spillovers of domestic research to other domestic firms may warrant more favorable deduction rules for research undertaken at home than abroad, as is the case in the United States. As a result, the optimal R&D treatment may be a tax credit rather than the less than complete deduction derived before. What remains, however, is a downward bias towards less generous R&D deductions for multinationals, as the benefits of the multinationals' R&D partly accrue to foreign shareholders and foreign treasuries.

The model can also be extended to allow for countries of different sizes. One straightforward way to introduce size asymmetries is to assume there are m plants in n countries where $m>n$. Let m_i be the number of plants in country i, such that $\sum_{i=1}^{n} m_i = m$. Then for country i eq. (13) becomes

$$(1-\rho_i)R-(m_i g'(R)-\theta_i)\frac{\mathrm{d}R}{\mathrm{d}\theta_i}=0. \tag{13'}$$

Eq. (13′) implies that, with equal ownership shares, i.e. $\rho_i = 1/n$, and equal tax rates across countries, deductibility parameters will be positively related to the number of firms across countries. Large countries with many production facilities, such as the United States, thus have larger incentives to allow the deduction of R&D expenses.

The results of the model clearly indicate that there is scope for international cooperation on rules for apportioning R&D expenses of multinationals to income sources in various countries. For rules to lead to an efficient level of R&D, it is necessary that the multinational can exactly expense the total of its R&D expenditures worldwide in the absence of technological and other research externalities.

Appendix

Proof of Proposition 1

(i) Note that for $\rho_i = 1$, (13) collapses to $g'(R)=\theta_i$. Then using (1), (5), (6), and (10), we see that $\mathrm{d}N_i/\mathrm{d}\tau_i = 0$ for all τ_i.

(ii) Now (13) implies that optimally $g'(R)>\theta_i$, so that $\mathrm{d}R/\mathrm{d}\tau_i<0$. The concavity of $g(R)$ now implies that in (12).

$$\tau_i=\frac{(1-\rho_i)(g(R)-\theta_i R)}{-(g'(R)-\theta_i)(\mathrm{d}R/\mathrm{d}\tau_i)}>0.$$

Proof of Proposition 2

(i) As $\rho_k=1$ we have that (13) implies $g'(R)=\theta_k>0$. From (13) we also have $R=(g'(R)-\theta_j)\,\mathrm{d}R/\mathrm{d}\theta_j>0$, which implies $\theta_k>\theta_j$.

(ii) Note that $g'(R)=\theta_k>\theta_j$. Now (3′) implies

$$\theta_k\sum_{i=1}^{n}(1-\tau_i)=1-\sum_{i=1}^{n}\tau_i\theta_i>1-\theta_k\sum_{i=1}^{n}\tau_i.$$

It follows that $n\theta_k>1$. Thus,

$$n\theta_k=\frac{1-\sum_{i=1}^{n}\tau_i\theta_i}{\frac{1}{n}\sum_{i=1}^{n}(1-\tau_i)}>1,$$

which implies

$$\sum_{i=1}^{n}\tau_i\theta_i<\frac{1}{n}\sum_{i=1}^{n}\tau_i.$$

(iii) Eq. (3′) implies

$$\sum_{i=1}^{n}(1-\tau_i)g'(R)\leqq 1,$$

which is equivalent to

$$g'(R)\leqq\frac{1}{\sum_{i=1}^{n}(1-\tau_i)}.$$

Therefore $\lim_{n\to\infty}g'(R)=0$ if $1-\tau_i$ is larger than a positive constant for all i. Since $g'(R)=\theta_k$, this implies $\lim_{n\to\infty}\theta_k=0$. Since $\theta_j<\theta_k$ from (i), we also have $\lim_{n\to\infty}\theta_j=0$.

(iv) Equating $\mathrm{d}R/\mathrm{d}\theta_i$ from (7) and (13) yields

$$g'(R)-\theta_j=-\frac{R\sum_{i=1}^{n}(1-\tau_i)g''(R)}{\tau_j}.$$

From (iii), $g'(R)$ approaches zero as n goes to infinity, and the right-hand side of the above expression goes to infinity [provided $g'''(R)<0$]. Thus, for $n>n^*$ ($n^*<\infty$) the above expression ceases to meet with equality and θ_j is optimally set to zero. Since θ_i approaches zero from (iii) as n increases, this means $\lim_{n\to\infty}\sum_{i=1}^{n}\theta_i=0$.

(v) $g'(R)=\theta_k$ from (*i*). Differentiation yields

$$\frac{d\theta_k}{d\theta_j}=\frac{g''(R)\dfrac{dR}{d\theta_j}}{1-g''(R)\dfrac{dR}{d\theta_k}}.$$

Since $g''(R)<0$, and $dR/d\theta_k=dR/d\theta_j>0$ from (7), we have $-1<d\theta_k/d\theta_j<0$.

Proof of Proposition 3

(i) Since $\rho_i<1$, $g'(R)>\theta_i$ in (13) for all i. (3′) can now be rewritten as

$$ng'(R)=1+\sum_{i=1}^{n}(g'(R)-\theta_i)\tau_i,$$

from which it follows that $g'(R)>1/n$. Hence (3′) now implies

$$\sum_{i=1}^{n}(1-\tau_i)\frac{1}{n}<1-\sum_{i=1}^{n}\tau_i\theta_i,$$

which can be rearranged as

$$\sum_{i=1}^{n}\tau_i\theta_i<\frac{1}{n}\sum_{i=1}^{n}\tau_i.$$

(ii) Analogous to Proposition 2, (iii) above.
(iii) Analogous to Proposition 2, (iv) above.
(iv) Equation $dR/d\theta_i$ from (7) and (13) yields

$$g'(R)-\theta_i=-\frac{(1-\rho_i)R\sum_{i=1}^{n}(1-\tau_i)g''(R)}{\tau_i}.$$

Differentiation yields

$$\frac{\mathrm{d}\theta_i}{\mathrm{d}\theta_j}=\frac{c_1}{1-c_1},$$

where

$$c_1=\left\{g''(R)+(1-\rho_i)\frac{1}{\tau_i}\left(\sum_{i=1}^{n}(1-\tau_i)\right)[g''(R)+Rg'''(R)]\right\}\frac{\mathrm{d}R}{\mathrm{d}\theta_i}.$$

For the case where $c_1<0$ [a sufficient condition is $g'''(R)<0$], we see that $-1<\mathrm{d}\theta_i/\mathrm{d}\theta_j<0$.

(v) Differentiation of the expression above also yields

$$\frac{\mathrm{d}\theta_i}{\mathrm{d}\rho_i}=\frac{c_2}{c_1-1}$$

where

$$c_2=\frac{1}{\tau_i}\sum_{i=1}^{n}(1-\tau_i)Rg''(R)<0$$

and $\mathrm{d}\theta_i/\mathrm{d}\rho_i>0$, if $c_1<0$ [which is true if $g'''(R)<0$].

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