FIVE ESSAYS ON TAX POLICY IN AN OPEN ECONOMY

by

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To my mother

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Contents

Chapter 1

OUTLINE OF THE THESIS

This thesis consists of five essays on tax policy in an open economy. Tax policy in an open economy has in recent years become increasingly relevant. The renewed interest is due to at least three factors. The first is the European Community's commitment to create an internal market where all obstacles to free migration of capital and labor will be removed. The removal of trade barriers may exacerbate differences in national tax systems and, therefore, raise the important question as to whether the possibility of tax competition prevents countries from following an independent tax policy. The second is the rapid integration of the world economy and especially the western economies in the post – war period. This integration has made it clear that substantial differences in tax systems affects the pattern of international trade. The third concerns the wave of tax reforms in the eighties, especially the U.S. tax reforms in 1981 and 1986. Despite the limited mobility of goods and services between the U.S and the rest of the western world, studies by Bovenberg et al (1989), McLure (1989) and Sinn (1985, 1988, 1989a), suggest that national tax policy can have adverse effects on world capital markets.

The possible international reallocation of resources induced by openness and differences in national tax systems has instigated the scientific community to undertake research in two directions. The first, which we may call the literature on international tax coordination, is concerned with tax measures that neutralize the adverse effects created by local tax policy. Researchers in this field have studied the impact of different jurisdictional principles of taxation (Biehl (1982)), the need for tax harmonization (Sinn (1989b)), as well as concepts for efficiency and taxpayer equity (R. Musgrave (1969) and P. Musgrave (1969)). In the tax coordination literature, many

important contributions have been collected in Cnossen (1987), while Sørensen (1990a) provides an excellent survey of some of the tax coordination literature.

The second area of research is complementary to the first, and examines the impact of non–harmonization of taxes when factors of production are internationally mobile. Still in its early days, this literature spans a wide range of issues. In danger of being pretentious, it is tempting to give the reader at least a flare of what some of the issues are by listing three areas of research. Not surprisingly, one issue is fiscal competition between countries. Hamada (1966) was the first to introduce the concepts of game theory to the study of international taxation. Recent contributions include Mintz and Tulkens (1988) and Wildasin (1988), while Wildasin (1986) offers a nice survey of most of this literature. Another area of research is concerned with how different systems of capital taxation may affect international allocation of capital. Sinn (1987) and Boadway and Bruce (1989) are examples of works in this category. A third issue has been the possibilities of tax arbitrage and tax evasion introduced by openness and unlimited mobility of capital. Giovannini and Hines (1989) study capital flight and tax competition, while Giovannini (1989b) and Razin and Sadka (1989) have undertaken work on tax evasion.

The essays presented in this thesis consists of five separate papers. All except for the first essay belong to the second category of works as portrayed above. That is, they are concerned with the impact of differences in national tax systems when taxes are not harmonized.

The first essay provides an overview of the Norwegian legislative rules governing the taxation of foreign source income.[0] The first chapter serves several purposes. First, it gives a general outline of principles for taxing international income. These principles

[0]Ault and Bradford (1989) have undertaken a similar study of the U.S. tax system.

and concepts are later used as a foundation for the theoretical papers – assuring that the modeling takes into account the real world of taxes. The second purpose of the paper is to provide insight about the Norwegian treatment of foreign source income. Such a study can reveal important information regarding the effective rate of tax on foreign source income and, hence, give a hint as to whether investment incentives are distorted in favor of domestic or foreign investments. A third objective is to evaluate the Norwegian tax rules concerning international capital income to see whether they meet certain standards of equity and efficiency.[1]

In addition to examining the taxation of international capital income, the first essay offers a brief survey of the rules governing the taxation of petroleum income. There are special rules given in the Norwegian tax legislation governing the exploration, extraction and production of petroleum as well as businesses related to petroleum activities on the continental shelf. These rules have emerged because the participants in the oil mining business are mostly large multinational companies thus, making it important to construct tax rules that assure a positive rent on natural resources.

Since the effect of national tax policy depends on the degree of openness in the Norwegian economy, the first essay also incorporates a short survey of the Norwegian foreign exchange regulations. Lately, several reforms have been undertaken that have liberalized the foreign exchange market and increased the mobility of capital.

The second paper examines the effects of differences in national tax systems on investment incentives between two countries. The ever closer integration of western economies and in particular the coming about of the EC's internal market have lead to the fear that tax arbitrage and the resulting tax competition would force countries to

[1]For an elaborate discussion on the principles of efficiency and taxpayer equity see Sörensen (1990a, 1990b).

harmonize their national tax systems. The need for tax harmonization is a complex issue involving topics such as indirect taxation (R. Musgrave (1969), Whalley (1979), Berglas (1981)), capital income taxation (Sinn (1987)), and the importance of financial decisions for the effects of tax policy (Alworth (1988), Hartman (1985)). There exists several excellent survey articles on the problem of tax harmonization such as Frenkel, Razin and Sadka (1990), Giovannini (1989a), Sinn (1989a) and Sørensen (1990b).

In particular, the second paper explores the effects of differences in national tax systems by studying the investment incentives of a multinational firm which undertakes investments in two countries. It is shown that the imposition of taxes affects investments between the two countries by increasing or decreasing the rental rate of capital relative to the pre tax situation and relative to each other. A main result of the paper – and an international tax paradox – is that differences in national tax systems may in some cases change the cost of capital in favor of the country with the highest tax rates and the least generous tax deductible expenditures. This result is established when personal, corporate and dividend taxes interact with tax deductible depreciation allowances and is due to distortions of interacting tax parameters when tax deductible allowances exceed the tax base.

The second essay is closely linked to work done by Sinn (1987, 1989a, 1989b, 1990). Sinn investigated the international allocation effects of alternative systems of capital income taxation characterized by different degrees of of integration between corporate and personal taxation as well as tax deductible expenses. As in the second paper, Sinn finds that interaction between tax parameters may provide counter intuitive results leading to international tax paradoxes.

The third paper studies optimal taxation of capital when capital is internationally mobile and can evade taxation with a certain probability. There has been a growing

public concern over the opportunities offered by tax havens for tax payers to evade domestic taxation on wealth and income. The most pessimistic conjectures have claimed that bank secrecy laws and tax havens may deprive a nation of an important part of its tax base. From a theoretical standpoint the question is how to deal with the obvious problems of tax evasion when capital freely can cross borders. Giovannini (1989b) and Razin and Sadka (1989) have studied the welfare effects of capital mobility and tax evasion. The paper by Giovannini concludes that the welfare costs of international capital outflows to evade domestic taxation, are larger, the larger the interest elasticity of domestic investment, relative to the interest elasticity of savings. Razin and Sadka asked whether the problems posed by tax evasion in an open economy with capital mobility should impose a country to set a capital export quota. The answer is affirmative. In another paper, Giovannini (1989a) examined the existing tax loopholes in Europe and conclude that unless some international agreement can be reached to abandon these, their presence will seriously hamper the efficiency of the EC's internal market.

The third essay takes on a different perspective on tax evasion than the works above. Previous studies have been carried out under the assumption that governments cannot tax foreign source income. Evidence, however, suggests that governments derive positive tax revenue from foreign source income. The perspective of the third paper, therefore, is that tax evasion is a problem of tax enforcement. Accordingly, the main purpose of the essay is to analyse how taxes should be set optimally when individuals in a country can save both abroad and domestically. It is assumed that foreign savings can evade taxation with a certain probability depending on the amount of resources allocated to tax enforcement by the government. Thus, the allocation of savings is a decision under uncertainty. From the perspective of the public sector the problem is to find; (a) how taxes should be set optimally on savings, (b) how much money should be

allocated to tax enforcement provided that efficiency is the only goal of the nation, and (c) what the optimal level of monitoring is.

The fourth paper examines how a linear income tax should be set optimally in an open economy with internationally mobile labor. So far, the issue of optimal income taxation has been somewhat neglected in the international taxation literature. A large part of the modern work done in this area has as its focal point the brain drain from developing countries and are collected in Bhagwati and Wilson (1989). This strand of the literature is concerned with the loss of human resources and tax revenue that developing countries suffer when highly qualified people migrate.

Recently, the rapid integration in the western world and the coming about of the European Community's internal market have made labor mobility an important issue. Although it seems reasonable to assume that labor is less mobile than many other factors of production, labor is not a uniform good. We do know that among some highly skilled professions such as academics and business managers, labor mobility is quite high. The EC Commission – having recognized this problem – has found it necessary to propose coordination of income taxes for two groups of workers within the E.C. The first group consists of "frontier workers", that is, workers who live in one country and work in another. These workers are to be taxed in their country of residence with a full credit for foreign taxes paid. The second group of workers are people who spend parts of the year abroad working while the rest of the time is spent in their home country. According to the Commission, these workers are to be taxed in the source country on equal terms to that of their home country. Ulph (1987) has analyzed the requirements for efficient taxation of "frontier workers". Ulph's analysis demonstrates that the Commission's proposal guarantees an efficient allocation of labor provided that workers are indifferent between working in either country, transport costs are tax deductible, no

pay–roll taxes are collected by the country of employment, and output markets are competitive.

The fourth paper differs from previous models in that it constructs a model where individuals can choose between countries based on preferences for leisure and consumption where to work. The structure of the model, therefore, is similar to standard models of labor supply. A special feature of the model is that working hours are fixed and different across countries. The fixity of working hours may be seen as determined by institutional constraints such as labor unions. Within this setting the paper formulates a social welfare function which takes into account the problem of migration. This is done by maximizing a social welfare function where the welfare weight depends on time spent domestically. The question answered by the social planner is how a linear income tax should be set optimally when residents of a nation freely can migrate. The tax policy instruments at hand is a linear income tax, a uniform lump sum transfer and a social insurance transfer. The social insurance transfer differ from the lump sum transfer by depending on time spent in the home country and is, therefore, distortionary. From an equity point of view, the redistributive impact of the social insurance transfer is not clear. If ability is positively correlated to time spent domestically, then, the social insurance transfer is a poor redistributive device. Not unexpected, the analysis is inconclusive as to which form of transfer is the best redistributive device. Moreover, compared to studies in a closed economy, the analysis leads to no definite result as to the level of taxation. The latter can be explained by the fact that the solution to the maximization problem is not explicit.

The fifth paper explores how the tax deduction scheme as opposed to the tax credit scheme affects the behavior of a multinational firm. Previous works have compared the tax credit and the tax deduction scheme from a world perspective to see which system

is preferred (P. Musgrave (1969), Hamada (1966) and Bond and Samuelson (1989)). Since the perspective of nations is adopted in these studies, they are all carried out under the conventional assumption that the tax deduction system introduces an anti–trade bias because traded capital is subjected to double taxation.

The objective of the fifth paper is twofold. The first is to characterize the optimal strategy of the firm when faced with the two tax schemes and examine whether the tax deduction scheme induces the firm to export less goods than does the tax credit scheme. The second is to examine the effects of the tax credit and the tax deduction scheme from the perspective of a nation and, to determine whether firms respond differently to tax policy under the two tax schemes.

The paper uses a simple model based on Horst (1977) of a monopolistic firm selling to two different countries simultaneously to examine the effects of the two tax schemes.[2] The analysis demonstrates that the double taxation implied by the tax deduction scheme does not necessarily induce the firm to export less goods than does the tax credit scheme. Moreover, the impact of tax policy on the transfer pricing behavior of the firm differs under the two tax systems and the tax deduction system induces a fiscal externality on a country. In particular, if a government chooses the tax deduction scheme, then, it cannot influence the behavior of the firm; if it chooses the tax credit scheme, its tax policy has real effects. In either case – when tax policy by either government has real effects – these are shown to depend on the first order condition for trade between the parent firm and its foreign subsidiary. Lacking this knowledge, the government cannot identify the sign or magnitude of the effects of its policy. In contrast, trade policy by the foreign country has an unambiguous impact on the transfer pricing behavior of the firm and, therefore, gives the foreign country the upper hand in any tax setting game irrespective of tax scheme in place.

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[2]For survey articles in this area see for example Eden (1989) and Kopits (1976).

To summarize, the objective of this thesis is to shed some light on the implications of differences in national tax policies in an open economy. Each essay is a distinct and separate piece of work. If there is a common feature present in all four theoretical essays, it is the assumption that goods, services, labor and capital are mobile across borders. Although perfect mobility still is fiction, limited mobility of goods and services are not. Moreover, if the efforts undertaken by some countries to integrate their economies are proven successful, fiction may soon become reality.

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Chapter 2

TAXATION OF INTERNATIONAL CAPITAL FLOWS: THE NORWEGIAN TAX SYSTEM*

Abstract

This paper describes the basic Norwegian legislative rules governing the taxation of foreign source income and explores the impact on efficiency and equity that these rules imply. Particular attention is paid to examine whether income derived in countries with which a tax treaty exists carry different effective rates of tax compared to income derived in non–treaty countries. A short survey is also given of the Norwegian foreign exchange regulations and the taxation of petroleum income.

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TAXATION OF INTERNATIONAL CAPITAL FLOWS: THE NORWEGIAN TAX SYSTEM

1. INTRODUCTION

The coming about of the European Community's intergrated market of 1992 has lead to a feverish activity among companies in Europe to gain strategic footholds before the curtain of regulations is lifted. These preparations are motivated by the change in the competitive environment implied by 1993. According to the plan, on new year's day 1993, all physical border controls will be lifted and labor and capital will be completely free to migrate. The new European market, if successful, will provide easy access to any market within the European Community. In the absence of customs and tariff barriers, and with factors of production free to move, the differences between national tax systems become increasingly important. The country with the most favorable tax rules will gain a competitive advantage that may influence commodity trade, capital movements, labor migration, and the location decision of the firm.

Several countries have recognized that the increasing integration of markets may pose serious problems for the independence of national tax rules. The fear of tax competition has forced authorities in different countries to have a closer look at their taxation of international capital flows. The Norwegian economy is among Europe's most open, highly dependent upon access to foreign markets. It is, therefore, important to understand how the Norwegian legislation treats international capital income flows. A biased national tax system, which through tax considerations affects the choice of a domestic taxpayer between foreign or domestic investment, may have important effects on the welfare of the nation.

The purpose of this paper is to describe and examine the basic Norwegian tax rules that govern the taxation of international income, and to explore the incentives they provide.[1] The paper must not be conceived as a complete description of the legislation in this area, rather, it is an attempt to describe the main rules under which international income is being taxed.

It should be noted at the outset, that the Norwegian legal rules that govern the taxation of international transactions are quite complicated and difficult to survey. Niels Bohr, the famous danish physicist, who had rules for writing, would have found in the Norwegian legislation that his third rule was violated.[2] Bohr's third rule says: " you shall not write more clearly than you can think ". Most of the rules, written in a period committed to nation building rather than integration, seem to have emerged from an ad hoc process instead of a grand strategy. The myriad of rules and exemptions in the treatment of international income is, therefore, a clear evidence of this part of the legislative process being a stepchild. In today's competitive environment it would be a serious error to view the choice of tax policy as made in an international vacuum.

The outline of the paper is as follows. Section 2 describes the jurisdictional principles governing the Norwegian tax system. Section 3 and 4 examines how foreign source income is taxed when derived in countries with which no double taxation tax treaty yet exists and in countries with which a tax treaty exists. The taxation of petroleum income is a distinct entity in the legislation, governed by different principles and rules, and these are described in section 5. The Norwegian foreign exchange regulations are surveyed in section 6, and section 7 offers a summary and a critical evaluation of the Norwegian tax system.

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[1]A similar study of the U.S. tax system has been undertaken by Ault and Bradford (1989).

[2]Dyson (1988).

2. JURISDICTIONAL PRINCIPLES [3]

The Norwegian tax system is based on the residence principle. The residence principle means that a Norwegian person is subject to tax on a worldwide basis. As a consequence, income derived abroad is subject to tax in Norway regardless of whether it also has been taxed in the source country. The use of the residence principle is modified by internal legislation and tax treaties in cases where double taxation occurs, and we will later examine how these affect the taxation of international income. In the next section we will concentrate our effort on examining how the legislation defines a Norwegian person.

Taxation of Norwegian Persons

Individuals. An individual is considered a Norwegian person if she has resided in Norway for six months regardless of whether the purpose of stay is temporary or not. Citizenship does not matter, only the period of residency. A Norwegian person who temporarily resides abroad, is still liable to pay tax in Norway on all her income for up to four years. If a temporary stay has lasted for one year, the tax liability to Norway ceases immediately if it can be proved that taxes are paid to the foreign country as if one was a resident of that country. In case of emigration, the tax liability to Norway ceases to exist when leaving Norway.

Corporations. Corporations are Norwegian tax units if they are situated in Norway or if they are managed from Norway. Thus, Norwegian owned foreign share holding companies are not subject to tax in Norway since they are regarded as independent

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[3]The legal rules and principles of taxation that are stated in the following sections are based on many sources. Among the most important have been the Norwegian tax legislation, especially the articles 15, 17, 22, 23, 26, 41, 42, 44, 45, and 54. Another major source has been A.J. Brudvik (1991).

entities not managed from Norway. In contrast, a Norwegian company which has a foreign branch, must pay taxes in Norway on the income from the branch because the branch is considered to be a part of the Norwegian firm.

The use of the residency principle in the Norwegian legislation connects a person's income and wealth to the taxing jurisdiction. There is one important exception to this rule in the legislation. Property with belonging movable assets abroad are exempted from wealth taxation. Income derived from such properties is, of course, taxable. The exemption of certain types of wealth from the wealth tax base has important consequences for the deductibility of debt and interest expenses against wealth and income in Norway. Wealth kept abroad limits the allowed deductions and the legislation uses a ratio rule to calculate these. Debt and interest expenses can only be deducted against wealth and income in Norway in proportion to the share of total wealth kept in Norway. For example, a Norwegian person who keeps 70 percent of his wealth abroad, can deduct 30 percent of his debt and interest expenses against wealth and income in Norway. It does not matter where the debt and interest expenses are accumulated, nor whether income earned abroad is zero.

Taxation of Foreigners

According to the tax legislation, a foreigner is a person who resides for less than six months in Norway and in addition, is not a Norwegian person[4]. Below we will examine the taxation of foreign individuals and corporations.

Individuals. Foreigners deriving wage income in Norway are subject to a modified version of the source principle. Under pure source taxation, income is taxed in the country where it is derived. According to the Norwegian tax legislation, a foreigner who

[4]The reservation "and in addition, is not a Norwegian person" stems from the rule mentioned previously which says that a Norwegian person who resides abroad temporarily, is still considered a Norwegian person for up to a maximum of four years.

has resided in Norway, is subject to tax on income that has been earned and made available for disbursement during the period of stay. As a consequence, salary earned in Norway but not due until after the foreigner has left the country is not taxable in Norway. Similarly, salary earned abroad which was received after the individual moved to Norway is not taxable. Hence, income must be both earned and made available during stay before it becomes taxable in Norway.

Corporations. Foreign corporations participating in trade or business activities situated in Norway or managing business activities in a foreign country from Norway are subject to tax in Norway on such activities. Thus, a foreign owned company which is either situated in Norway or managed from Norway are taxable in Norway.

Income From Other Sources. Foreigners are subject to wealth and income taxation on chattel and real estate situated in Norway. The taxation of chattel has become increasingly important due to the use of leasing across countries, and prevents tax arbitrage by precluding that foreigners lease production equipment to a Norwegian person and earn tax free income.

Foreigners deriving interest income in Norway are not subject to tax in Norway unless such income is part of their regular business activity. For example, a foreign bank established in Norway is subject to tax on all interest income while a foreigner's interest income from her Norwegian savings account is not taxable.

Sale of Shares. Foreigners selling shares in Norwegian companies are in general not subject to tax on capital gains in Norway. There are two exceptions to this rule. First, if shares owned as part of the seller's business activity is sold, the gain is subject to taxation. Second, foreigners selling a significant part of the share holding capital of a

firm becomes subject to tax on the gain. In section 3 we will elaborate on the rules governing the taxation of significant sales of shares.

Dividends. Dividends received from Norwegian companies are imposed a withholding tax in Norway. The tax rate is 25 percent, but tax treaties can regulate the tax rate.

The Relief of Double Taxation

Where several countries impose both residence and source based taxation, the same income stream may be taxed more than once. For example, if a Norwegian firm has a branch in England, both Norway as the country of residence, and England as the country of source, will assert the right to tax the branch income. The Norwegian attitude towards double taxation is that the same income stream should not be taxed twice. To help overcome the problem of double taxation, alleviation is given through internal legislative rules, tax treaties and by approval of the Ministry of Finance. The Norwegian policy to deal with double taxation, however, does not have as a goal that the tax burden imposed on foreign and domestic investments should be equal. As a consequence, the policy objective of equity which seem to apply for domestically earned income, is not present in the treatment of foreign versus domestic income. Not only does this treatment discriminate between the two income categories, but it may also distort investment incentives in favor of the country with the most generous tax system. In section 7 we will examine this problem in greater detail.

It is a general interpretation of the Norwegian tax legislation that in cases where a tax treaty implies a higher tax burden than internal tax rules, the rules which give the lowest tax burden should be applied. In the following we will focus on how income is taxed when derived in countries with which no double taxation treaty yet exists.

3. TAXATION OF FOREIGN SOURCE INCOME WHEN NO TAX TREATY APPLIES

A Norwegian person who derives income in a non – treaty country, is liable to pay tax in Norway on all foreign source income regardless of whether the income has also been taxed in the source country. The relief of double taxation is provided by using rules given in the tax legislation or by applying for reduction or exemption of Norwegian tax liability to the Ministry of Finance. More specifically, relief from double taxation is given by the following two policies:

Tax Deduction. According to legislative rules, a Norwegian person can deduct foreign income taxes against income taxable in Norway. The deduction method clearly does not provide a full relief from foreign taxes paid, and involves some amount of double taxation which can be seen by considering the following example.

Suppose a Norwegian corporation solely derives income from abroad. At first, the income is taxed abroad at the foreign rate. Then, foreign taxes paid are deducted against the foreign income, and the remaining amount is taxed in Norway. Hence, the part of the income which is taxable in Norway is taxed both abroad and at home without any relief from double taxation. The element of double taxation that is incurred by the use of the deduction method implies that domestic and foreign investments carry different effective rates of tax.

Tax Credit. The second way to reduce the burden of double taxation is to credit foreign income taxes imposed on foreign source income against otherwise applicable Norwegian tax liability. The tax credit depends upon the approval of the Ministry of Finance. Once the right to credit is given it normally lasts for three consecutive years. The magnitude of the tax credit, however, is limited to the amount of tax arising from the

Norwegian taxation of the foreign source income. In other words, if the foreign income tax exceed the Norwegian tax liability, the Ministry of Finance does not allow the overshooting part to be carried forward to the next year. Moreover, the Ministry of Finance only gives credit against pure profits taxes. Indirect taxes and duties cannot be credited. When calculating the Norwegian tax falling on the foreign source income, interest expenses must be portioned between the foreign source income and the domestic income. The rule given by the Ministry of Finance is that interest expenses must be distributed in proportion to income earned abroad and at home. Note that in this case the general rule that interest expenses should be distributed in proportion to wealth kept abroad and at home is exempted. In effect, the use of a limited tax credit means that the taxpayer pays the higher of the foreign and the Norwegian tax rate.

In the following we will outline the rules for taxation of business income, dividends and personal income. The treatment of these income categories under tax treaties is postponed to chapter 4.

Taxation of Business Income

There are two different ways of dealing with foreign source income depending on whether the foreign operations are undertaken by a foreign subsidiary (which is a Norwegian owned share holding corporation), or by a branch (which is merely an extension of the Norwegian firm and not regarded as a separate entity).

Foreign Branch Income. If a Norwegian company carries out business abroad through a branch, any income generated from the branch is subject to tax in Norway and expenditures incurred are deductible against taxable income in Norway. To reduce the burden of overall taxation, the parent company can apply to the Ministry of Finance to credit foreign taxes paid by the branch against the Norwegian tax liability falling on the income of the branch. According to the Ministry of Finance, credit is granted in

most cases. If for some reason the branch should not be allowed a limited credit, the Norwegian firm can by using legislative rules, deduct foreign taxes paid against taxable income.

Foreign Subsidiary. If operations abroad are undertaken by a foreign subsidiary which is a distinct and separate entity, income earned will not be taxable in Norway and expenditures not deductible. Repatriated dividends, however, are taxable. We will in a later section of this chapter study how foreign source dividends are taxed.

The Norwegian tax legislation allows in some cases the Norwegian parent company and its foreign subsidiary to be taxed in Norway as if they were a single Norwegian entity. Such treatment is called direct taxation, and has the effect that profits or losses on the foreign subsidiary's hand are added to the income of the Norwegian company. A company which uses the method of direct taxation must cancel all transactions between the parent and the subsidiary which have reduced the taxable income of the parent.

The legal rules governing direct taxation states that if operations abroad are undertaken by a subsidiary, the parent firm and its foreign subsidiary can apply to the Ministry of Finance to be taxed according to the rules of direct taxation. Approval of direct taxation depends upon two requirements being fulfilled at the same time. First, there must be no tax treaty in place between Norway and the country where the foreign firm is situated. Second, a maximum of 10 Norwegian persons must own at least 95 percent of the share holding capital in the foreign firm. As regarding to the latter requirement, approval is contingent upon the shares having been acquired due to common business interests among the share holders. The practice of the Ministry of Finance is to approve all applications that satisfy the required conditions. An approval is in most cases limited in time to two or three consecutive years whereby a new application must be submitted. When direct taxation is granted, relief from double

taxation is given by either applying for a limited tax credit or by deducting foreign taxes against taxable income in Norway.

Direct taxation has also been used by the tax authorities as a "look through" rule in cases where Norwegian ship owners register their ships in foreign countries. There are two requirements that must be satisfied in such cases. First, the registration of the foreign firm must not imply any real responsibility in the foreign country, that is, the foreign subsidiary is merely a mailbox company. Second, at least 50 percent of the foreign subsidiary's share holding capital is owned by Norwegian persons.

Taxation of Dividends

Norwegian owned foreign companies can defer the taxation of business income until it is repatriated in the form of dividends. Dividends from foreign sources are subject to both the state tax (27,8%), the municipal tax (21%) and the common tax (2%). In contrast, dividends from domestic sources are subject only to the state tax. Dividends arising abroad are in almost all cases taxed in the country of source as well as in the country where the recipient resides. There are three ways in which the double taxation of dividends is relieved in the Norwegian tax system:

Tax Deduction. As in the case of business income, a Norwegian person has the right through legislative rules, to deduct foreign dividend taxes paid against income taxable in Norway. Following the discussion above, this method implies double taxation and that foreign and domestic dividends carry different effective rates of tax.

Tax Credit. The taxpayer can apply to the Ministry of Finance to credit foreign dividend taxes against the otherwise applicable Norwegian tax on the foreign dividends. The tax credit cannot exceed the Norwegian tax liability on dividends.

Adjusted Tax Exemption. A Norwegian parent which receives dividends from a foreign subsidiary, can apply to the Ministry of Finance to be exempted from the municipal tax and the state tax. Such exemption is given if the total tax burden on the parent and the subsidiary's hand is higher than if the subsidiary was a Norwegian firm. When evaluating the total tax burden, the Ministry of Finance calculates the foreign tax on both business income and dividends. In pratice the ministry reduces the tax until the total corporate tax becomes 50.8 percent which is the statutory corporate tax rate in Norway.[5] If the corporation is subject to direct taxation, the firm cannot apply for an exemption. Exemption from dividend taxation can be given regardless of whether a tax treaty exists or not. Note that adjusted tax exemption – as it is practiced in Norway – implies that the firm faces the same effective rate of tax on domestic and foreign investments.

Taxation of Personal Income

A Norwegian person who derives personal income abroad, can credit foreign taxes paid against the Norwegian tax liability on the foreign source income. The credit cannot exceed the Norwegian tax.

The Taxation of Capital Gains from the Sale of Shares

A Norwegian person selling shares in a foreign company is exempted from tax on all such sales if she has owned the shares for more than three years. If shares are sold before the three year exemption rule applies, the gain is taxed at a rate of 40 percent.[6] The gain from the sale of shares is calculated as the difference between the purchase price and the sale price. If some shares are sold at a loss and others with a gain, the tax liability is calculated on the basis of the net gain. These rules are valid as long as the

[5]There is no rule in the tax legislation that grants a tax rate of 50,8 percent, but normally this rate is used.

[6]Losses from the sale of shares are tax deductible.

seller is not taxed according to the rules for a significant sale of shares or sells shares as part of her business activity.

A significant sale of shares is defined as the sale of 45 percent or more of the total share holding capital in an enterprise. If the buyer, however, acquires 50 percent or more of the shares or the majority of the votes, the seller will be taxed according to the rules of significant sale of shares if she sold only 30 percent of the shares. If a group of people sell shares in such quantities that either the 45 or the 30 percent rule applies, each seller can be taxed according to the rules for significant sale of shares irrespective of the amount sold by each individual. For the latter rule to be valid, the seller must be aware of that a transfer of ownership is in the process.

There are two ways to calculate the gain from a significant sale of shares depending on whether the firm whose shares are sold, is a Norwegian company or a foreign company. The gain from sale of shares in foreign firms is calculated as the difference between purchase price and sale price. If some shares are sold with a gain and others with a loss, only the net gain is taxable. For the sale of shares in a Norwegian firm, the gain can either be calculated as above or as if the firm sold assets corresponding to the number of shares being sold minus the purchase price. When shares in a Norwegian company are sold, the seller can choose which of these methods she wants to be taxed according to.

Foreigners selling Norwegian shares are not taxed on such gains unless they are selling shares owned as part of their business activity or deemed as a significant sale of shares.

Wealth Taxation of Shares

The rules for taxation of wealth in connection with shares are rather peculiar because there are different rules for the taxation of wealth on foreign and domestic shares.

Norwegian share holding companies are not subject to tax on wealth from their holding of domestic shares, while individuals are subject to tax on wealth from domestic shares. In contrast, both corporations and individuals are subject to wealth taxation on their holding of foreign shares. As a consequence, firms incur higher costs by holding foreign shares versus domestic shares, and individuals incur a higher tax burden than firms by holding domestic shares.

Transfer Pricing

It is a principle governing the Norwegian taxation of international income that income arising out of transactions between related parties, such as a parent company and its subsidiary, must be determined as if the parties were not related. This "arm's length" principle applies whether a tax treaty exists or not.

The purpose of transfer pricing is to shift income from high to low tax countries. Transfer pricing is in practice very difficult to prove since prices charged between a parent firm and its foreign subsidiary often cannot be compared to market prices. To convict someone for transfer pricing behavior, the burden of proof lies on the tax authorities when dealing with Norwegian persons. In contrast, if the taxpayer is a foreigner, the burden on proof lies on the foreigner. If a firm is found guilty of transfer pricing, its income will be increased until it reaches a level comparable to that had prices been established in a market.

4. TAX TREATIES

The taxation of international income when a tax treaty applies, is quite different from that when no treaty exists since the purpose of a treaty is to avoid that the same income stream is taxed twice. Norway has signed tax treaties with 59 countries,

including all of Europe except Albania. These treaties are bilateral except for the treaty between the Nordic countries, which establishes general rules for the taxation of capital flows between the Nordic countries.

Most of the treaties that Norway has signed are in general based on the OECD's Model Double Taxation Convention of 1963 (MDTC) except for some treaties with developing countries.[7] Developing countries are allowed a larger tax base for international income than what is generally recommended in the MDTC.

The purpose of the MDTC is to avoid that the same income stream is taxed twice, first at source, and then in the country where the recipient reside. To avoid double taxation, therefore, either the source country or the country of residence must give up its right to tax international income. When the source country gives up its right to tax income originating within its jurisdiction, it does so by exempting it from taxation. In contrast, the country of residence can apply two general policies to alleviate double taxation; tax exemption or tax crediting.

The Exemption Method. The exemption method is as the name indicates, based on exempting income which has already been taxed abroad from taxation in Norway. There are two versions of this method. The first version, called the full exemption method, exempts foreign source income that has been taxed abroad from taxation in Norway. The second version, called exemption with progression, also exempts income taxed abroad from taxation, but foreign source income is included in the tax base and, therefore, has a progression effect on domestic income. In the latter case the progression effect only occurs for personal income since the statutory corporate tax rate is flat at 50.8 percent. The tax treaties which Norway has signed are all based on the

[7]The OECD´s Model Double Taxation Convention was revised in 1977.

use of the exemption method with progression. The Ministry of Finance, however, has decided to suspend the use of this method and, instead, to apply the full exemption method.

Tax Credit. The credit method is the same as outlined above and is employed in connection with foreign source dividends and in some cases interest income. The reader is referred to the discussion in section 3 for the impact of using a limited tax credit.

Since most of the tax treaties are based on the advice of the Double convention, it is useful to examine how the Double Taxation Convention recommends that different income categories are to be taxed. In the next section we will do exactly that.

Taxation of Business Profits

Foreign Subsidiary. A Norwegian owned foreign share holding company is subject to tax in the state where it is located. In a later section in this chapter we will deal with the taxation of repatriated dividends.

Foreign Branch. The profits of a Norwegian enterprise are taxable only in Norway unless it carries on business in a foreign country through a permanent establishment situated therein. The term permanent establishment is defined in the Double Taxation Convention as a fixed place of business through which the business of an enterprise is partly or wholly carried on. The foreign country can only tax the profits which can be attributed to the permanent establishment

Taxable profits of a permanent establishment are the profits which the permanent establishment might be expected to make if it was a distinct and separate enterprise engaged in the same or similar activities. In calculating the true profits of a permanent establishment, expenses can be deducted which are incurred for the purposes of the

permanent establishment including overhead costs and general administrative expenses. To prevent transfer pricing, Norwegian tax authorities have the right to alter the size of such transfer prices if they can prove that the transfer prices deviate from market prices.

Taxation of Dividends

According to the Model Double Taxation Convention, dividends paid by a company which is resident of one country to some taxpayer in another country may be taxed in both countries. The MDTC restricts the size of the tax on dividends that the source country can impose. The withholding tax cannot exceed 5 percent of the gross amount of the dividends if the beneficial owner is a company which holds directly at least 25 percent of the capital of the company paying the dividends. In all other cases the rate is 15 percent.

The general rule governing the taxation of dividends in tax treaties between Norway and other countries is that both countries are allowed to tax such income. Norway has reserved the right to impose a withholding tax on dividends of 15 percent irrespective of how many shares the beneficial recipient holds. In some treaties with developing countries, the withholding tax that the developing country is allowed to impose exceeds the rate established by the MDTC. The highest withholding tax in such cases is 25 percent. To alleviate the double taxation of dividends the credit method is applied.

Taxation of Personal Income

The guiding principle governing the taxation of salaries and wages is that income is only taxable in the state where the recipient resides unless the actual work has been carried out in another state. In the latter case income is taxable in the contracting state. If both the employer and the employee reside in another state than the one where the work is carried out, the salary is taxable in the state where the worker resides if the

stay does not exceed 183 days in the fiscal year of the foreign country. Pensions are taxable in the country of residence. Pensions and remunerations paid as part of social welfare programs are taxable only in the state which pays these provisions.

Taxation of Interest Income

Interest income arising in a foreign country and paid to a Norwegian person may be taxed at source as well as in Norway. In most treaties interest income paid to Norwegian persons is taxed twice. Double taxation, however, is alleviated by the credit method as for dividends. The Double Taxation Convention recommends that withholding taxes for interest income should not exceed 10 percent. It is worth noting that Norwegian tax authorities do not levy a withholding tax on interest paid to foreigners. The reason is that there is no legal provision upon which such taxation can be based.

Royalties

Royalties arising in a foreign country and paid to a Norwegian person are only taxable in Norway. Developing countries, however, are allowed to tax royalties. In such cases the Ministry of Finance permits the use of a limited credit for foreign taxes paid. In the case of a Norwegian parent company receiving either royalties or interest income from a foreign subsidiary, the size of these transfers can be reduced if they exceed the market value of such services.

Taxation of Capital Gains

The rules governing the taxation of capital gains are not uniform across all treaty countries. The rules below must, therefore, not be perceived as generally valid. Income derived by Norwegian persons from the sale of immovable property situated abroad is only taxed in the foreign country. Expenses which have occurred in connection with the sale of such property cannot be deducted against income in Norway. The sale of

movable assets is in general taxable in Norway. In some treaties with developing countries the host country is allowed to tax the gain from such sales.

The gain from the sale of shares can only be taxed in the state where the seller resides. Thus, foreigners selling shares of Norwegian companies are not subject to tax on the gain except for in cases where they are selling shares owned as part of their regular business activity or if the sale is a significant sale of shares.

5. TAXATION OF PETROLEUM INCOME

There are special rules given in the Norwegian tax legislation governing the exploration, extraction and production of petroleum and businesses related to petroleum activities on the continental shelf. The term petroleum contains mineral oils, related hydro carbons and gases, and other minerals which are extracted in connection with oil mining.

The Jurisdictional Principle

In contrast to the regular legislation the jurisdictional basis to tax is the source principle. The application of source based taxation implies that any person or corporation who derives income from petroleum mining on the continental shelf is subject to tax in Norway. There is, however, one limitation to the use of the source principle and that is in connection with the taxation of foreigners from countries which Norway has signed tax treaties with. In most treaties, profits from foreign persons are taxable in Norway only if they carry on business through a permanent establishment situated in Norway. In older tax treaties, which do not explicitly mention the continental shelf, the meaning of the term permanent establishment is not well defined in connection with petroleum exploration. It is, therefore, an unsolved question which

country is the taxing jurisdiction in such cases[8]. New treaties have special rules that either secure the Norwegian right to tax activities on the continental shelf avoiding the problem of defining a permanent establishment, or explicitly leaves out the continental shelf, thereby guaranteeing Norway as the taxing jurisdiction.

Taxation of Income and Wealth

According to the legislation, both income and wealth derived from petroleum or petroleum related activities are taxable. Since there are no municipalities in the North Sea, the taxpayer must pay the regular state tax as given in the legislation (27,8 percent for share holding companies) and an additional tax of 23 percent to the government which corresponds to the total of the municipal and the common tax. In addition, there is a special tax of 30 percent on income from the extraction of oil, pipeline transportation and income related to these activities. The special tax accrues on income without the deduction for dividends in the case of share holding companies. There are some other special expenses which cannot be deducted from taxable income, but in the present context it hardly seems worth while to go into detail.[9] A very particular feature of the special tax is that it does only apply to taxable income after the deduction of a production/extraction allowance, which is independent of the investment costs of the tax-payer. At present, the allowance constitutes 15 percent of gross production value for oil fields which were approved by the Ministry of Oil after 1.1 1986.[10]

The Norm Price System

The problem of transfer pricing is thoroughly dealt with in the petroleum tax act through the norm price system. The guiding principle behind the norm price system is

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[8]O.E. Klingenberg (1977).

[9]Interested readers are refferred to A.J.Brudvik (1991) Skatterett for næringsdrivende, p. 392.

[10]For more details regarding the allowance on older oil fields see A.J.Brudvik (1991) p. 408.

that taxable income should be determined on the basis of price setting in a competitive market with no related parties. A special council, called the Petroleum Council, determines how gross income and the value of petroleum stocks should be evaluated. As opposed to the regular legislation where the burden of proof in cases of transfer pricing lies on the authorithies, the petroleum tax act gives rules for income determination. An example is illustrating. A firm cannot extend the period of credit for purchases beyond 30 days. If the 30 days rule is violated, the purchase price is increased by 0,036 percent per day exceeding the legal credit period. Rules like this restricts the possibility of transfer pricing behavior except for in cases where there are loopholes in the law. In such cases the authorities will have to proof that transfer pricing has occurred.

To further avoid that parent and sister companies try to lower taxable income, deficits derived abroad cannot be deducted against petroleum or petroleum related income. Moreover, deficits derived in connection with other business activities subject to Norwegian taxation, can only be deducted with one half. The other half must be deducted against mainland activities which falls outside the jurisdiction of the petroleum tax act.

6. FOREIGN EXCHANGE REGULATIONS [11]

The differences in national tax rates provide incentives for economic agents to localize their activities where the after tax rate of return is highest. The place of residence and even citizenship are choice variables. It seems reasonable to assume that commodity trade and capital movements are the most responsive factors to differences in national tax systems, and that corporations are more responsive than individuals. In general, if

[11]For a survey of the foreign exchange rules see also Kari Olsen (1990).

the after tax rate of return on investments abroad is higher than at home, we should at least in the long run observe an outflow of capital from Norway.

Previously, foreign exchange regulations were heavily regulated, thus, preventing the outflow and inflow of capital to Norway. The Central Bank (Norges Bank) removed most of the new regulations in spring 1990, and new rules entered into force on July 1 1990. The most important new rules are described below.

Direct Investments

Norwegian companies and individuals are free to make foreign direct investments without a foreign exchange license. Purchases and sales of shares, however, must be carried out by a Norwegian broker. The Central Bank may waive the stockbroker requirement upon application.

Portfolio Investments

The new rules allow all Norwegian persons to freely undertake any sale or purchase of shares or money market instruments/certificates denominated in foreign currency. Moreover, all quantity regulations have been removed. Foreigners are correspondingly allowed to purchase and sell Norwegian money market instruments. The only restriction left behind concerns the purchase and sale of foreign securities, bonds and certificates. These transactions must be effectuated by a Norwegian broker. Residents may open accounts in foreign banks but must notify the Central Bank.

Municipal Sector

According to the new legislation the municipal sector is prohibited from undertaking lending or borrowing transactions in foreign currency. Furthermore, any operation exposing the sector to a notable degree of foreign exchange risk is prohibited.

Rules for Payment Channels

Foreign exchange banks in Norway are under the new rules reserved the sole right to engage in foreign currency transactions. All transactions must be reported to the Central Bank. The information given to the Central Bank must contain the customer's residency as well as identity. There are no restrictions on the amount of money that can be channeled inwards or outwards of physical means of payment. However, any person who upon departure or entry carry more than the corresponding amount of NOK. 25 000, must declare the amount through the custom authorities. Residents can make payments to residents in foreign currency, but such transactions can only be effected through foreign exchange banks.

7. SUMMARY AND EVALUATION

Summary

The tax treatment of international income in the Norwegian legislation is based on taxation on a world wide basis with three different policies for the relief of double taxation: a limited tax credit, tax exemption and tax deduction. Foreign income derived in a country which has signed a tax treaty with Norway, is relieved from double taxation by either tax exemption or a limited tax credit. When no treaty applies, the taxpayer can reduce the burden of foreign taxes paid by choosing between a limited tax credit or tax deduction. If the goal of the taxpayer is to minimize the total tax burden, the limited tax credit is normally the choice of preference.

The asymmetric treatment of international income implies that investment in tax treaty countries and non-treaty countries carry different effective rates of tax. In addition and as outlined in section 3 above, the methods for relieving double taxation do not subject foreign and domestic investments to the same tax burden. We can,

therefore, conclude that the Norwegian tax legislation exposes the tax payer to different effective rates of tax depending on whether she; (*a*) invests abroad or at home, (*b*) invests in a treaty country or a non-treaty country. Thus, the rules for taxing international capital income may affect the localization of the tax-payer's investment and is, therefore, not neutral with respect to capital mobility.

The Problem of Double Taxation

Although the Norwegian tax legislation serves several purposes, one of its main goals is to avoid double taxation. This aim, however, is not executed thoroughly in connection with dividends[12]. Norwegian share holding companies can deduct dividend payments from taxable income but must pay the municipal tax (21%) and the common tax (2%). A shareholder which is a corporation, must pay the state tax of 27,8 percent on received dividends, while if the share holder is an individual, he is subject to both the state and the common tax (5%). In the latter case double taxation occurs since the common tax is applied twice. Double taxation also occurs in connection with the state tax when distributed dividends exceed taxable revenue. The distributing firm must in this case pay the state tax on the part of the dividend that exceeds taxable income. The state tax is, therefore, applied twice, first on the distributing firm's hand, and then on the recipient's hand.

The Chain Problem. The chain problem arises when ownership is linked in chains across borders. For example, a Norwegian parent company owns a subsidiary in England which in turn owns a firm in the U.S. etc. In such cases, the linkage between companies and the fact that they are situated in different countries may enlarge the problem of double taxation. To alleviate accumulated double taxation, the whole consolidated group needs to be taxed as a single company. This can be done in Norway through direct taxation if the Ministry of Finance approves the inclusion of the whole chain of

[12]NOU 1989:14, p.36

foreign companies. When applying direct taxation, the legislation does not impose double taxation since the credit method in most cases can be used.

Tax Incentives and the Choice Between Branch Versus Subsidiary

The credit method and the way it is practiced in Norway by only allowing a limited tax credit may affect the firm's choice of undertaking investments abroad through a branch or a foreign subsidiary. If a Norwegian company undertakes business activities abroad through a branch, income derived by the branch will be subject to tax in Norway and foreign losses will likewise be deductible against domestic income. When foreign operations are carried out by a subsidiary, only distributed dividends are taxable in Norway. Since the use of a limited tax credit to relieve double taxation of dividends implies that the firm pays the foreign or the domestic tax rate, whichever is highest, tax incentives are given to use foreign subsidiaries when the Norwegian effective tax rate exceeds the foreign effective tax rate.

TaxPayer Equity

The Norwegian tax legislation seems first of all to reflect an objective of equity. The rules governing the taxation of international income flows do not reflect such an objective. If taxpayer equity is defined as if two individuals with the same income are to pay the same tax is the main goal, the amount extracted by a foreign state must be taken into account as part of the total tax burden imposed by Norwegian authorities. Only then is there equality before the law. The present tax system with a limited credit for foreign taxes paid exposes the taxpayer to different effective rates of taxation on foreign versus domestic income and does, therefore, not provide equity. The system for taxation of international income that grants such equity is the residence principle with an unlimited credit for foreign taxes paid and no deferral. The use of deferral means that the residence country gives up its tax claim on foreign income that is being

reinvested abroad until it is repatriated as dividends. Muten (1983) has shown that the use of deferral works like the exemption system.

In the context of equity it is meaningful to discuss taxpayer equity in the taxation of corporations. Since corporations in most cases are owned by individuals, the corporate tax must in the end be born by the owners of the firm. Taxpayer equity, therefore, seems to call for a complete integration of the personal and the corporate tax[13]. If such equity was achieved, the corporate tax would undertake a function as a preliminary withholding tax against personal income or as a tool for the source country to tax income accruing to foreign owners.

Efficiency

From an economist's perspective national tax rules in an open economy should meet certain requirements that grant efficiency. The question of what constitutes economic efficiency in an open economy depends on the standing point of the spectator. In general, efficiency can be viewed from either a nationalistic or a global point of view.[14] In an open economy, savings in a country do not need to be equal to investments, although global savings must equal global investments. The separation of investments and savings, therefore, leads to two conflicting requirements for global efficiency.

The first requirement states that global efficiency is achieved when the marginal product of capital is equated across countries. Otherwise production could be reallocated and world output increased. Marginal rates of production are equated if firms are competitive, capital is perfectly mobile and foreign and domestic investments carry the same effective rate of tax. The latter condition implies capital export

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[13]Sørensen (1989) p.13.

[14]The principles for equity and efficiency have emerged as a result of the influential work of R. Musgrave (1969) and P. Musgrave (1969).

neutrality since investors have no preference for one particular jurisdiction. Recall that residence taxation with a full credit implies that income from all sources is taxed at the same rate. If capital is fully mobile, equilibrium in international capital markets and residence taxation require that the before – tax rate of return must be the same across countries. Otherwise residents could borrow unlimited amounts in the low interest rate country and invest the borrowed funds in the high interest country. In a world where all countries apply residence taxation, interest rates would be equal, ensuring that the marginal product of capital is equated across countries.[15] Thus, capital export neutrality exists under a system of residence taxation with a full credit and no deferral.

The second criterion for global efficiency states that the marginal rate of substitution between present and future consumption be equal across countries. If there is a tax wedge on savings across countries, an improvement could be obtained by reallocating savings from countries with preferences for future consumption to countries with preferences for present consumption. A tax system which leads to the same after tax rates of return across countries would satisfy this condition. Under the source principle, income is only taxed in the jurisdiction where it originates. When capital is fully mobile, equilibrium requires that an investor is indifferent between investing in different countries. Thus, after tax rates of return would be equated across countries. If all countries apply the source principle, after tax rates of return would be the same and intertemporal marginal rates of substitution are equated across countries. As a consequence, no supplier of capital would prefer one country to another and, hence, capital import neutrality would prevail.

A more natural goal for the Norwegian tax system seems to be that of national efficiency. Following Sørensen (1989), the level of capital exports that ensures national

[15]The efficiency of the residence principle in terms of assuring an optimal allocation of capital hinges on the assumption that economic profit is equal to taxable profit in each country.

efficiency demands that the domestic tax on capital income be set so that the social opportunity cost of capital equals the rate of return on foreign investment after payment of foreign taxes[16]. The reason for applying the post tax rate of return on foreign investments is that foreign taxes do not add to domestic welfare.

Sørensen (1989) shows that if a country's supply of capital is completely inelastic, the tax system that provides national efficiency is one in which foreign taxes are deducted from foreign income taxable at home. The intuition behind this result is that when capital supply is inelastic, taxes do only distort investment decisions, not savings. Hence, efficiency is achieved when the pre tax return on domestic investments equals the return from foreign investments after the payment of foreign taxes. Only then are there no gains from repatriating foreign investments.

Concluding Remarks

From the discussion above we can conclude that national efficiency and taxpayer equity cannot be united. However, if the goal of the tax legislation is to provide taxpayer equity and capital export neutrality, then both objectives can be achieved by applying the residence principle with an unlimited tax credit and no deferral.

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[16]The optimal tax rule is derived under the assumption that capital is perfectly mobile, and that the domestic economy is so small that it does not affect the foreign rate of return. The concept social opportunity cost of capital is due to Harberger (1976) and Horst (1980), and is defined as the weighted average of the after-tax and pre-tax rates of return to capital. The after-tax return to capital is the cost to compensate consumers for the loss of a unit of current consumption, while the pre-tax rate of return to capital under competitive conditions reflects the marginal product of capital. Thus, the social opportunity cost of capital is a weighted average of the opportunity cost of domestic savings and investments.

The use of an unlimited credit is connected with serious incentive problems in an internation context. A country which grants a full credit, can be exploited by other nations since they have an incentive to increase their taxes (infinitely high) on foreign owned capital, thereby transferring resources from the full credit country at no cost. Since investors from the full credit country know that they will be reimbursed for any level of taxation abroad, infinitely high rates of tax will not affect their behavior. The incentive problem faced by granting an unlimited credit is such that unless an international agreement can be signed preventing opportunistic behavior, the best strategy is to allow taxes paid abroad to be deducted against the domestic tax liability on the foreign income. By limiting the credit, the transfer of resources abroad is prevented.

In effect, the Norwegian system for taxing international income seems to lack a clear strategy made necessary by the new international environment, and must, to deal with the new challenges, have a clear opinion of what is the main objective of the tax system. If this objective is equality and capital export neutrality with respect to international taxation of income, the requirement is that domestic and foreign investments must be taxed by the same effective rate of tax. The only way to secure this is by a using the residence principle combined with an unlimited credit for foreign taxes paid even if this means reimbursing taxpayers for taxes paid abroad that exceeds the domestic tax liability. The incentive problem arising out of the limited tax credit can be overcome by tax treaties where the source country agrees to tax income earned by foreigners at the foreign rate of tax.

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Chapter 3

INVESTMENT INCENTIVES AND DIFFERENCES IN NATIONAL TAX SYSTEMS*

Abstract

A consumer is the sole owner of a multinational firm. The firm undertakes investments in two countries. It is shown that the imposition of taxes affects investments between the two countries by increasing or decreasing the rental rate of capital relative to the pre tax situation and relative to each other. The analysis demonstrates, contrary to conventional wisdom, that taxation may in some cases change the cost of capital in favor of the country with the highest tax rates and the least generous tax deductible expenditures. This result is established when personal, corporate and dividend taxes interact with tax deductible depreciation allowances. Differences in the composition of investments when taxes are non-distortionary are also studied.

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INVESTMENT INCENTIVES AND DIFFERENCES IN NATIONAL TAX SYSTEMS

1. Introduction

The rapid integration of western economies and the effects of transnational tax rates on investment incentives seem to have come like a bolt from the blue on most economists, whose interest in the subject just recently have been awaken by the coming about of the European community's integrated market of 1993.

The effect of the corporate income tax on investment incentives has been extensively studied by authors such as Mossin (1968), Hall and Joergensen (1967), Sandmo (1974) and Boadway and Bruce (1979). These studies, however, have analyzed the investment incentives of the firm in a single country setting without taking into account the aspect of an open economy where the factors of production are free to move between countries. Lately, Sinn (1987, 1988, 1989) and Jun (1989) among others have incorporated taxation into an open economy setting. In contrast to traditional analysis, these authors have put less emphasis on the distortionary effects of taxation. Nor has the strand of literature on multinational firm behavior properly analyzed investment incentives when tax systems differ. Horst (1971) studied optimal behavior of a multinational firm under different tariff and tax rates, but with emphasis on transfer pricing rather than tax competition between countries. More recent papers by Katrak (1981) and Itagaki (1989) have focused on optimal tariffs and profit taxes between countries without examining investment incentives of the firm.

The purpose of this paper is to study investment incentives between countries by using neoclassical theory of investment in a partial equilibrium model. The paper explicitly

integrates the investment decisions of the firm and the consumption decisions of the owner in a Fisherian 2-period model of savings and investment. Within this framework, we study the effects of personal, corporate and dividend taxes on the composition of investments between two countries. This is done by examining whether the influence of taxation increases or decreases the price of capital relative to the pre tax situation and relative to that of the other country. Conventional wisdom indicates that high taxes are discriminatory against investment in a country, and that under tax competition, the country with the lowest absolute corporate tax rate is the most attractive to invest in. This paper, however, shows that the interaction between different tax parameters and tax deductible expenses may easily yield the opposite result. The general conclusion of the paper is that the notion 'high' tax country is not meaningful in the sense that taxation changes investment incentives in favor of the country with the lowest level of taxation. The effect of high taxes depends not only on their size but also on how they interact and on the size of tax deductible expenses.

2. The Analytical Framework

The formulation of the model to be employed uses a neoclassical model for investment incentives based on Sandmo (1974) in a Fisherian framework. The model analyses investment incentives between two countries, called the home country and the foreign country, based on the relative generosity of their tax systems. In line with the convention in trade theory, capital letters denote variables pertaining to the foreign country. We shall postpone the introduction of taxes until later and first outline the basic features of the model.

A representative consumer living in the home country is the sole owner of a multinational firm. The consumer has preferences defined over the amounts of

consumption in a two period model. Her preferences can be represented by the utility function

$$U(c_1,c_2), \tag{1}$$

which is assumed to be increasing, strictly quasi concave and differentiable. The owner has a fixed amount of income, y_1 in the first period, which she can use to allocate consumption between the two periods by either borrowing or lending at given market interest rates (R, r) which are taxed at rates (Θ,θ)[1], or by investing through the firm. The firm can invest in capital goods (K, k) abroad and at home, and produce the consumption good according to the production functions $F(K)$ and $f(k)$. The production functions are assumed to be locally concave in the neighborhood of an optimum. For the sake of simplicity, we assume that the consumer is restricted from consumption abroad. In a world where capital is internationally mobile, it may seem awkward that consumption can not occur across borders. It is, however, quite reasonable to assume that capital moves more easily across borders than people. Moreover, as will be shown later, the consumption decision of the owner can be separated from the investment decision of the firm and, hence, does not interfere with the investment decision of the firm which is the scope of this paper.

The budget constraint for the first period is

$$y_1 = c_1 + (S + s) + (QK + qk), \tag{2}$$

where (S,s) denote savings and (Q, q) are the prices of capital goods. We will assume that the prices of capital are constant over time. The capital invested in each country

[1]We assume that interest income are only taxed at source. This may be due to control problems in the residence country or simply legislative rules.

depreciate between the first and the second period and the rates of true depreciation are (Δ, δ). At the end of the first period the firm is liquidated. In the second period, consumption is limited by the firm's production, plus the liquidation value of the firm, plus the amount of savings with interest added. Thus, consumption in the second period is

$$c_2 = S\left[1 + R(1 - \Theta)\right] + s\left[1 + r(1 - \theta)\right] + \left[F(K) + Q(1 - \Delta)K\right] + \left[f(k) + q(1 - \delta)k\right], \qquad (3)$$

Combining (2) and (3) we have that

$$c_1 + \frac{c_2}{\gamma} = y_1 + \frac{S}{\gamma}\left[R(1 - \Theta) - r(1 - \theta)\right] - (QK + qk) + \frac{1}{\gamma}\left[F(K) + (1 - \Delta)QK\right]$$

$$+ \frac{1}{\gamma}\left[f(k) + (1 - \delta)qk\right], \qquad (4)$$

where $\gamma = 1 + r(1 - \theta)$.

Equation (4) says, using the home country as referral, that the present value of consumption should equal the present value of income. To find the maximum of (1) subject to (4) we form the Lagrangian

$$L = U(c_1, c_2) - \lambda\left[c_1 + \frac{c_2}{\gamma} - y_1 - \frac{S}{\gamma}\left[R(1 - \Theta) - r(1 - \theta)\right] + (QK + qk)\right.$$

$$\left. - \frac{1}{\gamma}\left[F(K) + (1 - \Delta)QK\right] - \frac{1}{\gamma}\left[f(k) + (1 - \delta)qk\right]\right].$$

Setting the partial derivatives with respect to c_1, c_2, S, k and K equal to zero, we obtain after some rearrangement

$$\frac{U_1}{U_2} - 1 = r(1 - \theta). \tag{5}$$

$$F'(K) = Q\left[r(1 - \theta) + \Delta\right]. \tag{6}$$

$$f'(k) = q\left[r(1 - \theta) + \delta\right]. \tag{7}$$

$$R(1 - \Theta) = r(1 - \theta). \tag{8}$$

Equation (5) is Fisher's famous rule for optimal allocation over time. The rule states that the marginal rate of time preference should be equal to the interest rate after tax.

The investment decisions of the firm are given by (6) and (7). These conditions have a rather intuitive interpretation. In an optimum, the marginal revenue should be equal to the opportunity cost of holding a unit of capital for one period. The opportunity cost is the income lost from forfeited savings plus the depreciation. It is worth noting from (6) and (7) that the tax on savings is a subsidy to the firm by lowering the owner's loss from forfeited savings. Put differently, the tax on savings reduces the discount rate below the market rate and, therefore, promotes investment through the firm.

Equation (8) derives the condition for savings abroad. Since capital is free to move across countries, and since under certainty financial assets are perfect substitutes for each other, international arbitrage will equalize interest rates after tax in equilibrium. If the equilibrium condition for some reason did not hold, the consumer would borrow infinite amounts where the rates were lowest and lend where the rates were highest. A more realistic deviation from the perfect market assumption is that interest rates between the two countries are equal, but that lending and borrowing rates differ with borrowing rates being higher than lending rates. We will not examine this case since it

is an old result thoroughly analyzed in the literature (see for example Sandmo 1985).

The most spectacular feature of the solutions above is the result due to Fisher (1930) stating that the firm's investment decision can be separated from the consumption decision of its owner. The separation of consumption and investment decisions can be thought of as a sequential process where the owner first maximizes the present value of the firm's cash flows, and then, given the goods made available through the firm, decides on her savings.

3. The Introduction of Taxes and Depreciation Allowances

The separation of consumption and investment decisions means that we can study the impact of taxes on investment decisions solely by analyzing the maximization of the present value of the firm's production. From the above, it should be clear that since the value of the firm should be maximized to its owner, the appropriate discount rate to use is the consumption rate of interest r, net of the personal tax rate θ in the home country.

It is a well known result in public finance that a corporate tax is non-distortionary if taxable profit is the same as true economic profit. The insight is that in real terms, maximizing the full profit is equivalent to maximizing part of it. This result, however, hinges upon the assumption that the firm can deduct its true costs from taxable income. The introduction of taxes very often implies a set of rules governing depreciation rates. In general, these rates deviate from the true rates of depreciation, thereby causing a distorting effect of the corporate tax. In the following we shall measure the impact of this distortion between countries.

Since we are operating in a two period model there is no difference between the true capital stock and the accounting capital stock. The tax legislation in both countries provide for deductibility of interest on the full value of the capital stock. The firm's cost deductions can therefore be based on the opportunity cost of capital as given by equations (6) and (7).

Denoting tax deductible depreciation allowances (A,α), taxable profit abroad and at home is

$$\Pi = F(K) - (r + A)QK,$$

$$\pi = f(k) - (r + \alpha)qk,$$

where capital gains from the liquidation of the firm are not taxed. In principle, such gains should be taxed according to the difference between the booked value of the firm and the sale value. To simplify the analysis, and since this effect is qualitatively similar to the depreciation effect, it is omitted.

There are two basic principles for taxation of international capital income: the source principle and the residence principle. Under the source principle income is taxed only in the country where it is produced. The consequence of the source principle is that the firm faces different tax rates in each country.

The residence principle implies that all income is subject to tax in the country of residence of the firm regardless of 'geographic' source. Most countries levy taxes according to the residence principle on their residents, while applying the source principle on foreigners. The application of the residence principle does not distort investment incentives if it is followed by a full credit for foreign taxes imposed on

foreign source income against taxes in the country of residence. If a full credit is given, the firm faces the same effective tax on all investments. In practice, the foreign tax credit is limited in size to the domestic tax liability falling on the foreign source income. As a consequence, the firm pays the highest of the foreign and the domestic tax rate, and the effective tax rate differs between investments in different countries. This pratice is in reality a reinstatement of the source principle, and makes it fruitful to capture the essence of international taxation of income by examining the impact of source based taxation.

We will initially assume that distributed dividends from the investments of the firm are not subject to tax in any country, and will in a later section analyse the effect of dividend taxation.

Maximizing the owner's utility through the firm by the separation property, the firm maximizes its cash flows minus the tax liabilities. Defining corporate tax rates as (T,t), the present value of the cash flow is

$$V = -(QK + qk) + \frac{1}{\gamma}\left[F(K) + (1 - \Delta)QK\right] - \frac{T}{\gamma}\left[F(K) - (r + A)QK\right]$$

$$+ \frac{1}{\gamma}\left[f(k) + (1 - \delta)qk\right] - \frac{t}{\gamma}\left[f(k) - (r + \alpha)qk\right].$$

The first order conditions of the firm are

$$F'(K) = Qr\left[1 - \frac{\theta}{(1 - T)}\right] + Q\left[\Delta + \frac{T(\Delta - A)}{(1 - T)}\right]. \qquad (9)$$

$$f'(k) = qr\left[1 - \frac{\theta}{(1 - t)}\right] + q\left[\delta + \frac{t(\delta - \alpha)}{(1 - t)}\right]. \qquad (10)$$

Equations (9) and (10) determine the optimal investment decisions of the firm. As can

be seen from the equations, taxes do affect the marginal cost of the firm, and may increase and decrease the cost of capital depending on the interaction between the personal tax on savings, the corporate tax and the tax deductible depreciation allowances.

Suppose now that lump sum taxes apply to persons, that is, $\theta = 0$, and true depreciation rates equal tax deductible depreciation allowances. Equations (9) and (10) reduce to

$$F'(K) = Q(r + \Delta). \tag{11}$$

$$f'(k) = q(r + \delta). \tag{12}$$

In the absence of distortionary taxes, and if marginal revenue is equal in both countries, the firm would invest in the country where the production costs were lowest. The owner of the firm, however, maximizes the post-tax return on investments. As a result, the firm may not invest where the costs of production are lowest. Instead, commercial decisions may be guided to the country with the most generous tax system.

There are two ways in which taxes may lead to a distortion of pretax prices in this model. First, they may reduce the return from savings or the cost of borrowing and, thus, lead to increased investments through the firm. Second, taxes may influence the rental rates of capital in each country and distort investment incentives in favor of the country which experiences a reduction in its price of capital relative to that of the other country. In the next section we will investigate how taxes affect the rental rates of capital.

4. Investment Incentives Between Countries

To study the effect of taxes on the composition of investments between the home and the foreign country, we must examine whether taxation increases or decreases the shadow price of capital relative to the pre tax situation. By doing so we can, given some assumptions regarding the size of certain tax parameters between the two countries, tell whether taxation makes it cheaper to invest in one country relative to the other. More specifically, we compare the rental rates of capital between the two countries before and after the imposition of taxes. Define the rental rate of capital in the foreign and the home country before the corporate tax as

$$P = Q(r + \Delta). \tag{13}$$

$$p = q(r + \delta). \tag{14}$$

The rental rates of capital after the introduction of taxes are,

$$P_t = Qr\left[1 - \frac{\theta}{(1 - T)}\right] + Q\left[\Delta + \frac{T(\Delta - A)}{(1 - T)}\right]. \tag{15}$$

$$p_t = qr\left[1 - \frac{\theta}{(1 - t)}\right] + q\left[\delta + \frac{t(\delta - \alpha)}{(1 - t)}\right]. \tag{16}$$

Let p_t/p and P_t/P be the relative rental rates of capital in each country. If the fractions are equal to one, taxation does not alter the price of capital. A fraction less than one implies that taxation lowers the price of capital and vice versa for a fraction above one. We shall say that the tax system in the home country favors, is neutral to, or discriminates against investment at home if the relative rate of increase in the rental rate is less than, equal to, or bigger than that of the foreign country, that is,

$$\frac{p_t}{p} \lesseqgtr \frac{P_t}{P}. \tag{17}$$

Substituting from (13), (14), (15) and (16) into (17) and rearranging the terms we get,

$$\frac{(r + \Delta)}{(1 - t)}\Big[t(\delta - \alpha) - r\theta\Big] \lesseqgtr \frac{(r + \delta)}{(1 - T)}\Big[T(\Delta - A) - r\theta\Big]. \tag{18}$$

This is the general condition for the discriminatory effect between capital goods in the home and the foreign country of the personal and the corporate tax. We see that a high corporate tax may be advantageous to a country if the subsidy effect caused by the personal tax rate exceeds the depreciation effect. In this case, the country with the highest corporate tax (less than one) has the lowest price on capital. This case is likely to occur when the tax deductible depreciation allowance is very close to the true depreciation rate. For the tax systems to be neutral with respect to the composition of investments between the two countries, corporate taxes and tax depreciation must be equal to true depreciation across countries. In the following we will assume that the corporate tax is less than one. This is a realistic assumption since nominal tax rates in real life do not exceed 100 percent.

There are four special cases of (18) which are of particular interest. First, when true depreciation is equal in both countries ($\delta = \Delta$), (18) simplifies to

$$(1 - t)^{-1}\Big[t(\delta - \alpha) - r\theta\Big] \lesseqgtr (1 - T)^{-1}\Big[T(\delta - A) - r\theta\Big]. \tag{19}$$

Inspection of (19) indicates that the influence of the corporate tax on the relative price of capital between the two countries depends on the sign of the big bracket on both sides. More specifically, differentiation of the left hand side of (19) with respect to the corporate tax t, shows that an increase in the corporate tax will reduce the relative price of capital in the home country if $(\delta - \alpha - r\theta)$ is negative. It then follows that the

impact of differences in the size of the corporate tax depends on the relative size of the depreciation allowance.

If the firm is being subsidized in both countries, that is, $(\delta - \alpha - r\theta)$ is negative (similarly for the foreign country), then investment incentives change in favor of the country with the highest corporate tax and the highest depreciation allowance. The opposite conclusion holds in a positive regime, where investment incentives change in favor of the country with the lowest corporate tax and the highest depreciation allowance. The general conclusion is that high depreciation allowances are always advantageous, and that the impact of the corporate tax depends on whether the depreciation allowance is so large that it together with the personal tax on savings becomes a subsidy on capital.

The second case of interest occurs when true depreciation equals depreciation allowances in each country ($\delta = \alpha$, $\Delta = A$). Equation (18) is simplified to

$$- r\theta\left\{\frac{r + \Delta}{1 - t}\right\} \lessgtr - r\theta\left\{\frac{r + \delta}{1 - T}\right\}, \quad \text{or} \quad \left\{\frac{r + \delta}{1 - T}\right\} \lessgtr \left\{\frac{r + \Delta}{1 - t}\right\}. \tag{19}$$

The conclusion is, then, that when true depreciation equals depreciation allowances, the rental rate of capital is changed in favor of the country which has the lowest corporate tax rate and the most durable capital. The result is clearly in line with intuition which suggests that high corporate taxes reduces the return from investment through the firm and, therefore, increases the opportunity cost of capital.

Suppose now that corporate taxes are equal across countries. Equation (18) can then be rewritten as

$$tr\left[(\delta - \alpha) - (\Delta - A)\right] + t(\delta A - \Delta\alpha) + r\theta(\delta - \Delta) \lessgtr 0. \tag{20}$$

Equal corporate taxes changes the relative price of capital in favor of the country with the most durable capital, the highest depreciation allowances and the lowest depreciation ratio as given by δ/α and Δ/A. It is interesting to note that the absolute difference between true and tax deductible depreciation rates, that is $(\delta - \alpha)$ and $(\Delta - A)$, as well the relative size between the depreciation ratios matter. As can be seen from (20), if the first bracket is zero, reflecting that the absolute difference between depreciation allowances and true depreciation is equal, the left hand side of the equation is different from zero if $\delta/\alpha \neq \Delta/A$, indicating that the country with the lowest ratio is at an advantage.

The fourth case of interest is when corporate taxes and true rates of depreciation are equal in both countries. (18) simplifies to

$$\alpha \lesseqgtr A. \tag{21}$$

This means that the country with the highest depreciation allowance experiences a relative reduction in its rental rate of capital. The intuition is that when all tax parameters except for the depreciation allowances are equal across countries and true depreciation rates are the same, then the only distortion that matters is the size of the depreciation allowance. As intuition suggests, it is the country which has the most generous allowance that is favored.

5. Investment Incentives and Dividend Taxation

The foregoing analysis does not take into account that countries tax dividends. The residence country in addition often taxes dividends derived abroad. In such cases a

credit is given for taxes paid to the foreign country which in pratice is limited to the domestic tax liability on the foreign dividend. The limited credit implies that the firm pays the highest of the foreign or the domestic tax rate.

To capture that dividends in real life are taxed at different rates in different countries, we will assume that dividends are taxed according to the source principle. Define D as the tax on foreign dividends and d as the tax on domestic dividends.

The present value of the the cash flow of the firm is now

$$V = -(QK + qk) + (1 - D)\left[\frac{1}{\gamma}\left[F(K) + (1 - \Delta)QK\right] - \frac{T}{\gamma}\left[F(K) - (r + A)QK\right]\right]$$

$$+ (1 - d)\left[\frac{1}{\gamma}\left[f(k) + (1 - \delta)qk\right] - \frac{t}{\gamma}\left[f(k) - (r + \alpha)qk\right]\right].$$

The first order conditions of the firm are

$$F'(K) = Qr\left[1 + \frac{TD - \theta}{(1 - T)(1 - D)}\right] + Q\left[\Delta + \frac{T(\Delta - A)}{(1 - T)}\right]. \tag{22}$$

$$f'(k) = qr\left[1 + \frac{td - \theta}{(1 - t)(1 - d)}\right] + q\left[\delta + \frac{t(\delta - \alpha)}{(1 - t)}\right]. \tag{23}$$

Substituting from (22) and (23) into (17), and examining the change in the relative rental rates of capital, we see that dividend taxation will change prices in favor of investment in the home country, lead to no change, or change prices in favor of the foreign country according to whether

$$\frac{(r + \Delta)}{(1 - t)}\left[t(\delta - \alpha) + \frac{r(td - \theta)}{(1 - d)}\right] \lessgtr \frac{(r + \delta)}{(1 - T)}\left[T(\Delta - A) + \frac{r(TD - \theta)}{(1 - D)}\right]. \tag{24}$$

As expected, the result depends on the relative size between different tax parameters.

To be able to derive some meaningful conclusions from this we will examine three special cases in which (24) is simplified and which seem to be of practical interest.

First, if corporate taxes, true depreciation and depreciation allowances are equal in both countries and there is no tax distortion on depreciation ($T = t$, $\delta = \Delta = A = \alpha$), (24) can be rewritten as

$$\frac{(td - \theta)}{(1 - d)} \lesseqgtr \frac{(tD - \theta)}{(1 - D)}. \tag{25}$$

Equation (25) shows the effect on the rental rate of capital of differences in the level of dividend taxation between countries when all other tax parameters are equal. The rather surprising result is, then, that we cannot infer this effect without knowing the size of the corporate tax relative to the personal tax on savings. Suppose for example, that $T = t < \theta$. The numerator on both sides becomes negative irrespective of the size of the dividend tax and, hence, the whole fraction is negative. An increase in the dividend tax will actually increase the size of the negative fraction and reduce the price of capital. In this situation the price of capital changes in favor of the country with the highest dividend tax. Obviously, the conclusion does not hold if $T = t > \theta$ and the fractions are positive. In this case the country with the lowest dividend tax is favored.

The second case of interest occurs when corporate and dividend taxes differ between countries and depreciation allowances are equal across countries and equals true depreciation. Equation (24) reduces to

$$\frac{(td - \theta)}{(1 - d)(1 - t)} \lesseqgtr \frac{(TD - \theta)}{(1 - D)(1 - T)}. \tag{26}$$

This is the same expression as in (25) except for the impact of differences in the corporate tax. In the presence of taxation, the rental rate of capital is changed in favor

of the country with the lowest corporate tax and the lowest dividend tax. Equation (26) indicates that if a country does not have an absolute advantage in low taxes, there exists a perfect trade off between the corporate tax and the dividend tax. If the corporate tax in one country is higher than in the other, the difference can be offset by lowering the dividend tax below that of the other country until the difference in the level of dividend taxation exactly offsets the difference in the corporate taxation.

Suppose now that only the true rate of depreciation is equal across countries. Equation (24) can then be rewritten as

$$\frac{t(\delta - \alpha)}{(1 - t)} + \frac{r(td - \theta)}{(1 - t)(1 - d)} \lesseqgtr \frac{T(\Delta - A)}{(1 - T)} + \frac{r(TD - \theta)}{(1 - T)(1 - D)}. \qquad (27)$$

Equation (27) shows that when depreciation allowances are introduced, the perfect substitutability between the corporate and the dividend tax vanishes. If depreciation allowances exceed the true rate of depreciation, it is advantageous for a country to have a high corporate tax thereby enlarging the subsidy effect from depreciation allowances as shown in the first term, and countering the effect of high corporate taxes in the second term by lowering the dividend tax. The opposite result holds when true depreciation exceeds depreciation allowances. The overall conclusion from (26) is that there is a trade off between the depreciation effect and the effect from the interaction between the personal tax and the corporate and dividend tax. If for example, one country has the lowest corporate tax, the lowest dividend tax and the highest depreciation allowance, conventional wisdom would indicate that investment incentives should change in its favor. This is not necessarily so. The reader can convince himself of this by letting $t = 0.40 < T = 0.9$, $A = 0.45 < \alpha = 0.5$, $d = 0.3 < D = 0.35$, where $r = \theta = 0.1$ and $\Delta = \delta = 0.3$. In this case the foreign country is at an absolute disadvantage on all accounts according to conventional wisdom. The result is, however, that the cost of capital changes in favor of the foreign country. The reason is that the high corporate

tax increases the subsidy from depreciation to the extent that the foreign country's absolute disadvantage as a "high tax" country is reversed and an international tax paradox arises.[2] Surprisingly, the international tax paradox is quite robust to changes in the foreign corporate tax rate. For example, if we lower the foreign rate to 55 percent the cost of capital still changes in favor of the foreign country. This result is interesting since it suggests that one should be very careful interpreting the effects of taxation on investment incentives.

6. Borrowing Constraints and Taxation

The above analysis may give the impression that taxes only distort investment incentives when true profits deviate from taxable profits. In principle, this conclusion is correct, but taxes do matter for investment incentives even when no tax induced distortions exist. When borrowing constraints exists, the after tax return from the firm will determine where the owner wants to invest and, hence, taxes matter.

To model borrowing constraints, we will assume that there is a restriction on the total amount of money that can be invested through the firm. This restriction can be perceived as resulting from transaction costs in connection with borrowing costs or installation costs due to the physical installation of equipment. In both cases we will assume that these costs increase more than proportionally with each unit of capital invested through the firm. Thus, the transaction costs will at a certain level overtake the gains from investments and, therefore, become prohibitive. We will assume that this level of investment, called ψ, is below the amount of money that would have been invested if no transaction costs applied. The borrowing constraint can be written as,

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[2]Various types of international tax paradoxes also arise in Sinn (1988, 1989).

$$K + k = \psi. \tag{28}$$

To see that corporate taxes do have an impact on investment incentives when no tax distortions exist, we will assume that no dividend taxes applies, that there is no tax on savings and that true and tax deductible depreciation are equal. In this case the corporate tax is non-distortionary and the maximization problem of the firm can be rewritten as

$$\text{Max } V = -(QK + qk) - \frac{(1 - T)}{(1 + r)}\left[F(K) + (1 - \Delta)QK\right] + \frac{(1 - t)}{(1 + r)}\left[f(k) + (1 - \delta)qk\right],$$

s.t. $K + k = \psi$.

By solving the Lagrangian to this problem and setting the first order condition for investment in the foreign country equal to that of the home country we get

$$-Q + \frac{(1 - T)}{(1 + r)}\left[F'(K) + Q(1 - \Delta)\right] = -q + \frac{(1 - t)}{(1 + r)}\left[f'(k) + q(1 - \delta)\right]. \tag{29}$$

Suppose now that taxes in both countries are zero initially. Comparative statics on (29) with respect to K and T gives

$$\frac{dK}{dT} = \frac{F'(K) + Q(1 - \delta)}{f''(k) + (1 - T)F''(K)} < 0. \tag{30}$$

Equation (30) shows that corporate taxes are not neutral with respect to investment decisions even when they are non-distortionary. The country which increases its corporate tax above that of the other country will reduce the amount of money invested in it. The reason, of course, is that the owner of the firm prefers to receive the whole profit instead of for example, half of it.

7. Concluding Remarks

We have explored the effects of differences in national tax systems on investment incentives in a partial equilibrium model. The analysis shows that the relative sizes of interacting tax parameters determine whether taxes increase or lower the price of capital in a country relative to that of the other country. Hence, the notion 'high' tax country is not meaningful. As a matter of fact, the imposition of taxes may change investment incentives in favor of the country with the highest tax rates.

A natural extension of the model is to construct a general equilibrium model. Such a model would be able to capture whether a rise in one or more of the taxes in one country would, through international equilibrium conditions, lead to incidence effects that would increase the price of capital in other countries. The need for a general equilibrium model, however, does not render the partial equilibrium approach useless. If that were to happen, the results from the general equilibrium model would have to lead to counteracting tendencies that would reverse the initial effects of differences in tax systems. Such drastic conclusions would have to violate very sensible stability conditions which reduces the plausibility of such models.

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Chapter 4

OPTIMAL TAXATION, CAPITAL MOBILITY AND TAX EVASION*

Abstract

Starting from the issue of capital flight and tax evasion, this paper considers the optimal taxation of savings when a consumer can save both abroad and domestically. Due to bank secrecy laws and tax havens, the government's ability to tax foreign savings is a function of money allocated to tax enforcement. Thus, the allocation of savings between countries is a decision under uncertainty. Given consumer behavior, the problem of the government is to decide on how taxes should be set optimally on foreign and domestic savings and how much money if any should be allocated to tax enforcement.

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OPTIMAL TAXATION, CAPITAL MOBILITY AND TAX EVASION

1. Introduction

The rapid process of linking together national economies by allowing free factor mobility has stirred a growing public concern over problems of capital flight and tax evasion on capital. Many countries fear that capital mobility may lead to capital flight from high to low tax countries in such large amounts that it deprives a nation its tax base and as a consequence, its welfare system. Today's international climate with bank secrecy laws protecting foreign investor's anonymity in addition to substantial differences in national tax rates, makes this fear a real one.

The problem of international capital flows evading domestic wealth and capital income taxes is also worrisome both from an equity as well as an efficiency point of view. To the extent that labor cannot evade taxation as easily as capital, labor is subject to higher effective tax rates than capital. The presence of capital flight will, therefore, impose a higher tax burden on individuals who only posses human capital, and thereby create inequality.

The efficiency effect of tax evasion is more ambiguous. Giovannini (1989a) is concerned that the combination of capital controls and secrecy laws will represent insuperable obstacles to the development of an efficient European Capital market by limiting the possibility of openess. Giovannini (1989b) and Razin and Sadka (1989) have studied the

welfare effects of capital flight. The standard assumption in these authors' works is that foreign savings cannot be taxed. Facing the problem of complete tax evasion on foreign income, it is welfare improving to set a binding export quota on capital. In the paper by Razin and Sadka (1989), the export quota should be set so high that the marginal product of capital in the home country falls below that of the world, thus resulting in over–investment in the home country. This is a second best result in which increasing the number of distortions in the economy makes the nation better off.

It is by the nature of the problem very difficult to assess how widespread capital flight is and how sensitive capital is to differences in transnational tax rates. Dooley (1988) estimates for a large group of developing countries that capital flight from these countries makes up about one third of their external debt in the period 1977 – 1984. Most of the evidence of capital flight, however, is in indirect form such as rerouting of capital flows through tax havens after the imposition of taxes. One such example is given by Papke (1988) who assesses the impact of the U.S. withholding tax of 30 percent levied on interest payments to nonresidents. Before the withholding tax was repealed in 1984, virtually all U.S. corporate bond issues were done through the Netherlands Antilles. Moreover, in 1983, almost one third of all interest payments of U.S. citizens to foreigners were channeled through the Netherlands Antilles which through a tax treaty with the U.S. offered a zero rate withholding tax on interest payments as well as anonymity vis a vis the recipient's home country.

Although evidence suggests that governments have difficulties taxing foreign source income, governments derive positive tax revenue from foreign source income. The problem of capital flight and tax evasion, therefore, seems to be a problem of tax enforcement. It is this problem that will be the focus of this paper. More specifically, the purpose of this paper is twofold.

First, our objective is to construct a model of capital tax evasion in a partial equilibrium setting. We will analyze the intertemporal savings decisions of an individual who can allocate consumption between two periods by borrowing and lending abroad and at home, and where the return from foreign savings with a certain probability can evade domestic taxation. Within this framework the model's comparative static properties are examined. Very little if any work has been done along these lines in the field of capital tax evasion despite that the literature on income tax evasion was pioneered in the seventies by Allingham and Sandmo (1972).

Second, the purpose of the paper is to examine the problem of capital mobility and tax evasion within the literature on optimal taxation.[1] We will assume that the government by allocating funds to tax enforcement can influence the probability of being detected as a tax evader. Hence, the purpose of the analysis is to examine how taxes and the probability of detection should be set optimally, provided that the consumer saves both abroad and at home.

2. A Model

To incorporate tax evasion on capital into the analysis of optimal taxation we will use a two period model of a small open economy where capital is mobile internationally.[2] To simplify, we will assume that there is only one consumer in the economy. This assumption is equivalent to assume that all consumers are identical. The consumer

[1]Kaplov (1990) has studied optimal commodity taxation and enforcement costs in a closed economy. Sandmo (1976) offers a survey of the optimal taxation literature while Cowell (1985) has summarized the findings in the literature on tax evasion.

[2]The structure of the model is partly based on Sandmo (1981) who analyses tax evasion in the context of labor supply and personal income.

derives utility from consumption in the two periods and we will assume that the utility function is additive separable in consumption, thus,

$$U(c_1,c_2,g) = v(c_1) + u(c_2) + b(g), \tag{1}$$

where $b(g)$ is second period utility from consumption of the public good.[3] To simplify the model, we will assume that the government is only active in the second period.

The individual can allocate consumption between the two periods by distributing an initial income y_1, to savings abroad S, and savings at home s. The budget constraint for the first period is

$$c_1 = y_1 - s - S. \tag{2}$$

We will assume that income from foreign savings is not taxed in the source country. This is obviously a simplification but can be justified if we think of foreign savings as occurring in tax havens where tax rates are zero or close to zero, or if the tax authorithies in the foreign country due to control problems cannot tax foreigners.

The allocation of savings between the home and the foreign country is a decision under uncertainty. The reason being that foreign savings is only known to the tax authorities with a probability q, depending on the amount of money allocated to tax enforcement. Thus the rate of return from foreign savings is subject to tax with a probability q. Note that the consumer makes his subjective assessment of the probability of taxation occurring. In contrast, domestic savings is known to the tax authorities with certainty, and is taxed at the rate t. The consumer's problem is to decide how to allocate his

[3]The separability between private and public consumption as given by (1) makes sure that government spending on public goods does not affect the consumer's consumption. We will assume that both $u(c_2)$ and $b(g)$ are concave.

initial income between the two different forms of savings facing the uncertainty regarding foreign savings. By placing savings abroad the consumer becomes a tax evader since we do not make explicit allowance for the possibility that the individual might want to report foreign income. In a sense the consumer can do so simply by placing all savings in the domestic market. It is, therefore, no need for such an accommodation.

If the consumer is caught as a tax evader, he must immediately pay a tax rate P on his foreign earnings. The tax P, can be thought of as consisting of the regular tax on foreign income as well as a penalty for tax evasion. The consumer makes his decision about how much to save in the beginning of the first period. Second period consumption depends on his tax treatment. If caught as a tax evader, his consumption becomes c_2^e, while in the event that he escapes detection, his consumption is c_2^o. The budget constraints for the two outcomes are

$$c_2^o = s(1 + r(1 - t)) + S(1 + R) + \hat{y}, \tag{3}$$

$$c_2^e = s(1 + r(1 - t)) + S(1 + R(1 - P)) + \hat{y} + \tilde{y}, \tag{4}$$

where $\hat{y}$ and $\tilde{y}$ are lump sum income in the second period. The main reason for allowing lump sum income to differ in the two states is for analytical convenience, but the difference in lump sum income also has an economic interpretation since $\tilde{y}$ can be thought of as minus any fine due to tax evasion.

A problem arises in the model if interest expenses can be deducted against taxable income. In that case the consumer would like to report foreign borrowing, but reporting foreign savings contradicts the model. Since the purpose of this paper is to study the effects of capital flight and tax evasion, it seems reasonable to eliminate this problem

by restricting the model in the sense that only foreign savings are allowed. Hence, the consumer is a lender in the foreign market ($S > 0$). Although this assumption reduces the generality of the model, it has no implications for the cases we attempt to study.

Substituting (2), (3) and (4) into (1), the consumer will now choose s and S so as to maximize

$$U \equiv v(y_1 - s - S) + (1 - q)u(s(1 + r(1 - t)) + S(1 + R) + \hat{y}) +$$

$$qu(s(1 + r(1 - t)) + S(1 + R(1 - P)) + \hat{y} + \tilde{y}) + b(g). \tag{5}$$

The first order conditions for an interior maximum of (5) with respect to s and S are given by

$$U_s \equiv - v'(c_1) + (1 - q)u'(c_2^o)(1 + r(1 - t)) + qu'(c_2^e)(1 + r(1 - t)) = 0. \tag{6}$$

$$U_S \equiv - v'(c_1) + (1 - q)u'(c_2^o)(1 + R) + qu'(c_2^e)(1 + R(1 - P)) = 0. \tag{7}$$

Rearranging (6), the optimum condition for domestic savings becomes

$$\frac{v'(c_1)}{(1 - q)u'(c_2^o) + qu'(c_2^e)} = 1 + r(1 - t), \tag{8}$$

which is Fisher's rule for optimization over time stating that the marginal rate of substitution should be equal to the price of future in terms of present consumption, which is the discount factor. Unfortunately, the optimum condition for foreign savings cannot be interpreted as easily. The first order conditions for savings describe an interior maximum. The focal point of this paper will be to examine the case of an

interior solution, where the optimal choice of tax parameters induce the consumer to save both abroad and domestically. Thus, it is of interest to study whether taxes, the probability of detection and interest rates can be such that an interior solution is an optimum. If we for the moment assume that $\tilde{y} = 0$ and $S = 0$, then

$c_2^o = s(1 + r(1 - t)) + \hat{y}$, and $c_2^e = s(1 + r(1 - t)) + \hat{y}$, thus, $c_2^o = c_2^e = c_2$.

From (6) and (7) it now follows that the condition for $S = 0$ becomes

$$q > \frac{R - r(1 - t)}{RP}, \quad \text{or} \quad R(1 - qP) < r(1 - t). \tag{9}$$

The first expression in equation (9) states that for foreign savings to be zero, the probability of detection must be greater than the risk premium for foreign savings. We see that if $R - r(1 - t) = 0$, then (9) requires that $q > 0$, that is, when there are no gains to foreign savings, the deterrence condition is that the probability of detection is positive. The second expression of (9) is just another way of writing the deterrence condition, saying that the expected return to savings abroad must be less than the return to domestic savings if foreign savings are to be zero. Hence, to incur a risk averse person to take this gamble, he must be compensated. Equation (9), therefore, restricts the range of the parameters necessary to achieve an interior solution. If $R < r(1 - t)$, there are no gains from foreign savings and $S = 0$. If $R(1 - P) > r(1 - t)$, there is no penalty for tax evasion and $s = 0$. Thus, $R(1 - P) < r(1 - t) < R$, for an interior solution to be the optimum one. Note, however, that the range of the parameters have been determined under the assumption that $\tilde{y} = 0$. If $\tilde{y} \neq 0$, the picture becomes more complicated since the tightness of the conditions depends on income effects.

The second order conditions for an interior maximum are

$$U_{ss} < 0 \qquad \text{and} \qquad |H| = \begin{vmatrix} U_{ss} & U_{sS} \\ U_{Ss} & U_{SS} \end{vmatrix} > 0.$$

The maximization of the consumer's utility function yields the saving demand functions

$$s = s(P, t, q, \hat{y}, \tilde{y}), \tag{10}$$

$$S = S(P, t, q, \hat{y}, \tilde{y}). \tag{11}$$

The utility obtained from these demand functions gives the indirect utility function

$$V = V(P, t, q, \hat{y}, \tilde{y}, g). \tag{12}$$

It can easily be shown using the envelope theorem where λ_1, λ_2 and λ_3 are the Lagrange multipliers of equations (2), (3) and (4), respectively, that the partial derivatives of the indirect utility function with respect to the tax parameters are[4]

$$V_t = - sr(\lambda_2 + \lambda_3), \tag{13}$$

$$V_p = - \lambda_3 SR, \tag{14}$$

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[4]This can be seen by examining the Lagrange function

$$\Lambda = v(c_1) + (1 - q)u(c_2^o) + qu(c_2^e) + b(g) - \lambda_1(c_1 - y_1 + s + S)$$

$$- \lambda_2(c_2^o - s(1 + r(1 - t)) - S(1 + R) - \hat{y})$$

$$- \lambda_3(c_2^e - s(1 + r(1 - t)) - S(1 + R(1 - P)) - \hat{y} - \tilde{y})$$

$$V_q = u(c_2^e) - u(c_2^o), \tag{15}$$

$$V_{\hat{y}} = (\lambda_2 + \lambda_3), \tag{16}$$

$$V_{\tilde{y}} = \lambda_3. \tag{17}$$

The Lagrange multiplier λ_3 denotes the marginal expected utility of income in the case the consumer is caught as a tax evader, while $(\lambda_2 + \lambda_3)$ is the expected marginal utility from certain income in the second period.

3. Comparative Static Results

The aim of this section is to examine the comparative static results of the model by investigating the properties of the Slutsky equations. It is well known in theory that the total effect of say a change in the tax of domestic savings can be decomposed into an income effect and a substitution effect, where the latter gives the change in savings demand provided that the consumer is compensated so as to maintain the same level of utility as before the tax change. In our case we have the choice of stating the compensating income necessary to maintain a certain level of utility $\bar{U}$, by three income parameters, y_1, $\tilde{y}$, or $\hat{y}$. It turns out that the use of y_1 does not lend itself very easily to interpretation, so for all purposes our choice of compensating income is limited to $\tilde{y}$ or $\hat{y}$. In optimum, then, using $\hat{y}$ as compensating income

$$\hat{S}(t, P, q, \bar{U}) \equiv S(t, P, q, \hat{y}(t,P,q,\bar{U})), \tag{18a}$$

$$\hat{s}(t, P, q, \bar{U}) \equiv s(t, P, q, \hat{y}(t,P,q,\bar{U})), \tag{19a}$$

where $\hat{s}$ and $\hat{S}$ denote the compensated savings demand corresponding to lump sum income $\hat{y}$. We could alternatively have expressed this identity in terms of $\tilde{y}$ as

$$\tilde{S}(t, P, q, \bar{U}) \equiv S(t, P, q, \tilde{y}(t,P,q,\bar{U})), \tag{18b}$$

$$\tilde{s}(t, P, q, \bar{U}) \equiv s(t, P, q, \tilde{y}(t,P,q,\bar{U})). \tag{19b}$$

In deriving the Slutsky equations we will study changes in t compensated by changes in $\hat{y}$, while changes in q and P are compensated by $\tilde{y}$. The reason for this division is that it considerably improves the interpretation and intuition behind the results.

From (18b) we now obtain

$$\partial S/\partial P = \tilde{S}_P - (\partial S/\partial \tilde{y})(\partial \tilde{y}/\partial P), \tag{20}$$

where $\tilde{S}_P$ denotes the substitution effect using $\tilde{y}$ as compensating income.

The term $(\partial \tilde{y}/\partial P)$ is the derivative of the expenditure function using $\tilde{y}$ as expenditure minimizing income. We can find the derivative of the expenditure function directly by using the implicit function theorem. Since we are examining the revenue adjustment following a tax change necessary to keep the consumer on the same utility surface as previously, the derivative of the expenditure function is given by the marginal rates of substitution of the indirect utility function, thus

$$(\partial \tilde{y}/\partial P) = - V_P/V_{\tilde{y}} = RS. \tag{21}$$

Substituting (21) into (20), we obtain the Slutsky equation as

$$\partial S/\partial P = \tilde{S}_p - RS(\partial S/\partial \tilde{y}). \tag{22}$$

By the same procedure we derive the remaining Slutsky equations as

$$\partial S/\partial t = \hat{S}_t - sr(\partial S/\partial \hat{y}). \tag{23}$$

$$\partial S/\partial q = \tilde{S}_q - \left[u(c_2^o) - u(c_2^e)\right](\partial S/\partial \tilde{y})/\lambda_3. \tag{24}$$

$$\partial s/\partial t = \hat{s}_t - sr(\partial s/\partial \hat{y}). \tag{25}$$

$$\partial s/\partial P = \tilde{s}_p - SR(\partial s/\partial \tilde{y}). \tag{26}$$

$$\partial s/\partial q = \tilde{s}_q - \left[u(c_2^o) - u(c_2^e)\right](\partial s/\partial \tilde{y})/\lambda_3. \tag{27}$$

From the concavity of the expenditure function it follows that the compensating own price effects are nonpositive, thus

$$\hat{s}_t \leqq 0, \quad \text{and} \quad \tilde{S}_p \leqq 0. \tag{28}$$

As regards the compensated cross price effects, these signs cannot be determined from theory. It seems, however, reasonable to assume that when the return from foreign savings decrease, domestic savings increase and vice versa. Hence,

$$\tilde{s}_p > 0, \quad \text{and} \quad \hat{S}_t > 0. \tag{29}$$

The income effects are given by the last terms in the Slutsky equations. In general there are no restrictions on the sign of these terms, but we will assume that domestic savings decreases with lump sum income ($\tilde{y}$), while foreign savings increases since $\tilde{y}$ is

equal to minus any fine. Hence, an increase in lump sum income in the second period implies a reduction in the fine, thus[5]

$$\partial s/\partial \tilde{y} < 0, \quad \text{and} \quad \partial S/\partial \tilde{y} > 0. \tag{30}$$

Applying the same argument again, it follows that

$$\partial s/\partial \hat{y} > 0, \quad \text{and} \quad \partial S/\partial \hat{y} > 0. \tag{31}$$

Turning to the total effects, it now follows from (28) and (31) that an increase in the tax on domestic savings implies reduced domestic savings for a lender, while for a borrower the outcome depends on the relative magnitudes of the income and substitution effects. This result is in accordance with standard theory of savings and taxation. We see from (26), that an increase in the tax on foreign savings increases domestic savings since we have assumed $S > 0$.

Intuition suggests that the total price effects on domestic savings would be duplicated on foreign savings in the sense that one would expect an increase in P to decrease foreign savings when the consumer is a lender. As can be seen from (22), using (28) and (30), this is indeed the case. Moreover, from (23) we see that an increase in the domestic tax increases foreign savings if the individual is a borrower in the domestic market, otherwise the effect is indeterminate.

The effect of a change in savings due to an increase in the probability of being detected as a tax evader cannot be determined without further assumptions. There is, however, another method of deriving the Slutsky equations which provides more information and

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[5]Using the first order conditions to derive the Slutsky equations, it can be seen that the income effects are sensible to the relative size of the domestic and foreign interest rates. If we for example, assume that $R \leqq r$, then the signs in (30) are reversed(See Appendix B).

is helpful in this case. By differentiating the first order conditions (6) and (7), the emerging Slutsky equations (see appendix A) show that if $R \leqq r$, domestic savings increase when the probability of detection increases, while foreign savings decrease.

The necessary restriction on interest rates to bring forward these results, may be seen as generated from two different processes. First, the determination of the relative size of the two interest rates could be thought of as emerging from trade between non–profit organizations dominating the market. Under such circumstances interest rates would be equalized ($R = r$). Second, the result could have been generated from international arbitrage brought forward by domestic investors who could completely evade taxation on the return from foreign savings. In this case the arbitrage condition becomes $r(1 - t) = R$, which implies that $R \leqq r$. None of these two cases, however, seems very realistic.

4. Optimum Capital Taxes in the Presence of Tax Evasion

The modeling of tax evasion seems to pose some fundamental problems inherent in the asymmetry of information that such models contain. The first problem relates to the asymmetry of information between the government and the tax–payer concerning the probability of detection as a tax evader. Unlike Ulysses, who before setting out towards the Sirens, knew the ex post outcome of not binding himself, the individual faces uncertainty regarding the outcome of his savings decisions. As Isachsen and Strøm (1981) have shown in their study of the black economy in Norway, most individuals overestimate the probability of detection. The question, therefore, arises as to whether the government should maximize ex ante or ex post utility. The easiest way to solve this problem is by assuming that the consumer by coincidence has the same probability belief of detection as the true probability of detection. Ex post and ex ante utility will

then be the same. For simplicity we will adopt this approach here, but one might as well have maximized a weighted average of ex ante and ex post utility.

The second difficulty that arises concerns the general formulation of the model. Since we have assumed that the economy is made up of one consumer or many identical consumers, the government by detecting one tax evader, must be lead to believe that all individuals are tax evaders. To avoid this problem we assume that only those caught are penalized. Thus, any person suspected of a crime must be convicted on behalf of the proofs presented against him. This assumption seems to be in line with how most courts of law treat criminals. Note that we could have constructed a model containing two groups of individuals, one non–evader group who only saved domestically, and one group of evaders who saved both abroad and domestically. Preferences would then differ among the two groups. This way of formulating the model, however, does not alleviated the problem since detection of one tax evader would lead the government to believe that the whole group of evaders was guilty of tax evasion.

Another problem is whether one should allow illegal behavior to be represented in the social welfare function. Put differently, should utility from foreign savings be accepted. A concern for 'fairness' or obedience towards the legislation would lead policy–makers to punish illegal behavior by constructing a welfare function consisting of utility from consumption plus individual welfare weights reflecting the society's attitude towards tax evasion. In a two group setting as outlined above, moralistic preferences could easily be incorporated by attaching different welfare weights to each group reflecting the society's tolerance towards tax evasion. A general discussion on how the welfare weights should be constructed could, for example in this case, be based on the concept of the value of resources to an individual as depicted by Sen (1982). The two group model has its advantage over the single consumer model by incorporating the aspect of

equity. Obviously, this is a weakness of the single consumer model which focus is solely on the efficiency of taxation facing the problem of tax evasion.

Realizing that the equity aspect of taxation cannot be represented in the single consumer model, the use of welfare weights only reflects moralistic considerations. The government can undertake two extreme standpoints towards tax evasion. The first is to ban tax evasion altogether. It can do so simply be setting the fine $\tilde{y}$ indefinitely high [Becker (1968)]. In real life such a threat may not be credible since it on grounds of justice may be perceived as overstating the seriousness of the crime. Thus, moralistic considerations must be weighted against the credibility problem. It is beyond the scope of this paper to elaborate on this issue, but interested readers are referred to Becker (1968) as a first reference. The second view is to fully allow preferences for illegal activities to be tolerated in the social welfare function. We will adopt this view here. Whether we use some functional form to discriminate against foreign savings or not, will not add anything of significance to the analysis. Therefore, to leave the mathematics as uncluttered as possible we take the extreme view. The problem, then, is one of deciding which instruments of taxation causes the smallest possible loss in welfare and balances the public budget.

Since the consumer side of the economy can be treated as if there was only one consumer and we have adopted a utilitarian approach, the welfare function of the consumer is

$$W = V(t, P, q, \hat{y}, \tilde{y}, g). \tag{32}$$

We assume that the government is only active in the second period and derives revenue from taxes on foreign and domestic savings. The revenue T, is spent on public consumption g, from which the consumer derives utility, and tax enforcement. The

probability of detection for not reporting foreign savings is a continuous and differentiable function of the amount of money e allocated to tax enforcement. The probability function is written as $q(e)$ with $q'(e) > 0$. It seems reasonable to assume that the marginal return to of tax enforcement is decreasing so that $q''(e) < 0$, and $q(0) = 0$. Public revenue is now given by

$$T(t,P,q,\hat{y},\tilde{y}) = srt + q(e)SRP - \hat{y} - q(e)\tilde{y}. \tag{33}$$

The government must balance its revenue against its spending and the money allocated to tax enforcement, thus

$$T(t,P,q,\hat{y},\tilde{y}) = g + e. \tag{34}$$

The problem facing the government is to find the level of public expenditure that maximizes the welfare of the consumer. A central question in this model is whether revenue should be raised through higher taxes which are distortionary or through increased tax enforcement which increases the marginal effective tax rate as well as consumes resources. Intuitively one would expect the latter to be the most costly approach. The optimal tax problem is given by the Lagrange function

$$L = V(t,P,q,\hat{y},\tilde{y}) + b(g) + \mu\left[T(t,P,q,\hat{y},\tilde{y}) - e - g\right].$$

The necessary conditions for a constrained optimum are found by setting the partial derivatives with respect to the parameters t, P, e, $\hat{y}$, $\tilde{y}$ and g, equal to zero.

$$t: \quad -rs(\lambda_2 + \lambda_3) + \mu\left[\frac{\partial T}{\partial t}\right] = 0. \tag{35}$$

$$P: \quad -\lambda_3 SR + \mu\left[\frac{\partial T}{\partial P}\right] = 0. \tag{36}$$

$$\hat{y}: \quad (\lambda_2 + \lambda_3) + \mu\left[\frac{\partial T}{\partial \hat{y}}\right] = 0. \tag{37}$$

$$\tilde{y}: \quad \lambda_3 + \mu\left[\frac{\partial T}{\partial \tilde{y}}\right] = 0. \tag{38}$$

$$e: \quad \left[\left[u(c_2^e) - u(c_2^o)\right] + \mu\frac{\partial T}{\partial q}\right] q'(e) = \mu. \tag{39}$$

$$g: \quad b'(g) = \mu. \tag{40}$$

We have defined the Lagrange function L so that μ is a positive number. It now follows directly from equations (35) to (39), that at the optimum, the government revenue function must satisfy the following conditions

$$\frac{\partial T}{\partial t} > 0, \text{ (lender).} \qquad \frac{\partial T}{\partial t} < 0, \text{ (borrower).}$$

$$\frac{\partial T}{\partial P} > 0. \qquad \frac{\partial T}{\partial q} > 0. \tag{41}$$

$$\frac{\partial T}{\partial \hat{y}} < 0. \qquad \frac{\partial T}{\partial \tilde{y}} < 0.$$

The first of these inequalities says that at an optimum, we should be on the increasing part of the Laffer curve, when this is defined for each type of savings. Since the consumer's welfare is decreasing with higher taxes, it can never be optimal to have higher tax rates than necessary to achieve a certain level of public spending. The other inequalities have similar interpretations and we will not elaborate on these.

In what follows we will discuss how taxes, public spending and tax enforcement should be set optimally in two separate sections. The division is done partly to make the analysis tractable and partly because the analysis logically can be done in two separate

parts. The first section will examine the question of optimal taxes on savings, while the second concerns the optimal size of the public sector as well as the optimal level of tax enforcement.

5. The Optimal Taxation of Savings

In considering how taxes on savings should be set optimally, we write the first order conditions (35), (36), (37) and (38) out in full as follows

$$t\text{: } -rs(\lambda_2 + \lambda_3) + \mu\left[rs + rt(\partial s/\partial t) + qRP(\partial S/\partial t)\right] = 0. \tag{42}$$

$$P\text{: } -\lambda_3 SR + \mu\left[rt(\partial s/\partial P) + qSR + qRP(\partial S/\partial P)\right] = 0. \tag{43}$$

$$\hat{y}\text{: } (\lambda_2 + \lambda_3) + \mu\left[rt(\partial s/\partial \hat{y}) + qRP(\partial S/\partial \hat{y}) - 1\right] = 0. \tag{44}$$

$$\tilde{y}\text{: } \lambda_3 + \mu\left[rt(\partial s/\partial \tilde{y}) + qRP(\partial S/\partial \tilde{y}) - q\right] = 0. \tag{45}$$

Multiplying equation (45) by SR and adding it to (43), we obtain

$$rt\left[\partial s/\partial P + SR(\partial s/\partial \tilde{y})\right] + qRP\left[\partial S/\partial P + SR(\partial S/\partial \tilde{y})\right] = 0. \tag{46}$$

Substitution of the Slutsky equations (22) and (26) into (46) yields

$$rt\tilde{s}_p + qRP\tilde{S}_p = 0. \tag{47}$$

By the same procedure, multiplying (44) by sr and adding it to (42), using the Slutsky equations (23) and (25), we have that

$$rt\hat{s}_t + qRP\hat{S}_t = 0. \tag{48}$$

From (47) and (48), then, we can conclude that one solution to the problem is that $t = P = 0$. That is, when lump sum taxes are feasible, it is in general not optimal to tax savings. Hence, the introduction of uncertainty and tax evasion in the context of savings produce results similar to those of optimal commodity taxation. In the context of savings, the result is in accordance with Atkinson and Sandmo (1980) who have shown that lump sum taxes are the first best choice in an intertemporal model of savings and certainty.

These results are first best in the sense that we have assumed the use of lump sum transfers. If lump sum transfers are not available, equations (44) and (45) are eliminated, and optimal tax rates are characterized by equations (42) and (43). Assuming initially that cross price effects are zero, equations (42) and (43) can be rewritten as

$$\frac{t}{(1 - t)} = \frac{(\lambda_2 + \lambda_3 - \mu)}{\mu\varepsilon_{ss}}, \tag{49}$$

$$\frac{P}{(1 - P)} = \frac{(\lambda_3 - \mu q)}{\mu\varepsilon_{SS}}, \tag{50}$$

where ε denotes the uncompensated own price elasticity[6].

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[6]The own price elasticities are defined as

$$\varepsilon_{ss} = \left[\frac{\partial s}{\partial(r(1 - t))}\right]\left[\frac{(-r)(1 - t)}{s}\right] \quad \text{and} \quad \varepsilon_{SS} = \left[\frac{\partial S}{\partial(R(1 - P))}\right]\left[\frac{(-R)(1 - P)}{S}\right]$$

It should be noted that the signs of the own price elasticities are ambiguous.

Equations (49) and (50) are the well known inverse elasticity rules in the case of savings, stating that the asset with the lowest own price elasticity of demand should be taxed highest, minimizing the allocative distortion imposed by taxation. This result, however, is reversed if savings should be subsidized. In the case of domestic savings we see by examining (49), that if ε_{ss} is negative, domestic savings should be subsidized if the demand for savings decreases as income ($\hat{y}$) increases (inferior "goods"). This result follows directly from equation (44). Turning to the taxation of foreign savings, examination of (50) together with (45) reveals that if ε_{SS} is negative, foreign savings should be subsidized provided it decreases as income ($\tilde{y}$) increases. If both types of savings are normal "goods" according to the definition in (30), the sign of the tax rate on foreign savings depends on the relative magnitude of parameters normally determined in a general equilibrium framework as well as on the relative size of the income effects.

When cross price effects are different from zero, the general conditions for optimal taxation of capital become more complicated. Following Diamond (1975), we define γ as the social marginal utility of income. γ is defined for each category of lump sum income as

$$\hat{\gamma} = (\lambda_2 + \lambda_3 - \mu) + \mu\left[tr(\partial s/\partial \hat{y}) + qPR(\partial S/\partial \hat{y})\right],$$

$$\tilde{\gamma} = (\lambda_3 - \mu q) + \mu\left[tr(\partial s/\partial \tilde{y}) + qPR(\partial S/\partial \tilde{y})\right].$$

The general condition for the relative size of optimal taxes on savings can now be written as

$$\frac{t}{P} = \frac{qR}{r}\left[\frac{rs\hat{\gamma}\tilde{S}_p - RS\tilde{\gamma}\tilde{s}_p}{RS\tilde{\gamma}\hat{s}_t - rs\hat{\gamma}\hat{S}_t}\right]. \qquad (51a)$$

The general case as stated by (51a), is very complicated and depends on the relative size of compensated own and cross price effects as well as on the relative size of the two expressions for social marginal utility of income[7]. It provides very little intuitive insight into the structure of taxation, and no easy comparison can be done with the case of zero cross price effects.

The general case, however, can be stated in an alternative way. Using the symmetry conditions of the expenditure function we have that

$$\frac{\partial^2 \tilde{y}}{\partial t \partial P} = r\lambda^{-1}\tilde{s}_P = \frac{\partial^2 \tilde{y}}{\partial P \partial t} = R\tilde{S}_t,$$

$$\frac{\partial^2 \hat{y}}{\partial t \partial P} = r\hat{s}_P = \frac{\partial^2 \hat{y}}{\partial P \partial t} = R\lambda\hat{S}_t, \qquad \text{where } \lambda \equiv \lambda_3/(\lambda_2 + \lambda_3).$$

Using these conditions, the optimal tax formulae for each type of savings can be written as

$$\frac{t\hat{s}_t\lambda + qP\hat{s}_P}{s} = \frac{\hat{\gamma}\lambda}{\mu}. \tag{51b}$$

$$\frac{t\tilde{S}_t\lambda + qP\tilde{S}_P}{S} = \frac{\tilde{\gamma}}{\mu}. \tag{51c}$$

These conditions have a striking similarity to the familiar Ramsey rule in optimum commodity taxation. There are, however, two differences. From the left hand side of

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[7]From the two expressions of social marginal utility of income it follows directly that

$$\hat{\gamma} > \tilde{\gamma} \;\Rightarrow\; \left[\lambda_2 + \mu(q-1)\right] + \mu_{rt}\underset{+}{\left[(\partial s/\partial \hat{y}) - \underset{-}{(\partial s/\partial \tilde{y})}\right]} + \mu_{qRP}\underset{+}{\left[(\partial S/\partial \hat{y}) - \underset{+}{(\partial S/\partial \tilde{y})}\right]} > 0.$$

As can be seen from this expression, it is not clear whether the inequality really holds.

both equations we notice that λ appears in the numerator. The Ramsey rule has only tax rates in the numerator in addition to the compensated substitution effects. Second, the Ramsey rule states that the proportionate reduction of compensated demand should be the same for all goods. This is not the case in (51b) and (51c). In general it seems unlikely that $\hat{\gamma} = \tilde{\gamma}$, hence, only by coincidence would the right hand side of the equations be equal ($\hat{\gamma}\lambda = \tilde{\gamma}$). The formulae, therefore, contrast the Ramsey rule by stating that the relative decrease in compensated demand following on the tax change (weighted by λ) should be different for foreign and domestic savings.

Summarizing the results above, it is not necessarily so that (51b) and (51c) provide more insight into the structure of taxation than (51a). We can, then, conclude that the general case does not lend itself easily to interpretation.

6. The Optimum Probability and Size of the Public Sector

Rewriting the first order conditions for e and g, we have

$$e: \quad \left[\left[u(c_2^e) - u(c_2^o)\right] + \mu\frac{\partial T}{\partial q}\right] q'(e) = \mu. \tag{39}$$

$$g: \quad b'(g) = \mu. \tag{40}$$

Equation (40) derives the condition for the optimal size of public spending. We see that the marginal utility from public spending should equal the marginal cost of public funding. That is, the size of the public sector should be expanded until the marginal utility from expansion equals the marginal cost caused by a larger public sector.

Rearranging equation (39), the first order condition for tax enforcement can be written as

$$q'(e) = \mu / \left[\left[u(c_2^e) - u(c_2^o) \right] + \mu \frac{\partial T}{\partial q} \right]. \tag{52}$$

This condition says that it is worthwhile to spend some resources on tax enforcement, which is costly, instead of providing public consumption solely by raising taxes. In other words, increasing public revenue through higher taxes causes a distortion which is larger than raising the level of tax enforcement.

The Lagrange multiplier μ in equation (52) is the marginal cost of public funds. The smaller μ is, the more should be spent on tax enforcement[8]. Likewise, the greater the return to tax enforcement is, that is, the more one obtains from increasing the probability of detection, the more should be spent on enforcement. The reason being that more enforcement buys more public consumption and/or a reduction in distortion. The difference in utility between the two states as expressed in the denominator is negative, so the greater the difference is, the less should be spent on enforcement. A large difference indicates that the penalty is already quite high and, hence, that enforcement should be reduced since both parameters work to deter tax evasion.

Since $q(e)$ is a continuous and differentiable function it has an inverse function which describes the cost of tax enforcement as a function of the probability of detection. Using (52), we can write the inverse as

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[8]This is easily seen by realizing that

$$\frac{\partial q'(e)}{\partial \mu} = \frac{u(c_2^s) - u(c_2^s)}{\left[u(c_2^s) - u(c_2^s) + \mu(\partial T / \partial q) \right]^2} < 0.$$

$$e'(q) = \left[u(c_2^e) - u(c_2^o)\right]/\mu + \frac{\partial T}{\partial q}. \tag{53}$$

To proceed, we now multiply (45) by $\left[u(c_2^o) - u(c_2^e)\right]/\lambda_3$, and add it to (53). By using the Slutsky equations (24) and (27), several terms cancel and we are left with

$$e'(q) = rt\tilde{s}_q + qRP\tilde{S}_q - \tilde{y} + SRP - (q/\lambda_3)\left[u(c_2^o) - u(c_2^e)\right]. \tag{54}$$

The last term on the right hand side can be approximated by a Taylor expansion as

$$u(c_2^o) - u(c_2^e) = u'(c_2^e)(c_2^o - c_2^e) + (1/2)u''(c_2^e)(c_2^o - c_2^e)^2.$$

Since $c_2^o - c_2^e = SRP - \tilde{y}$, and $u'(c_2^e) = (\lambda_3/q)$ from the maximization of (1) subject to (2), (3) and (4), we can rewrite (54) as

$$e'(q) = rt\tilde{s}_q + qRP\tilde{S}_q - \frac{1}{2}\frac{u''(c_2^e)(c_2^o - c_2^e)^2}{u'(c_2^e)}, \tag{55}$$

which says that at the optimum, the marginal cost of increasing q should equal the marginal tax revenue net of the money necessary to keep the evader at a constant utility level plus a term reflecting the degree of risk aversion by the consumer. This optimum condition is similar to that of Sandmo (1981) which models tax evasion in the context of labor supply and income tax evasion. As shown by Slemrod and Yitzhaki (1987), the optimum condition for tax collection in this case can also be given the interpretation that at the margin, the marginal cost of increasing the probability of detection should equal the saving of excess burden due to the decline in the exposure of risk.

7. Concluding Remarks

We have examined some comparative static properties of taxation as well as optimum taxation in a model of capital tax evasion. A focal point of the analysis has been to establish the requirement for an interior solution in which the choice of optimal tax rates induce the consumer to save both abroad and at home. As already pointed out, the model has several weaknesses. One important weakness is that individuals are identical. As a consequence the analysis is solely concerned with the efficiency of taxation. One possible extension of the model, therefore, is to allow individuals to be different so that equity aspects of taxation can be studied.

Another problem of the model is that of moral and justice. There is no doubt that a penalty could have been found that would have deterred tax evasion. Such a penalty, however, would probably not be perceived as justifiable by the seriousness of the offense. Second, a very high penalty conflicts with preferences for income inequality. These two problems suggests that more attention should be devoted to the treatment of justice and morality in a broader sense than this model suggests. A third expansion of the model would be to analyse capital tax evasion in a general equilibrium model with tax competition. The perspective of tax competition would probably instigate the simultaneous application of game theory. Countries could then be seen as tax havens with bank secrecy laws trying to maximize the net stock of capital taking into consideration capital inflow as well as capital flight. This approach could hopefully add realism to the model.

Appendix A

In this section we will state the Slutsky equations $\partial s/\partial q$ and $\partial S/\partial q$, derived by differentiating the first order conditions as given by equations (6) and (7).

$$\frac{\partial S}{\partial q} = \frac{1}{|H|}\Big[u'(c_2^o)\Big[v''(y_1)\big[R - r(1-t)\big] + qu''(c_2^o)RP(1 + r(1-t))^2\Big]$$

$$+ u'(c_2^e)\Big[v''(y_1)\big[r(1-t) - R(1-P)\big] + (1-q)u''(c_2^o)RP(1 + r(1-t))^2\Big]\Big]. \qquad \text{(A1)}$$

$$\frac{\partial s}{\partial q} = \frac{1}{|H|}\Big[u'(c_2^o)\Big[v''(y_1)\big[r(1-t) - R\big] + qu''(c_2^e)(1 + r(1-t))(1 + R(1-P))(-RP)\Big]$$

$$+ u'(c_2^e)\Big[v''(y_1)\big[R(1-P) - r(1-t)\big] + (1-q)u''(c_2^o)R(1 + r(1-t))\big[-RP\big]\Big]\Big]. \qquad \text{(A2)}$$

Examining equations (A1) and (A2), we see that $\partial s/\partial q > 0$ and $\partial S/\partial q < 0$, if $R \leqq r$ and an interior solution exisits in which $R(1-P) < r(1-t) < R$.

Appendix B

In this appendix we show the Slutsky equations derived from differentiating the first order conditions (6) and (7). We will not show the calculations only the final results. The effect of changes in $\tilde{y}$ on savings can, thus, be written as

$$\frac{\partial s}{\partial \tilde{y}} = \frac{1}{|H|}\Big[qu''(c_2^e)\Big[v''(y_1)(R(1-P) - r(1-t))$$

$$+ (1-q)u''(c_2^o)(-R^2P)(1 + r(1-t))\Big]\Big]. \qquad \text{(B1)}$$

$$\frac{\partial S}{\partial \tilde{y}} = \frac{1}{|H|}\Big[qu''(c_2^e)\Big[v''(y_1)\big[r(1-t) - R(1-P)\big]$$

$$+ (1-q)u''(c_2^o)R^2P(1 + r(1-t))\Big]\Big]. \qquad \text{(B2)}$$

(B1) is positive and (B2) is negative if $R \leqq r$ and we have an interior solution.

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Chapter 5

OPTIMAL INCOME TAXATION AND INTERNATIONAL LABOR MOBILITY*

Abstract

This paper considers how a linear income tax should be set optimally when individuals are internationally mobile. The model is one where individuals can choose which country to work in based on preferences for consumption and leisure. The optimum tax analysis is founded on a social welfare function which reflects labor mobility by using endogenous welfare–weights. Within this context, the discussion of the optimal income tax is organized from two perspectives. The first relates to the optimum income tax when a uniform lump sum transfer is used while the second concerns the optimal rate of tax when a transfer is used which depends on time spent in the taxing jurisdiction.

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OPTIMAL INCOME TAXATION AND INTERNATIONAL LABOR MOBILITY.

1. Introduction

The purpose of this article is to present an analysis of optimal income taxation when labor is mobile across countries. Although economists have lately realized that the effects of tax policy in an open economy may differ from those in a closed economy, the literature on taxation of labor income in an open economy is scarce. A large part of the modern work done in this area belong to one of two categories: (*i*) those studying the effects of migration on optimal taxation, and (*ii*) those examining the implications of tax harmonization for labor mobility. The first category has as its focal point the brain drain from underdeveloped countries [Bhagwati and Wilson (1989)]. This literature is concerned with the loss of tax revenue and human capital that developing countries suffer when highly qualified people migrate. Among the measures proposed to neutralize the effects of migration is the taxation of the emigrant's foreign income [Bhagwati (1980)]. The second category contains to this author's knowledge only one work, that by Ulph (1987). Ulph studied the requirements for efficient international taxation of workers who live in one country and work in another.

The present paper differs from the works above in two respects. First, it models labor mobility in a partial equilibrium framework where each worker decides where to work based on his preferences for consumption and leisure. The structure of the model, therefore, is similar to the basic model of labor supply in a one country setting where the individual is maximizing a utility function defined over net income and leisure [Robbins (1930); Cooper (1952)]. Second, in contrast to the literature concerned with

migration from developing countries, the paper only analyzes how taxes should be set optimally on domestic income. Implicit in this approach is the recognition that international income tax coordination may be difficult or even unwanted by some nations. To simplify the model, we assume that workers can move between countries at no cost. Obviously, this is a weakness of the model and reflects the difficulty of incorporating all effects that play a role in migration decisions. The outline of the paper is as follows. Section 2 presents the basic model of labor mobility, while section 3 studies how a linear income tax should be set optimally when labor is internationally mobile. In particular, we examine how a linear income tax should be set optimally when the government can redistribute income by: a uniform lump sum transfer or, a uniform social insurance transfer which depends on time spent in a country. Finally, section 4 offers some concluding remarks.

2. The Model

The model to be employed analyses work and leisure decisions between two countries called the home and the foreign country. In line with the convention in trade theory, capital letters will denote variables pertaining to the foreign country. The economy we consider consists of n individuals who can allocate time, t_i, T_i, between the home and the foreign country. Let Ω denote the total number of hours available. The time constraint of each individual can then be written as

$$t_i + T_i = \Omega. \tag{1}$$

The consumer can allocate his time in each country between leisure, f_i, F_i, and labor time, l_i, L_i, so that

$$l_i + f_i = t_i \,. \tag{2a}$$

$$L_i + F_i = T_i \,. \tag{2b}$$

We assume that the consumer can choose continuously between the two countries where to allocate his labor and leisure time. There are several ways of interpreting this flexibility. One is to view the choice of time spent in each country in a lifelong perspective. The time constraint, Ω, can then be interpreted as the number of years available before retirement. The individual must decide on how many years of his life to stay abroad versus domestically, before retirement. Such choices are not uncommon and are exemplified by guest workers who stay for a limited period of time abroad to earn higher incomes than what would otherwise have been possible. Another interpretation of the model, more in line with standard theory of labor supply, is to accept that individuals can continuously choose between countries where to work. Certainly this is true for some occupations such as academics, physicians and other highly skilled workers. Moreover, federation of states such as the U.S. and the European Community's internal market, allows unrestricted labor mobility. The model, therefore, can be seen as picturing a well functioning international labor market.

To proceed, we assume that working hours are fixed and a fraction (φ_i, Φ_i) of time spent in each country. Thus,

$$l_i = \varphi_i \, t_i \,. \qquad \Rightarrow \qquad f_i = (1 - \varphi_i) t_i \,. \tag{3a}$$

$$L_i = \Phi_i \, T_i \,. \qquad \Rightarrow \qquad F_i = (1 - \Phi_i) T_i \,. \tag{3b}$$

As seen by (3), the freedom of an individual to vary working hours is restricted within each country. The constraint on choice may be perceived as a case where the working hours are fixed by the employer for a particular job and that the worker cannot change his occupation. Another interpretation is to see the fixed coefficients as institutional constraints. For example, working hours may be determined by labor unions or by government rules and legislation in each country. Note that compared to standard models of income taxation and labor supply where labor time is chosen freely, the fixity of labor time may appear to constrain the choice of the individual considerably. The individual, however, enjoys some flexibility. By changing his allocation of time between the two countries, the consumer is able to choose between a number of points on the budget line. Moreover, in a world of many nations, all with different working regulations, the individual is offered an almost continuous work schedule.

From (1) and (3) it can be seen that the choice of t_i implicitly determines total time abroad as well as labor time and leisure in each country. Since labor time is a fixed proportion of time in each country, the individual cannot spend time in a particular country without working some amount of the total time. This is clearly an assumption not in line with reality since people do occasionally spend their leisure time away from their work place. As will turn out shortly, the assumption of fixed coefficients is vital to the model in assuring an interior solution and, therefore, also a weakness of the model.

The consumer has preferences defined over amounts of consumption and leisure. We assume that the utility from leisure is the same across countries. It could equally well have been the case that the consumer derived higher utility from leisure in one country than the other. Thus, this assumption is simply a matter of taste, and the fundamental results of the model are not changed by this assumption.

Individuals' preferences are the same and the utility function is given by

$$U^i = U(c_i, f_i + F_i) = U(c_i, (\Phi_i - \varphi_i)t_i + (1 - \Phi_i)\Omega). \qquad (4)$$

The utility function has the usual properties of strict quasi–concavity and differentiability.

The consumer receives a social insurance transfer (a, A) in proportion to total time spent in each country. If we perceive the model as portraying work decisions before retirement, the inclusion of a social insurance transfer may be seen as some sort of a pension scheme. Thus, by allocating part of his time abroad, the consumer would loose some pension benefits in the home country. Since migration decisions have an effect on future public pensions, the inclusion of social insurance transfers, means that the model becomes more realistic.

Note that there are several other ways in which we could have made the consumer eligible for the social insurance payment. For example, we might have related the social insurance transfer to total income in a lifelong perspective, $\varphi_i t_i w_i$, or total working time, $\varphi_i t_i$, instead of total time spent in a country, t_i. The approach chosen reflects a stronger preference for equity than the others since it makes everyone eligible for the transfer independent of ability or income. Many countries provide social insurance to housewives and other groups of society which are not part of the formal sector, and the use of t_i allows us to incorporate this feature.

Each worker's marginal productivity is denoted, w_i , W_i . Both economies are characterized by perfect competition and consumption is the numeraire so, w_i, W_i, are the wage rates. The consumer's budget constraint now becomes

$$c_i = w_i \varphi_i t_i \beta + t_i a + b + W_i \Phi_i T_i B + T_i A, \qquad (5)$$

where (β, B) denote the marginal after tax rates in each country and b is a lump sum transfer provided by the home country.

As seen by (5), the consumer is taxed according to the source principle, that is, economic activities carried on within a particular country are subject to taxation only in the country where the income is derived. There are two reasons for adopting source taxation in this model. First, since the consumer may be seen as making decisions in a lifelong perspective, the tax legislation in most countries would imply source taxation. Second, most countries apply residence taxation with a limited tax credit for foreign taxes paid. The limited tax credit, however, leads to source taxation when the foreign tax rate exceeds the domestic tax rate.

The consumer's maximization problem is to find the allocation of time between the two countries that yields the highest possible utility. The problem would appear to be to maximize (4) subject to the multiple constraints (1) and (5). There is, however, really one basic constraint since the choice of t_i determines T_i. We can, thus, restate the individual's problem by the indirect utility function as

$$V^i(\cdot) = \max_{c_i, t_i} U^i(c_i, (\Phi_i - \varphi_i)t_i + (1 - \Phi_i)\Omega)$$

$$\text{s.t. } c_i = t_i(w_i \varphi_i \beta + a) + b + (\Omega - t_i)(W_i \Phi_i B + A).$$

The first order condition is

$$U_1^i(w_i \varphi_i \beta + a - W_i \Phi_i B - A) + U_2^i(\Phi_i - \varphi_i) = 0. \tag{8}$$

Rearranging (8) we obtain

$$\frac{U_2^i}{U_1^i} = \frac{(W_i \Phi_i B + A - w_i \varphi_i \beta - a)}{(\Phi_i - \varphi_i)}. \tag{9}$$

At the optimum the marginal rate of substitution between leisure and consumption equals the net economic gain from spending an extra unit time abroad in terms of the net working requirement abroad. The first order condition is all but trivial, depending on eight different parameters.

The first order conditions characterize an interior solution. It is, therefore, important to check whether tax rates, wages and work hours are such that an interior solution can indeed be the optimal. Suppose initially that $\Phi_i = \varphi_i = \varphi$ for all i and that $T_i = 0$. Then, from (8) it follows that

$$w_i \varphi \beta + a > W_i \varphi B + A. \tag{10}$$

Equation (10) states that for time spent abroad to be zero, the economic compensation per unit time in the home country must exceed that of the foreign country. Equal working hours, therefore, lead to a corner solution where the consumer works in the country providing the best financial compensation. Thus, for an interior solution to occur, working hours must be different across countries. The best way of seeing this is by assuming that $\Phi_i \neq \varphi_i$ and $T_i = 0$. From (8), then, we obtain

$$\frac{U_2^i}{U_1^i} > \frac{(W_i\ \Phi_i\ B + A\ -\ w_i\ \varphi_i\ \beta\ -\ a)}{(\Phi_i\ -\ \varphi_i)} \qquad \text{if } \Phi_i > \varphi_i\,. \tag{11a}$$

$$\frac{U_2^i}{U_1^i} < \frac{(W_i\ \Phi_i\ B + A\ -\ w_i\ \varphi_i\ \beta\ -\ a)}{(\Phi_i\ -\ \varphi_i)} \qquad \text{if } \Phi_i < \varphi_i\,. \tag{11b}$$

Equation (11) gives the requirements for a corner solution in which the consumer spends all his time domestically. The left hand side of equation (11a) and (11b) is the marginal rate of substitution between leisure and consumption – which is positive. Note that a corner solution can only be assured from (11a). This occurs when the right hand side becomes negative and the home country has the shortest working day as well as the best economic compensation per unit time. Thus, from (11) it follows that a requirement for an interior solution is that the country with the highest economic compensation has the longest work day.

To derive comparative static properties of the model we use the expenditure function approach. The purpose of the analysis is to investigate the properties of the Slutsky equations for time supply. Since the consumer's allocation of time must add to Ω, a change in time spent in one country will lead to exactly the opposite change in time spent in the other country. It follows immediately that we need only investigate the Slutsky equation for time supply in the home country.

Let b be the minimum expenditure required to achieve utility level $\bar{U}^i$. The relationship between compensated and uncompensated supply at utility level $\bar{U}^i$ is then

$$\hat{t}_i(\beta, B, a, A, \Phi_i, \varphi_i, \bar{U}^i) = t_i(\beta, B, a, A, \Phi_i, \varphi_i, b), \tag{12}$$

where $(\hat{\cdot})$ denotes compensated time supply, and b is the lump sum income needed to reach utility level $\bar{U}^i$, that is,

$$b(\cdot) = \min c_i - t_i(w_i \varphi_i \beta + a) - (\Omega - t_i)(W_i \Phi_i B + A)$$

$$\text{s.t. } U^i(c_i, (\Phi_i - \varphi_i)t_i + (1 - \Phi_i)(\Omega - t_i)) = \bar{U}^i.$$

Taking the derivative of (12) and using the expenditure function, the Slutsky equations are found as

$$\frac{\partial t_i}{\partial \beta} = \frac{\partial \hat{t}_i}{\partial \beta} + w_i \varphi_i t_i \frac{\partial t_i}{\partial b}. \tag{13}$$

$$\frac{\partial t_i}{\partial B} = \frac{\partial \hat{t}_i}{\partial B} + W_i \Phi_i (\Omega - t_i) \frac{\partial t_i}{\partial b}. \tag{14}$$

$$\frac{\partial t_i}{\partial a} = \frac{\partial \hat{t}_i}{\partial a} + t_i \frac{\partial t_i}{\partial b}. \tag{15}$$

$$\frac{\partial t_i}{\partial A} = \frac{\partial \hat{t}_i}{\partial A} + (\Omega - t_i) \frac{\partial t_i}{\partial b}. \tag{16}$$

$$\frac{\partial t_i}{\partial \varphi_i} = \frac{\partial \hat{t}_i}{\partial \varphi_i} + t_i(w_i \beta - U_2^i \pi_i) \frac{\partial t_i}{\partial b}. \tag{17}$$

$$\frac{\partial t_i}{\partial \Phi_i} = \frac{\partial \hat{t}_i}{\partial \Phi_i} + (\Omega - t_i)(W_{i\,B} - U_2^i \pi_i)\frac{\partial t_i}{\partial b}, \tag{18}$$

where π_i is the Lagrange multiplier pertaining to the expenditure minimization problem.

The Slutsky equations depend on the relative magnitudes and signs of the income and substitution effects. There are no a priori restrictions on the sign of the income effect implied by theory. If we apply the conventional assumption that leisure is a normal good, then

$$\frac{\partial(f_i + F_i)}{\partial b} = \frac{\partial((\Phi_i - \varphi_i)t_i + (1 - \Phi_i)\Omega)}{\partial b} > 0.$$

By using the chain rule we find that the sign of the income effect is given by the condition

$$(\Phi_i - \varphi_i)\frac{\partial t_i}{\partial b} > 0. \tag{19}$$

Equation (19) indicates that if leisure is a normal good, then depending on the relative length of the work day in each country, either domestic or foreign time will be an inferior good. If domestic time is a normal good, then domestic leisure as well as labor are normal goods while foreign labor and leisure ar inferior goods. Compared to standard theory of labor supply where labor is assumed to be inferior, the deviation from the convention may seem awkward. The reason for the departure is simply that the fixity of the workday implicitly determines the normality and inferiority of goods. From a principal point of view there is nothing wrong with labor and leisure being

inferior in one country and not in the other since a good never is inferior on its own, but is inferior relative to a given preference ordering.

Turning to the compensated price effects, we see from (5) that an increase in β, φ_i or a has the same effect as an increase in the wage rate. In the traditional model of labor supply we know that the compensated supply of labor increases when the wage rate rises. The intuition being that since labor is supplied and leisure demanded, a wage increase makes it more expensive to spend leisure and more profitable to work. The general result, however, does not easily carry over to our model with two countries. This can be seen by initially considering the case when labor time is not fixed. An increase in say the domestic wage rate would, in accordance with standard labor theory, lead to an increase in time spent domestically since the price of leisure does not differ across countries.

The introduction of fixed working hours complicates the standard result since leisure cannot be chosen freely. Once the consumer allocates his time in a given country, his work hours and leisure time are determined. A partial increase in the wage rate is now made up of two relative prices, one for economic compensation between the two countries and one for leisure. As previously, a wage increase makes it more profitable to work and less favorable to spend leisure. Thus, a domestic wage increase makes it more attractive to work in the home country and more expensive to spend leisure. Note that the substitution effect is only positive if leisure is in short supply in the home country since it then becomes relatively more expensive both to work and spend leisure abroad. In all other cases the sign is indeterminate depending on the relative magnitudes of the two price effects. Consider, for example, the case when leisure is abundant in the home country. Since it becomes more expensive to spend leisure, the consumer wants to spend more time in the foreign country. At the same time economic compensation becomes relatively better domestically and leads the consumer to prefer working at

home. The outcome of the wage increase, therefore, depends on the relative size of these two effects. Formally we have

$$\frac{\partial \hat{t}_i}{\partial \beta} > 0, \quad \frac{\partial \hat{t}_i}{\partial a} > 0, \quad \frac{\partial \hat{t}_i}{\partial \varphi_i} > 0, \qquad \text{if } \Phi_i < \varphi_i, \tag{20}$$

and

$$\frac{\partial \hat{t}_i}{\partial B} < 0, \quad \frac{\partial \hat{t}_i}{\partial A} < 0, \quad \frac{\partial \hat{t}_i}{\partial \Phi_i} < 0, \qquad \text{if } \Phi_i > \varphi_i. \tag{21}$$

The case shown in (20), which yields a positive substitution effect, implies a negative income effect. We can, then, conclude that the signs of the Slutsky equations (13), (15) and (17) are indeterminate. The same result is true for the Slutsky equations (14), (16) and (18), where the substitution effect is negative while the income effect is positive. From the discussion above it now follows that in general the total effect of changes in the parameters of the model cannot be determined without further assumptions regarding the relative magnitudes of substitution and income effects.

3. The Public Sector

The government is assumed to choose the parameters of the tax system so as to maximize the welfare of its residents. Since this is a model of labor mobility in which individuals can allocate time between two countries, we need to specify what we mean by residency. That is, should the government maximize the utility of its citizens regardless of where they live ? In a model of tax competition one may perceive that the utility of individuals is allowed in the welfare function regardless of residence. The

home country, then, would engage in a battle with the foreign country to attract the optimal number of taxpayers. Such a situation is quite similar to the median voter model where tax policy is designed to attract the optimal size of voters.

The perspective of this paper, however, is different. We assume that the tax policy of the foreign country is given exogenously. The game theoretic aspect of tax competition, therefore, vanishes and the sole problem is to define whose utility to maximize. In the literature on migration and income taxation the most common way to solve this problem is by maximizing the utility of those left behind [Bhagwati and Hamada (1989)]. In the traditional formulation, those left behind are assumed to be a constant fraction of the population invariant to changes in tax parameters. Implicitly, the assumption is that whatever policies lead to migration, no tax policy will ever make the whole population migrate. In itself this is a strong assumption.

We will not adopt the conventional approach to the social welfare function. Instead, we let each individual count in the welfare function according to the amount of time he spends in the home country. The welfare weight may then be seen as emphasizing seniority over the life span of a consumer or simply reflect the choice of each consumer at a certain point in time. Thus, the social welfare function can be written as

$$W = \sum_i t_i V^i(\cdot). \tag{22}$$

The use of time spent at home as the welfare weight is appealing since it takes into account features from real life. In some countries a person looses his voting right if he stays abroad too long. Although the loss of voting rights in real life happens instantaneously, the model mimics real life fairly well by reducing the influence of a person.

Another implication of the choice of welfare weight is that it varies with different sets of tax parameters. If we were to compare say the average welfare of individuals' under one set of taxes to that under another set of taxes, we would in fact compare different subsets of the population. The two subsets, therefore, are not comparable. If the purpose of our study were to make such comparisons, this would certainly be a weakness of the model. Our task, however, is to characterize optimal tax rates. Using t_i as the welfare weight, therefore, seems reasonable.[1]

The public sector's tax budget constraint requires that total tax revenue be zero,

$$R(\beta, a, b) = \sum_i \left[(1-\beta) w_i \varphi_i t_i - t_i a - b\right] = 0. \tag{23}$$

The optimization problem can now be formulated by means of the Lagrangian

$$\Delta = W + \mu\left[R(\beta, a)\right],$$

where the first order conditions are given by[2]

$$\frac{\partial \Delta}{\partial \beta} = \sum_i V^i \frac{\partial t_i}{\partial \beta} + \sum_i w_i \lambda_i \varphi_i t_i^2 + \mu(1-\beta)\sum_i w_i \varphi_i \frac{\partial t_i}{\partial \beta} - \mu \sum_i w_i \varphi_i t_i - \mu a \sum_i \frac{\partial t_i}{\partial \beta} = 0. \tag{24}$$

$$\frac{\partial \Delta}{\partial a} = \sum_i V^i \frac{\partial t_i}{\partial a} + \sum_i \lambda_i t_i^2 + \mu(1-\beta) \sum_i w_i \varphi_i \frac{\partial t_i}{\partial a} - \mu \sum_i t_i - \mu a \sum_i \frac{\partial t_i}{\partial a} = 0. \tag{25}$$

$$\frac{\partial \Delta}{\partial b} = \sum_i V^i \frac{\partial t_i}{\partial b} + \sum_i \lambda_i t_i + \mu(1-\beta)\sum_i w_i \varphi_i \frac{\partial t_i}{\partial b} - \mu a \sum_i \frac{\partial t_i}{\partial b} - n\mu = 0. \tag{26}$$

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[1]The complexity introduced by a welfare weight that is not invariant to changes in tax parameters has hitherto been overlooked in the literature on taxation and migration.

[2]From the indirect utility function it is easily seen that

$\partial V/\partial \beta = \lambda_i w_i \varphi_i t_i$, $\partial V/\partial a = \lambda_i t_i$, $\partial V/\partial b = \lambda_i$, where λ is the Lagrange multiplier.

In what follows it seems useful to organize the discussion of optimal tax rates from two different perspectives. The first relates to the optimum income tax when a uniform lump sum transfer is used. We know from theory that there is a distortion associated with any redistribution of income from the more able to the less able. The distortion arises since the government does not have at its disposal the information required to make specific lump sum redistributions. The inherent distortion in redistributive tax policies give rise to an equity – efficiency trade off. Our first task, therefore, is to examine this trade off when the optimal marginal rate of tax is used in combination with a uniform lump sum transfer.

The second perspective concerns the optimal marginal rate of tax when the government prefers the use of a uniform social insurance transfer to the lump sum transfer. The social insurance differs from the lump sum transfer by depending on time spent domestically and is, therefore, distortionary. From an equity point of view, the redistributive impact of the social insurance transfer is not clear. If ability is positively correlated to time spent domestically, then, the social insurance transfer is a poor redistributive device. A priori one would expect the optimal tax rate to entail some correction formula which deals with the ambiguity of the social insurance transfer as a redistributive device. From the perspective of tax policy, the use of a time dependent transfer is interesting since it (a) clearly is feasible, and (b) may provide an answer to whether the inclusion of a social insurance transfer impose less of a burden on the optimal income tax than does the uniform lump sum transfer.

To arrive at our first optimal tax formulae we multiply (26) by $\Sigma_i(w_i\,\varphi_i\,t_i)/n^2$ and divide (24) by n. Note that since $a = 0$, (25) is eliminated as well as the two last terms in (24) and (26).

Subtracting (26) from (24) we obtain

$$\left(\frac{\sum_i V^i \frac{\partial t_i}{\partial \beta}}{n} - \frac{\sum_i V^i \frac{\partial t_i}{\partial b}}{n} \cdot \frac{\sum_i w_i \varphi_i t_i}{n}\right) + \left(\frac{\sum_i w_i \lambda_i \varphi_i t_i^2}{n} - \frac{\sum_i \lambda_i t_i}{n} \cdot \frac{\sum_i w_i \varphi_i t_i}{n}\right)$$

$$+ \mu(1-\beta)\left(\frac{\sum_i w_i \varphi_i \frac{\partial t_i}{\partial \beta}}{n} - \frac{\sum_i \frac{\partial t_i}{\partial b} w_i \varphi_i}{n} \cdot \frac{\sum_i w_i \varphi_i t_i}{n}\right) = 0. \qquad (27)$$

Consider first the case when all individuals are equal, that is, $\lambda_i = \lambda$, $w_i = w$, $\varphi_i = \varphi$, and $\Phi_i = \Phi$ for all i. By equation (27) – using the Slutsky equation (13) – we obtain

$$(1-\beta) = -\frac{V}{\mu w \varphi}. \qquad b = -\frac{V}{\mu} \cdot t + \frac{R}{n}. \qquad \lambda = \frac{\mu}{t}. \qquad (28)$$

Quite unexpected, then, the optimal tax policy when individuals are equal entails the use of both the income tax and the lump sum transfer. In particular, the home country should subsidize work domestically through the income tax in combination with a uniform lump sum tax. This result has a very natural interpretation. Since the social welfare function maximizes the individual's indirect utility function weighted by time spent domestically, social welfare is increased by inducing the consumer to spend more time domestically. Thus, work should be subsidized. If the government budget is to be balanced, tax revenue must be collected in the most efficient way. As a consequence, a lump sum tax is levied which is neutral with respect to the individuals marginal evaluation of time spent domestically.

Note that this conclusion hinges on the assumption that the utility of the consumer is positive ($V > 0$). If his utility is negative, then, the policy recommendations are reversed. The the consumer should now be taxed so as to minimize his stay in the home country. Obviously, the equivocal impact of tax policy is a weakness of the model and

due to the endogenous welfare weight. To avoid the problem, it is necessary to restrict the utility of individuals to positive values. This is a strong assumption. The problem with endogenous welfare weights, however, is inherent in the whole literature on migration and can only be avoided by having constants as welfare weights. The difficulty with this approach is that one has to find a social criterion for setting the welfare weight – for example, by defining a part of the population spending sufficient time domestically regardless of tax policy to be included in the social welfare function – i.e. one adopts the principle of maximizing the utility of those left behind. Clearly, this approach has some major conceptual difficulties as well. Using constants as welfare weights, the optimal choice for raising tax revenue is to set $\beta = 1$, $\alpha = R/n$ and $\mu = \lambda$. Thus, the externality from endogenous welfare weights that yielded distortionary taxation disappears and the conventional result from the closed economy case appears (Dixit and Sandmo (1977)).

To proceed, we simplify the notation and the interpretation of the next formula by using Diamond's definition of the social marginal utility of income γ, as

$$\gamma_i \equiv \lambda_i t_i + \frac{\partial t_i}{\partial b}\left[V^i + \mu((1-\beta)w_i \varphi_i\right]. \tag{29}$$

The social marginal utility of income to individual i is simply the gain in social welfare from provision of an additional unit non–labor income. The welfare gain can be divided into two effects, a direct and an indirect. The direct effect is, $\lambda_i t_i$, which is the private marginal value of income evaluated by the welfare weight. The indirect effects are caused by the induced change in allocation of time due to the marginal increase in non–labor income. They are; $\frac{\partial t_i}{\partial b} \cdot V^i$, which is the marginal effect on social utility following the change in the welfare weight, and $\frac{\partial t_i}{\partial b}\mu(1-\beta)w_i \varphi_i$, which is the induced

change in tax revenue valued at the marginal utility of income to the government.

Substituting the Slutsky equation (13) into (27) and solving for $(1-\beta)$, the optimal tax formula for the marginal tax rate can be written as [3]

$$(1-\beta) = -\frac{1}{\mu} \cdot \frac{\sum_i \frac{\partial \hat{t}_i}{\partial \beta} V^i}{\sum_i \frac{\partial \hat{t}_i}{\partial \beta} w_i \varphi_i} - \frac{1}{\mu} \cdot \frac{cov\ (w_i \varphi_i t_i, \gamma_i)}{\frac{\sum_i \frac{\partial \hat{t}_i}{\partial \beta} w_i \varphi_i}{n}}. \tag{30}$$

Note that the solution is not explicit since β appears on both sides. We can, however, still gain some useful insights. The right hand side consists of two terms, both denoting the equity – efficiency tradeoff. The denominator in both terms is the same and reflects the efficiency concern which is the average compensated reduction in time spent domestically measured in efficiency units. The equity concern in the last term is the covariance between domestic labor income and the social marginal utility of income. In general one would expect the covariance term to be negative. The numerator in the first term is the average effect on social indirect utility from a compensated change in the welfare weight. This term is specific to the open economy model in the sense that it is an equity formula necessitated by the use of a tax dependent and residence based welfare weight. As we have already noted, the substitution effect $(\partial \hat{t}/\partial \beta)$, is of indeterminate sign in this model unless $\Phi < \varphi$, in which case the substitution effect is positive. Since the substitution effect appears in both the numerator and the denominator, the first term is of negative sign and, ceteris paribus, this is an argument in favor of decreased taxation.

If we had chosen constants as welfare weights – as in the traditional literature – the

[3]See appendix A for the transition.

first term would vanish, leaving only the last term behind. The optimal tax formula then becomes almost similar to the optimal tax formula found by Dixit and Sandmo (1977, eq. (16)), in a model for a closed economy. The difference between the two models, then, is that the substitution effects in the open economy model are expressed in terms of time and not labor, as is the case in the model by Dixit and Sandmo. It seems reasonable to assume that the substitution effects are higher in the open economy case implying lower taxes.

Turning to the case when the government uses a time dependent social insurance transfer, equation (22) is eliminated. As in the case of the uniform lump sum transfer, we can simplify the notation by defining $\tilde{\gamma}_i$ as the social marginal utility of income to individual i, hence

$$\tilde{\gamma}_i \equiv \lambda_i t_i - \mu + \frac{\partial t_i}{\partial b}\left[V^i + \mu(1-\beta)w_i\varphi_i - \mu a\right]. \tag{31}$$

Compared to the definition in (29), the social marginal utility is slightly altered. In addition to the previous formula we must now also account for the cost of providing the social insurance transfer μ, as well as the induced change in tax revenue $\frac{\partial t_i}{\partial b}a$, from the social insurance transfer valued at the marginal cost of providing public funds.

To derive the optimal tax formula we multiply (25) by $\Sigma_i(w_i\varphi_i)/n^2$, and divide (24) by n. We then subtract the latter from the former using the Slutsky equations to obtain the optimal tax formula[4]

[4]The transition has been relegated to Appendix B to leave the text as uncluttered as possible.

$$(1-\beta) = \frac{\frac{1}{n}\sum_i \left[\frac{\partial \hat{t}_i}{\partial \beta}\ (\mu a - V^i)\right]}{E} + \frac{\frac{1}{n^2}\sum_i w_i\ \varphi_i \sum_i \left[\frac{\partial \hat{t}_i}{\partial a}\ (V^i - \mu a\ )\right]}{E}$$

$$- \frac{cov(w_i\ \varphi_i\ ,\ t_i\ \tilde{\gamma}_i)}{E}, \qquad (32)$$

where we have defined E as

$$E \equiv \mu\left(\frac{1}{n}\sum_i w_i \varphi_i \cdot \frac{\partial \hat{t}_i}{\partial \beta} - \frac{1}{n^2}\sum_i w_i \varphi_i \cdot \frac{\partial \hat{t}_i}{\partial a} \cdot \sum_i w_i \varphi_i\right). \qquad (33)$$

The optimal marginal rate of tax now consists of three terms, all reflecting an equity – efficiency trade off. As previously, the denominator denotes the efficiency concern and is the same for all three terms. The efficiency concern now also takes into account the distortion imposed by the social insurance transfer and is made up of an averaged difference between the compensated substitution effect of the tax rate and the social insurance transfer. A priori, one would expect the substitution effects to have the same sign. If they do, then, from (33) we see that the two effects are counteracting. Note that a decrease in the tax rate and an increase in the social insurance transfer both induces the consumer to spend more time domestically. Thus, to minimize the total distortion induced by taxation, the two effects should be opposing.

The equity concern as portrayed in the numerator of the last term on the right hand side is almost similar to the previous tax formula. The numerator is now the covariance between the wage rate measured in terms of the working requirement and the social marginal utility of income weighted by domestic time. It is very difficult to say whether the new way of expressing the covariance term implies a higher or lower

covariance than in the previous case. The change, however, should not alter the sign which is presumed to be negative.

The numerators in the two first terms on the right hand side are equity effects and measure the average net effect on social welfare from a compensated change in time spent domestically. As already noted, the substitution effects $(\partial \hat{t}/\partial \beta)$ and $(\partial \hat{t}/\partial a)$ are of indeterminate sign but are expected to have the same sign making the terms counteracting. It is difficult to say whether the sum of the two first terms leads to a reduction in the optimal tax rate. If $(\mu a - V^i)$ is positive and the magnitude of the two substitution effects are the same, one would expect the second term to overtake the first term, thus, making the sum negative. Ceteris paribus, this is an argument in favor of lowering the optimal marginal rate of tax. In general, however, the result is indeterminate. A special case occurs if the two first terms cancel and only the last term remains. The optimal tax formula, then, again inherits the same structure as that found by Dixit and Sandmo (1977, eq. (16)).

An interesting question arises as to whether the use of a time dependent welfare weight leads to a lower marginal tax rate than a uniform lump sum transfer. In contrast to the lump sum transfer, the social insurance transfer allows the government to differentiate the transfer between individuals based on time spent in the home country. However, since this differentiation is not based on ability to pay higher taxes, it may not be a very good redistributive device. By examining the optimal tax formulae in (30) and (32), it seems difficult to argue that one tax formula leads to a higher optimal rate of tax than the other. This conclusion may be disappointing but hardly surprising seen in the context of other results in the optimal taxation literature.

4. Concluding Remarks

The purpose of this paper has been twofold. First, we have developed a model where labor is internationally mobile and examined some comparative static results. Second, the analysis has examined how a linear income tax should be set optimally when individuals can choose between countries where to work.

The model we have constructed is in line with conventional labor supply models where each individual decides where to work based on his preferences for leisure and consumption. The focal point of the model has been on an interior solution in which after tax economic compensation and working hours are such as to induce the consumer to work both abroad and at home. Such international flexibility is not common among individuals but are true for certain types of highly skilled workers. The model constructed suppresses many features which may be relevant to individuals who are internationally mobile. One weakness of the model is that it does not take into account moving costs or cultural differences between countries. Another weakness it that the relative size of the public sector in a country does not matter for labor mobility. Obviously, an extension of the model would be to allow the size of the welfare state to influence the consumers choice of residency.

The second objective of the paper has been to find a formula for the optimal marginal tax rate which highlights some of the problems encountered when labor is internationally mobile. We assume that the government does not have at its disposal the information required to make specific lump sum distributions, thus, the analysis studies the equity – efficiency trade off from two different perspectives. In the first, the government uses a uniform lump sum transfer in connection with the linear rate of tax, while in the second, a residency based social insurance transfer is used instead of the lump sum transfer. The latter approach makes it possible for the government to

distinguish between individuals based on how much time they spend domestically. The time dependent social insurance transfer, however, may not be a good redistributive tool since ability to pay taxes is not necessarily positively correlated to time spent domestically. Our examination of the optimal marginal rates of tax is inconclusive as to whether one type of redistribution policy impose less of a burden on the income tax than does the other.

Appendix A

We here derive the first best solution using (24) and (26). We multiply (26) by $\Sigma_i(w_i \varphi_i t_i)/n^2$ and divide (24) by n. Subtracting (26) from (24) we obtain

$$(A1)\quad \left(\frac{\sum_i V^i \frac{\partial t_i}{\partial \beta}}{n} - \frac{\sum_i V^i \frac{\partial t_i}{\partial b}}{n} \cdot \frac{\sum_i w_i \varphi_i t_i}{n}\right) + \left(\frac{\sum_i w_i \lambda_i \varphi_i t_i^2}{n} - \frac{\sum_i \lambda_i t_i}{n} \cdot \frac{\sum_i w_i \varphi_i t_i}{n}\right)$$

$$+ \mu(1-\beta)\left(\frac{\sum_i w_i \varphi_i \frac{\partial t_i}{\partial \beta}}{n} - \frac{\sum_i \frac{\partial t_i}{\partial b} w_i \varphi_i}{n} \cdot \frac{\sum_i w_i \varphi_i t_i}{n}\right) = 0.$$

Using the Slutsky equation $\frac{\partial t_i}{\partial \beta} = \frac{\partial \hat{t}_i}{\partial \beta} + w_i \varphi_i t_i \frac{\partial t_i}{\partial b}$, and denoting $\frac{\partial \hat{t}_i}{\partial \beta} \equiv s_i$, we rewrite the expression as.

$$(A2)\quad \left(\frac{\sum_i ((s_i + w_i \varphi_i t_i \frac{\partial t_i}{\partial b}) V^i)}{n} - \frac{\sum_i V^i \frac{\partial t_i}{\partial b}}{n} \cdot \frac{\sum_i w_i \varphi_i t_i}{n}\right) + cov(w_i \varphi_i t_i, \lambda_i t_i)$$

$$+ \mu(1-\beta)\left(\frac{\sum_i (w_i \varphi_i (s_i + w_i \varphi_i t_i \frac{\partial t_i}{\partial b}))}{n} - \frac{\sum_i \frac{\partial t_i}{\partial b} w_i \varphi_i}{n} \cdot \frac{\sum_i w_i \varphi_i t_i}{n}\right) = 0.$$

Rearranging the terms in the big brackets we obtain

$$(A3)\quad \left(\frac{\sum_i s_i V^i}{n} + \frac{\sum_i w_i \varphi_i t_i \frac{\partial t_i}{\partial b} V^i}{n} - \frac{\sum_i V^i \frac{\partial t_i}{\partial b}}{n} \cdot \frac{\sum_i w_i \varphi_i t_i}{n}\right) + cov(w_i \varphi_i t_i, \lambda_i t_i)$$

$$+ \mu(1-\beta)\left(\frac{\sum_i w_i \varphi_i s_i}{n} + \frac{\sum_i w_i \varphi_i t_i \frac{\partial t_i}{\partial b} w_i \varphi_i}{n} - \frac{\sum_i \frac{\partial t_i}{\partial b} w_i \varphi_i}{n} \cdot \frac{\sum_i w_i \varphi_i t_i}{n}\right) = 0.$$

This expression can be rewritten as

$$(A4) \qquad \left(\frac{\sum_i s_i V^i}{n} + cov(w_i \varphi_i t_i, V^i \frac{\partial t_i}{\partial b})\right) + cov(w_i \varphi_i t_i, \lambda_i t_i)$$

$$+ \mu(1-\beta)\left(\frac{\sum_i w_i \varphi_i s_i}{n} + cov(w_i \varphi_i t_i, w_i \varphi_i \frac{\partial t_i}{\partial b})\right) = 0.$$

Combining the covariance terms we obtain

$$(A5) \qquad \frac{\sum_i s_i V^i}{n} + \mu(1-\beta)\frac{\sum_i w_i \varphi_i s_i}{n} + cov(w_i \varphi_i t_i, \gamma_i) = 0,$$

where $\gamma_i \equiv \lambda_i t_i + \frac{\partial t_i}{\partial b}\left[V^i + \mu((1-\beta) w_i \varphi_i\right]$.

Solving for $(1-\beta)$, the optimal tax formula becomes

$$(A6) \qquad (1-\beta) = -\frac{1}{\mu} \cdot \frac{\sum_i \frac{\partial \hat{t}_i}{\partial \beta} V^i}{\sum_i \frac{\partial \hat{t}_i}{\partial \beta} w_i \varphi_i} - \frac{1}{\mu} \cdot \frac{cov\ (w_i \varphi_i t_i, \gamma_i)}{\frac{\sum_i \frac{\partial \hat{t}_i}{\partial \beta} w_i \varphi_i}{n}}.$$

Appendix B

To derive the optimal tax formula we multiply (25) by $\Sigma_i(w_i \varphi_i)/n^2$, and divide (24) by n.

$$(B1) \qquad \left[\frac{\Sigma_i V^i \frac{\partial t_i}{\partial \beta}}{n} - \frac{\Sigma_i V^i \frac{\partial t_i}{\partial a}}{n} \cdot \frac{\Sigma_i w_i \varphi_i}{n}\right] + \left[\frac{\Sigma_i w_i \lambda^i \varphi_i t_i^2}{n} - \frac{\Sigma_i w_i \varphi_i}{n} \cdot \frac{\Sigma_i \lambda^i t_i^2}{n}\right]$$

$$+ \mu(1-\beta)\left[\frac{\Sigma_i w_i \varphi_i \frac{\partial t_i}{\partial \beta}}{n} - \frac{\Sigma_i w_i \varphi_i}{n} \cdot \frac{\Sigma_i w_i \varphi_i \frac{\partial t_i}{\partial a}}{n}\right] - \mu\left[\frac{\Sigma_i w_i \varphi_i t_i}{n} - \frac{\Sigma_i w_i \varphi_i}{n} \cdot \frac{\Sigma_i t_i}{n}\right]$$

$$- \mu a\left[\frac{\Sigma_i \frac{\partial t_i}{\partial \beta}}{n} - \frac{\Sigma_i w_i \varphi_i}{n} \cdot \frac{\Sigma_i \frac{\partial t_i}{\partial a}}{n}\right] = 0.$$

Substituting the Slutsky equations (13) and (15) into (1), and rearranging, we obtain

$$(B2) \qquad \left[\frac{\Sigma_i (V^i (\frac{\partial \hat{t}_i}{\partial \beta} + w_i \varphi_i t_i \frac{\partial t_i}{\partial b}))}{n} - \frac{\Sigma_i (V^i (\frac{\partial \hat{t}_i}{\partial a} + t_i \frac{\partial t_i}{\partial b}))}{n} \cdot \frac{\Sigma_i w_i \varphi_i}{n}\right]$$

$$+ cov(w_i \varphi_i, \lambda_i t_i^2) - \mu cov(w_i \varphi_i, t_i)$$

$$+ \mu(1-\beta)\left[\frac{\Sigma_i (w_i \varphi_i (\frac{\partial \hat{t}_i}{\partial \beta} + w_i \varphi_i t_i \frac{\partial t_i}{\partial b}))}{n} - \frac{\Sigma_i w_i \varphi_i}{n} \cdot \frac{\Sigma_i (w_i \varphi_i (\frac{\partial \hat{t}_i}{\partial a} + t_i \frac{\partial t_i}{\partial b}))}{n}\right]$$

$$- \mu a\left[\frac{\Sigma_i (\frac{\partial \hat{t}_i}{\partial \beta} + w_i \varphi_i t_i \frac{\partial t_i}{\partial b})}{n} - \frac{\Sigma_i w_i \varphi_i}{n} \cdot \frac{\Sigma_i (\frac{\partial \hat{t}_i}{\partial a} + t_i \frac{\partial t_i}{\partial b})}{n}\right] = 0.$$

By rearranging the big brackets and combining the covariance terms we obtain

$$(B3) \qquad \left[\frac{\sum_i V_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i V_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n} + \frac{\sum_i V_i w_i \varphi_i t_i \frac{\partial t_i}{\partial b}}{n} - \frac{\sum_i w_i \varphi_i}{n} \cdot \frac{\sum_i V_i t_i \frac{\partial t_i}{\partial b}}{n}\right]$$

$$+ cov(w_i \varphi_i, t_i(\lambda_i t_i - \mu))$$

$$+ \mu(1-\beta)\left[\frac{\sum_i w_i \varphi_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i w_i \varphi_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n} + \frac{\sum_i w_i \varphi_i t_i \frac{\partial t_i}{\partial b}\ w_i \varphi_i}{n} - \frac{\sum_i w_i \varphi_i}{n} \cdot \frac{\sum_i w_i \varphi_i t_i \frac{\partial t_i}{\partial b}}{n}\right]$$

$$- \mu a\left[\frac{\sum_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n} + \frac{\sum_i w_i \varphi_i t_i \frac{\partial t_i}{\partial b}}{n} - \frac{\sum_i w_i \varphi_i}{n} \cdot \frac{\sum_i t_i \frac{\partial t_i}{\partial b}}{n}\right] = 0.$$

Equation (*B3*) can be further simplified by realizing that some of the terms in the big brackets can be expressed as covariance terms. Thus

$$(B4) \qquad \left[\frac{\sum_i V_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i V_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n} + cov(w_i \varphi_i, t_i V_i \frac{\partial t_i}{\partial b})\right] + cov(w_i \varphi_i, t_i(\lambda_i t_i - \mu))$$

$$+ \mu(1-\beta)\left[\frac{\sum_i w_i \varphi_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i w_i \varphi_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n} + cov\,(w_i \varphi_i,\ w_i \varphi_i t_i \frac{\partial t_i}{\partial b})\right]$$

$$- \mu a\left[\frac{\sum_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n} + cov(w_i \varphi_i, t_i \frac{\partial t_i}{\partial b})\right] = 0.$$

We define

$$\tilde{\gamma}_i \equiv \left[(\lambda_i t_i - \mu) + \frac{\partial t_i}{\partial b}\left[V_i + \mu(1-\beta) w_i \varphi_i - \mu a\right]\right],$$

as the social marginal utility of income to individual *i* from time spent domestically. Combining all the covariance terms we have

$$(B5)\qquad \left[\frac{\sum_i V_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i V_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n}\right] + \mu(1-\beta)\left[\frac{\sum_i w_i \varphi_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i w_i \varphi_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n}\right]$$

$$- \mu a\left[\frac{\sum_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n}\right] + cov(w_i \varphi_i,\ t_i \tilde{\gamma}_i) = 0.$$

Rearranging,

$$(B6)\qquad \mu(1-\beta)\left[\frac{\sum_i w_i \varphi_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i w_i \varphi_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n}\right] = \mu a\left[\frac{\sum_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n}\right]$$

$$- \left[\frac{\sum_i V_i \frac{\partial \hat{t}_i}{\partial \beta}}{n} - \frac{\sum_i V_i \frac{\partial \hat{t}_i}{\partial a}}{n} \cdot \frac{\sum_i w_i \varphi_i}{n}\right] - cov(w_i \varphi_i,\ t_i \tilde{\gamma}_i).$$

Solving for $(1-\beta)$,

$$(1-\beta) = \underbrace{\frac{1}{n}\sum_i \left[\frac{\partial \hat{t}_i}{\partial \beta}\ (\mu a - V^i)\right]}_{E} + \underbrace{\frac{1}{n^2}\sum_i w_i\ \varphi_i \sum_i \left[\frac{\partial \hat{t}_i}{\partial a}\ (V^i - \mu a)\right]}_{E}$$

$$- \underbrace{\frac{cov(w_i\ \varphi_i\ ,\ t_i\ \tilde{\gamma}_i)}{E}}_{},$$

where we have defined E as

$$E \equiv \mu\left(\frac{1}{n}\sum_i w_i \varphi_i \cdot \frac{\partial \hat{t}_i}{\partial \beta} - \frac{1}{n^2}\sum_i w_i \varphi_i \cdot \frac{\partial \hat{t}_i}{\partial a} \cdot \sum_i w_i \varphi_i\right)$$

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Chapter 6

TAX DEDUCTION VERSUS TAX CREDIT: THE CASE OF THE MULTINATIONAL FIRM*

Abstract

This paper explores how the tax deduction scheme as opposed to the tax credit scheme affects the behavior of a multinational firm. The paper demonstrates that: (1) the double taxation implied by the tax deduction system does not necessarily impose more of an anti–trade bias than does the tax credit system, (2) under the tax deduction scheme, a government cannot influence the behavior of the firm and, thus, induces a fiscal externality upon itself, (3) domestic and foreign tax policy have real effects when the tax credit is applied – these effects are shown to depend on the first order condition for trade between the parent firm and its foreign subsidiary.

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TAX DEDUCTION VERSUS TAX CREDIT: THE CASE OF THE MULTINATIONAL FIRM

1. Introduction

In a world with free mobility of goods and factors, differences in national tax systems can have substantial effects on the volume and pattern of international trade and, thus, on nations' welfare. Most countries allow domestic firms to credit foreign taxes paid against the domestic tax liability falling on foreign source income rather than simply to deduct them as costs from taxable income. From a world perspective, the question arises as to which tax system is preferred – the tax credit scheme or the tax deduction scheme.

Musgrave (1969) concludes that capital exporting countries will prefer the tax deduction system despite the double taxation on foreign source income that it implies. He argues that the tax credit scheme is inferior since it surrenders more tax revenue to the foreign country. Hamada (1966) finds that two countries, one investing in the other are both better off under the tax credit system due to the efficient allocation of capital under this scheme. More recently, Bond and Samuelson (1989) examine the two tax schemes in a tax–setting game played by a capital exporting and a capital importing country. They find, however, that both countries prefer tax deduction to tax credit due to strategic forces arising in this game. These works all examine the question purely from a macro point of view, that is, from the perspective of countries. Because the microeconomics of the firm has been neglected, these studies are all carried out under the conventional assumption that the tax deduction scheme introduces an anti–trade bias because traded capital is subjected to double taxation.

This paper addresses whether the tax deduction system really leads to an anti–trade bias. To answer such a question one cannot examine countries but their agents – the behavior of multinational firms. A simple model of a monopolistic firm selling to two national markets simultaneously is used to examine the effects of the tax deduction versus the tax credit system. Specifically, the objectives are twofold. The first is to characterize the optimal strategy of the firm when faced with different ways of alleviating double taxation. Does the tax deduction scheme induce the parent to export less goods to the foreign subsidiary than does the tax credit scheme ? The second is to examine the effects of the tax deduction and the tax credit scheme from the perspective of a nation and, to determine whether firms respond differently to tax policy under the two tax schemes.

2. *The Analytical Framework*

The model to be employed is based on Horst (1971) and analyses a multinational firm's choice of production levels, exports and transfer price between two countries called the home and the foreign country. We assume that the firm is the sole owner of the production plants in both countries. Capital letters denote variables pertaining to the foreign subsidiary. We shall postpone the introduction of taxes and systems of taxing foreign source income until later and first outline the basic features of the model.

The multinational firm produces and sells a single product to two different countries. The firm is a monopolist in both markets. Revenue and cost considerations are such that the firm exports part of its production in the home country, z, to the foreign country, and sets a transfer price, p, per unit on the exported quantity. The foreign country levies an ad valorem tariff, τ, on its import. Sales in each country (y, Y)

depend only on the prices (q, Q) charged, so, $y = y(q)$ and $Y = Y(Q)$. Amounts of production are denoted (x, X), and the cost functions are given by $c(x)$ and $C(X)$. We assume that the firm faces increasing marginal costs of production. Total revenue in each country is given by $r(x - z) = yq$ and $R(X + z) = YQ$. The profit functions are written as

$$\pi = r(x - z) - c(x) + pz. \tag{1}$$

$$\Pi = R(X + z) - C(X) - p(1 + \tau)z. \tag{2}$$

To simplify the analysis we will not distinguish between profit taxes and dividend taxes, but assume that all dividends must be repatriated immediately to the home country. Hence, the corporate and the dividend tax can be consolidated into a single effective rate of taxation denoted (t, T).

There are two jurisdictional principles for taxing international income, the source principle and the residence principle. Under the source principle income is only taxed within the jurisdiction it originates. The residence principle in contrast, subjects the taxpayer to taxation in the country of residence on all his income regardless of geographic source. Most countries apply the residence principle and the focus of this paper will be on residence taxation when dividends are repatriated immediately.[1] Since income earned abroad is often taxed at source as well as in the country of residence, double taxation occurs. There are three policy tools that tax authorities can apply to alleviate double taxation; a tax credit, tax exemption and tax deduction. The tax exemption method – just as the name indicates – exempts foreign source income from

[1]In Europe, all countries except France and the Netherlands apply the residence principle. France exempt from taxation foreign source income if it is derived by a french owned permanent establishment. Dutch owned foreign subsidiaries are also tax exempt if they represent an investment effectively linked with the business of the parent company and satisfy certain equity requirements (see Giovannini (1990)).

taxation in the country of residence. It is a special case of the tax credit and will not be treated separately.

3. The Tax Credit System

The tax credit scheme is the most common way of alleviating double taxation on repatriated foreign earnings. Under the tax credit scheme, the firm can credit foreign taxes paid ($T\Pi$) against the domestic tax liability falling on the foreign source income ($t\pi$). Thus, total tax liability to the home country becomes ($t\pi - T\Pi$). In most countries the maximum allowable tax credit is the tax applied to the foreign income at the home tax rate. As a consequence, the firm pays the highest of the foreign or the domestic tax rate on its foreign source profits, and two different global after tax profit functions arise,

$$V = \pi - t\pi + \Pi - T\Pi - (t - T)\Pi,$$
$$= (1 - t)(\pi + \Pi), \qquad \text{if } t \geqq T, \qquad (3)$$

$$V = (1 - t)\pi + (1 - T)\Pi, \qquad \text{if } t < T. \qquad (4)$$

The firm's maximization problem can be thought of as a sequential process where the firm first finds the optimal transfer price and, then, given this price, decides on its production and export levels. The two conditions for a positive optimal transfer price are

$$\frac{\partial V}{\partial p} = z(1 - t)\left[-\tau\right] > 0, \qquad \text{if } t \geqq T. \qquad (5)$$

$$\frac{\partial V}{\partial p} = z(1 - T)\left[\frac{(T - t)}{(1 - T)} - \tau\right] > 0, \qquad \text{if } t < T. \qquad (6)$$

The results in (5) and (6) are both well known from Horst (1971). Equation (5) states that when domestic and foreign income are subject to the same tax rate, transfer pricing is never profitable if the tariff is positive. In this case the firm will choose the lowest possible transfer price. Condition (6) indicates that when the term in the big bracket is positive, that is, if the relative differential in tax rates between the importing and the exporting country is greater than the importing country's tariff, the firm will always choose the highest possible transfer price.[2] Hence, transfer pricing is only profitable when domestic and foreign income carry different effective rates of tax.

Extremely high transfer prices are rarely observed in real life. How, then, is the transfer price determined? The transfer pricing problem is the foreign government's choice of a rule for pricing traded goods between related parties. Income arising out of transactions by related parties are often determined on an arm's length basis, that is, as if the parties were not related. In this model, one possibility of finding an arm's length price is to assume that the foreign government can observe the price charged in the domestic market. There are, however, many reasons why this assumption may not hold. For example, the parent firm may be able to at no cost attach a cosmetic feature to goods exported so that they appear as different goods. Alternatively, the parent firm could channel exports through a third firm not recognized by tax authorities as linked with the parent firm. Since the possibilities offered to the firm of masking the real price of the good exported are many, a more realistic assumption seems to be that the foreign government only imperfectly can observe the domestic price. However, for the purpose of this model, it does not seem useful to incorporate mechanisms for determining the transfer price. To simplify the model, therefore, and in accordance with most of the

[2]Kant (1988a, 1988b) and Samuelson (1982) have examined how high a profitable transfer price is, while Hines (1990) explores various ways of inducing the firm to set the proper transfer price from the perspective of the government.

literature, it is assumed that the transfer price is positive and that an upper bound exists given by government rules and regulations.

Provided that the ad valorem tariff is positive, it follows from (5) and (6) that transfer pricing occurs when $t \leqq T$. The global after tax profit function in this case is

$$V = (1 - t)\left[r(x - z) - c(x) + pz\right] + (1 - T)\left[R(X + z) - C(X) - p(1 + \tau)z\right].$$

The first order conditions with respect to x, X and z, are

$$\frac{\partial V}{\partial x} = (1 - t)\left[r'(x - z) - c'(x)\right] = 0. \tag{7}$$

$$\frac{\partial V}{\partial X} = (1 - T)\left[R'(X + z) - C'(X)\right] = 0. \tag{8}$$

$$\frac{\partial V}{\partial z} = (1 - t)\left[p - r'(x - z)\right] + (1 - T)\left[R'(X + z) - p(1 + \tau)\right] = 0, \tag{9}$$

where the primes denote derivatives.

Equations (7) and (8) state that the firm decides its production level in each country by equating marginal revenue to marginal costs. Note that the optimal level of production in each country is a function of the level of exports since marginal revenue changes when exports change. The condition for optimal exports is given by (9). It has two interpretations. In the first, the multinational firm equates the net marginal gain of exports by the parent firm (first term) to the net marginal loss of imports by the foreign subsidiary (second term). The second interpretation is a reversal of the first. The parent firm now equates the net marginal loss from exports (first term is negative) to the net marginal gain of imports by the foreign subsidiary (second term is positive).

We assume that the second order conditions are satisfied. It can be shown that if $(r'' - c'') < 0$, $(R'' - C'') < 0$, $(r'', R'') < 0$, and $(c'', C'') > 0$, the second order conditions hold. [3]

4. The Tax Deduction System

Under the tax deduction system, the country of residence allows the multinational firm to alleviate double taxation by deducting foreign taxes paid (TΠ) against taxable income in the home country (π + Π). Tax deduction does not provide a complete relief from double taxation since part of the foreign income will be taxed twice, first in the foreign country and then, in the home country.

Formally stated, the global after tax profit function under the tax deduction system is

$$V = \pi + \Pi - t\pi - T\Pi - t(\Pi - T\Pi) = (1 - t)\left[\pi + (1 - T)\Pi\right].$$

If the multinational firm can manipulate the transfer price, it is chosen according to the sign of the expression

$$\frac{\partial V}{\partial p} = z(1 - t)\left[T - \tau(1 - T)\right]. \qquad (10)$$

The multinational firm, then, will set the transfer price as high as possible if the foreign tax rate is greater than the part of the ad valorem tariff that the firm has to cover itself. Put differently, transfer pricing occurs when the domestic tax rebate exceeds the cost of transfer pricing. Compared to the tax credit case, the transfer pricing condition depends solely on the relative size of foreign tax parameters. This induces a fiscal

[3]For a more detailed discussion of the second order conditions see appendix A.

externality on the home country if it chooses the tax deduction scheme over the tax credit scheme. The externality is seen by realizing that the foreign country by changing its tariff or tax rate, can alter the transfer pricing behavior of the firm. By doing so, the foreign country changes taxable revenue in the home country. For example, by setting the ad valorem tariff equal to the ratio of the tax rate to the after tax rate, $\tau = T/(1-T)$, the foreign country induces the firm to charge the lowest possible transfer price.[4] As a consequence, the home country gains no tax revenue from exports. Note that the fiscal externality disappear if the foreign country imposes a unit tariff on imports. The condition for a positive transfer price now becomes: $z(1-t)T > 0$, and only if the foreign country sets its corporate tax rate equal to zero can it induce the parent firm to charge the lowest possible transfer price.[5] A zero corporate rate of tax, however, is hardly a realistic alternative.

The global after tax profit function is

$$V = (1-t)\Big\{r(x-z) - c(x) + pz + (1-T)\big[R(X+z) - C(X) - p(1+\tau)z\big]\Big\}.$$

Provided transfer pricing occurs, the first order conditions with respect to x, X, and z, are[6]

$$\frac{\partial V}{\partial x} = (1-t)\big[r'(x-z) - c'(x)\big] = 0. \qquad (11)$$

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[4]It should be noted that it may not be optimal for the foreign country to set its tax parameter in such a way as to minimize the transfer price.

[5]The global after tax function of the firm in the case of a unit tariff is

$$V = (1-t)(r - c - pz + (1-T)(R - C - pz - \tau z)).$$

The condition for a positive transfer price becomes

$$\partial V/\partial p = z(1-t)T > 0.$$

[6]The second order conditions are given in appendix B.

$$\frac{\partial V}{\partial X} = (1 - T)(1 - t)\left[R'(X + z) - C'(X)\right] = 0. \tag{12}$$

$$\frac{\partial V}{\partial z} = (1 - t)\left[p - r'(x - z)\right] + (1 - t)(1 - T)\left[R'(X + z) - p(1 + \tau)\right] = 0. \tag{13}$$

Production levels are found by equating marginal revenue to marginal costs. The production decision, therefore, is in principle analog as to those found in the tax credit case. Similarly, the the condition for optimal exports (13), states that the net marginal gain from exports by the parent firm should be equal to the net marginal loss from imports by the foreign subsidiary and vice versa. As expected, the net marginal loss (gain) from importing is less in the tax deduction case since foreign source income is taxed twice, first by the foreign and then by the domestic rate of tax. Thus, by comparing (9) to (13), the analysis leads us to conclude that $z_d \neq z_c$, where subscripts c and d denote the tax credit and the tax deduction case respectively. Thus, production and sales also differ under the two tax systems.

The double taxation induced by the tax deduction scheme has lead many economists to conclude that tax deduction leads to an anti–trade bias. Moreover, tax deduction is used by some countries as a special means to prevent transfer pricing behavior by multinational firms.[7] The supposition is that tax deduction by imposing double taxation reduces the incentive by the firm to transfer income from the home country to its foreign subsidiary. In the next section we will examine this question in greater detail.

[7]The most prominent example is the Norwegian petroleum tax law which only allows multinational oil companies operating on the continental shelf to deduct foreign taxes paid against Norwegian taxable income. This contrasts the practice on the mainland where the tax credit method is granted.

5. Profit Shifting: A Numerical Example

The concern over tax arbitrage from high to low tax countries has lead some countries to apply the tax deduction method when taxing multinationals. According to conventional wisdom, the double taxation of foreign source income makes it favorable for the multinational firm to shift profits from the foreign subsidiary to the parent firm. Thus, exports and as a consequence tax revenue in the home country should be higher in the tax deduction case. To gain some insight as to whether the conventional intuition holds we must compare the conditions for optimal exports under the two schemes. Unfortunately, such an exercise does not yield any conclusive results. To proceed, therefore, we construct a numerical example to investigate which tax system lead to the highest level of tax arbitrage.

As previously, we assume that the revenue of the firm depends on the amount it chooses to supply. There is a linear inverse demand curve in both countries written as

$$q(y) = a - by, \tag{14a}$$

$$Q(Y) = A - BY, \tag{14b}$$

where (A, a) and (B, b) are constants. The revenue function in each country is now defined as

$$r(y) = q(y)y = ay - by^2 = a(x - z) - b(x - z)^2. \tag{15a}$$

$$R(Y) = Q(Y)Y = AY - BY^2 = A(X + z) - B(X + z)^2. \tag{15b}$$

To simplify the maximization problem of the firm we assume that marginal costs are constant in the foreign country and increasing in the domestic country. Thus,

$$c(x) = x^2, \tag{16a}$$

$$C(X) = KX, \tag{16b}$$

where K is a constant.

The two profit functions are given by

$$\pi = a(x - z) - b(x - z)^2 - x^2 + pz.$$

$$\Pi = A(X + z) - B(X + z)^2 - KX - p(1 + \tau)z.$$

Examining the tax credit case first, we know from above that for transfer pricing to occur, the global after tax profit function must be written as

$$V = (1 - t)\pi + (1 - T)\Pi.$$

The first order conditions for profit maximization are

$$x_c = \frac{a}{2(b + 1)} + \frac{bz_c}{(b + 1)}. \tag{17}$$

$$X_c = \frac{(A - K)}{2B} - z_c. \tag{18}$$

$$z_c = \frac{p(1 + b) - a}{2b} + \frac{(1 - T)(1 + b)(K - p(1 + \tau))}{2b(1 - t)}. \tag{19}$$

Turning to the tax deduction system, the the global after tax profit function is

$$V = (1 - t)\left[\pi + \Pi - T\Pi\right] = (1 - t)\left[\pi + (1 - T)\Pi\right].$$

The first order conditions are

$$x_d = \frac{a}{2(b + 1)} + \frac{bz_d}{(b + 1)}. \tag{20}$$

$$X_d = \frac{(A - K)}{2B} - z_d. \tag{21}$$

$$z_d = \frac{p(1 + b) - a}{2b} + \frac{(1 - T)(1 + b)(K - p(1 + \tau))}{2b}. \tag{22}$$

Subtracting (19) from (22), we obtain

$$z_c - z_d = \frac{(1 + b)(1 - T)(K - p(1 + \tau))t}{2b(1 - t)}. \tag{23}$$

The question now, is, what values we must impose on the parameters for the tax deduction system to imply the highest level of profit shifting from the foreign country to the home country. From (23) we see that exports are higher under the tax deduction scheme if the following inequality is satisfied

$$z_c < z_d \Rightarrow K < p(1 + \tau).$$

From the first order conditions (8) and (12) we know that $C'(X) = R'(Y)$ in optimum. Since $C(X) = KX$, it follows that $R'(Y) = K$. Thus, this is the case when the foreign subsidiary incurs a net marginal loss from importing ($R'(Y) < p(1 + \tau)$). Exports are higher under the tax deduction system in this case since the double taxation of foreign source income makes it profitable to reduce taxable income abroad as much as possible.

The main lesson from this example, however, cannot be carried over to the general case since it can be shown that its simplicity depends on the assumption of constant marginal costs in the foreign country.[8]. Moreover, the specific result above is reversed when $K > p(1 + \tau)$ and the subsidiary derives a net marginal gain from importing. We can, then, conclude that which tax scheme implies the highest degree of profit shifting from the foreign country to the home country is ambiguous and depends on revenue and cost considerations as well as the relative size of tax parameters. This result is rather surprising since it suggests that the total outcome on exports of any tax scheme is much more complicated than what one may be lead to believe by simply examining the plain algebra of any tax system. Of course, this is due to the complicated environment surrounding the firm.

6. The Effects of Tax Policy

In this section we compare the effects of government policies under the tax credit system and the tax deduction system. This section is organized as follows. First, we examine the effects of domestic tax policy. Then, we move on to study the impact of a change in the foreign corporate rate of tax. Finally, foreign trade policy is analyzed.

Domestic Tax Policy. Differentiating the first order conditions pertaining to the tax deduction case, we obtain[9]

The Tax Deduction System:

$$\frac{\partial x}{\partial t} = \frac{\partial X}{\partial t} = \frac{\partial z}{\partial t} = \frac{\partial y}{\partial t} = \frac{\partial Y}{\partial t} = 0. \tag{24}$$

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[8]The reader can convince himself of this by replacing the cost function $C(X) = KX$ by the cost function $C(X) = 2X^2$. Which system implies the highest level of exports will then depend on cost and revenue parameters as well as the relative size of tax parameters.

[9]The differentiation is done in appendix B.

Equation (24) states that a change in the domestic rate of tax does not influence production, sales and export levels in either country. The mechanism at work can be understood by examining the first order conditions (11), (12) and (13). Such an examination reveals that neither exports nor production are sensitive to changes in the domestic rate of tax. We can, then, conclude that the tax deduction scheme is neutral with respect to changes in the domestic corporate tax. From a strategic point of view, however, the tax deduction system induces a fiscal externality on the home country. The fiscal externality – as will be shown below – occurs since intra–firm trade, production and sales are affected by foreign tax policy under the tax deduction system. The foreign country, therefore, can set its tax rates without having to take into consideration strategic responses by the home country.

Turning to the tax credit case we study the comparative static results of a change in the domestic rate of tax by differentiating equations $(7-9)$[10]

The Tax Credit System:

$$\frac{\partial x}{\partial t} = \frac{1}{H}(1-t)(1-T)r''(R''-C'')(p-r') \qquad \begin{cases} < 0 \text{ if } (p-r') > 0 \\ > 0 \text{ if } (p-r') < 0. \end{cases} \tag{25}$$

$$\frac{\partial X}{\partial t} = -\frac{1}{H}(1-t)(1-T)R''(r''-c'')(p-r') \qquad \begin{cases} > 0 \text{ if } (p-r') > 0 \\ < 0 \text{ if } (p-r') < 0. \end{cases} \tag{26}$$

$$\frac{\partial z}{\partial t} = \frac{1}{H}(1-t)(1-T)(R''-C'')(r''-c'')(p-r') \begin{cases} < 0 \text{ if } (p-r') > 0 \\ > 0 \text{ if } (p-r') < 0. \end{cases} \tag{27}$$

$$\frac{\partial y}{\partial t} = \frac{1}{H}(1-t)(1-T)(R''-C'')(p-r')c'' \qquad \begin{cases} > 0 \text{ if } (p-r') > 0 \\ = 0 \text{ if } c'' = 0 \\ < 0 \text{ if } (p-r') < 0. \end{cases} \tag{28}$$

[10]The derivations are done in appendix A.

$$\frac{\partial Y}{\partial t} = \frac{1}{H}(1-t)(1-T)(r'' - c'')(p - r')(-C'') \quad \begin{cases} < 0 \text{ if } (p - r') > 0 \\ = 0 \text{ if } C'' = 0 \\ > 0 \text{ if } (p - r') < 0. \end{cases} \tag{29}$$

where H is the Hessian determinant ($H < 0$).

The neutrality of the tax deduction system contrasts sharply to the results under the tax credit system. From equations (25 – 29), we see that domestic tax policy has real effects. The effects depend on whether the parent firm equates its net marginal gain from exporting to the net marginal loss by the foreign subsidiary from importing or vice versa.[11] In the following we will discuss the comparative static results under these two scenarios.

(*i*) *Net Marginal Gain From Exporting.* An increase in the domestic rate of tax lowers the gain from exporting and makes the parent firm reduce the level of exports ($\partial z/\partial t < 0$). The fall in exports means that for a given level of production, more can be sold domestically and less abroad. The change in exports, therefore, necessitates an adjustment in production levels for marginal revenue to equal marginal costs. At home, the increase in sales lower marginal revenue below marginal costs while abroad, the situation is just the opposite. Thus, domestic production falls ($\partial x/\partial t < 0$) and foreign production increases ($\partial X/\partial t > 0$). Note that change in exports affects only marginal revenue while a change in production also affects marginal costs. If marginal costs are increasing, the fall in exports must exceed the change in production. As a result,

[11]Restating the first order condition for exports, equation (9), we have that

$$(1 - t)(p - r') + (1 - T)(R' - p(1 + \tau)) = 0.$$

As seen from this equation if the first term is positive, $(p - r') > 0$, that is, the parent firm derives a net marginal gain from exports, then the second term must be negative, $(R' - p(1 + \tau)) < 0$, for the first order condition to hold (and vice versa). The second term indicates the net marginal loss (gain) by the foreign subsidiary from importing.

domestic sales increase ($\partial y/\partial t > 0$) and foreign sales decrease ($\partial Y/\partial t < 0$). A special case occurs when marginal costs are constant. A change in exports are now exactly offset by the change in production and sales are unaffected.

(*ii*) *Net Marginal Loss From Exporting.* The results above are now reversed. Since the firm derives a net loss from exporting, an increase in the domestic rate of tax reduces the loss from exporting. The firm, therefore, wants to expand its exports ($\partial z/\partial t > 0$). The increase in exports means that for a given level of production, domestic sales decrease and foreign sales increase. By the same mechanism as outlined above, it now follows that domestic production increases ($\partial x/\partial t > 0$) and foreign decreases ($\partial X/\partial t < 0$). As previously – since marginal costs are increasing – the change in production levels is less than the increase in exports. Thus, domestic sales decrease ($\partial y/\partial t < 0$) and foreign sales increase ($\partial Y/\partial t > 0$). Obviously, the case of constant marginal costs is still valid and implies that sales are unaffected by domestic tax policy.

To conclude, then, the impact of domestic tax policy under the tax credit system differs according to whether the multinational firm derives a marginal net gain or loss from exporting. It seems reasonable to argue that knowledge about the first order condition for exports is private to the firm. If this is true, the home country government cannot identify the sign or magnitude of the effects of its tax policy.

The Foreign Corporate Tax. Turning to the effects of foreign tax policy under the two tax systems, the comparative static results indicate that the direction of change is the same under each tax system but that the size of the effects may differ.[12] Again, we must examine the comparative static results under two different scenarios, depending on whether the firm equates the gain from exporting to the loss from importing or vice

[12]See appendix A and B for the calculation of the comparative static results.

versa. The general directions of change under both tax systems are as follows

$$\frac{\partial x}{\partial T}\begin{cases} > 0 \text{ if } (R' - p(1+\tau)) < 0 \\ < 0 \text{ if } (R' - p(1+\tau)) > 0. \end{cases} \tag{30}$$

$$\frac{\partial X}{\partial T}\begin{cases} < 0 \text{ if } (R' - p(1+\tau)) < 0 \\ > 0 \text{ if } (R' - p(1+\tau)) > 0. \end{cases} \tag{31}$$

$$\frac{\partial z}{\partial T}\begin{cases} > 0 \text{ if } (R' - p(1+\tau)) < 0 \\ < 0 \text{ if } (R' - p(1+\tau)) > 0. \end{cases} \tag{32}$$

$$\frac{\partial y}{\partial T}\begin{cases} < 0 \text{ if } (R' - p(1+\tau)) < 0 \\ = 0 \text{ if } c'' = 0 \\ > 0 \text{ if } (R' - p(1+\tau)) > 0. \end{cases} \tag{33}$$

$$\frac{\partial Y}{\partial T}\begin{cases} > 0 \text{ if } (R' - p(1+\tau)) < 0 \\ = 0 \text{ if } C'' = 0 \\ < 0 \text{ if } (R' - p(1+\tau)) > 0. \end{cases} \tag{34}$$

(*i*) *Net Marginal Gain From Exporting.* The increase in the foreign rate of tax reduces the cost of importing and, hence, makes it more profitable to expand exports ($\partial z/\partial T > 0$). Accordingly, domestic production increases ($\partial x/\partial T > 0$) but by less than exports due to increasing marginal costs. Thus, domestic sales decrease ($\partial y/\partial T > 0$). The expansion of exports increases sales abroad and, therefore, decreases marginal revenue below marginal costs. For the first order condition for production to hold, foreign production must decrease ($\partial X/\partial T < 0$). As previously, the decline is less than the increase in exports so that foreign sales increase ($\partial Y/\partial T > 0$). Again, if marginal costs are constant, sales in both countries are unaffected by tax policy.

(*i*) *Net Marginal Loss From Exporting.* Again, the results are reversed. The firm now derives a net gain from importing. However, the tax increase lowers the gain from importing and, thus, leads to a reduction in exports ($\partial z/\partial T < 0$). Following the reasoning above, domestic production decreases ($\partial x/\partial T < 0$), foreign production increases ($\partial X/\partial T > 0$), domestic sales increase ($\partial y/\partial T > 0$), and foreign sales decrease ($\partial Y/\partial T < 0$).

To summarize, then, unless the foreign tax authorities has private information about the firm, it is in an equally weak position as the home country in terms of predicting the effect of its tax policy on the behavior of the multinational firm.

Foreign Trade Policy. The effects of trade policy are the same under both tax schemes although the magnitude of the effects may differ. An increase in the ad valorem tariff increases the cost of importing the good or decreases the gain from importing it. In either case, exports decline ($\partial z/\partial \tau < 0$), and trade policy by the foreign country has an unambiguous effect on exports. As previously, the decline in exports alters marginal revenues and leads to a fall in domestic production ($\partial x/\partial \tau < 0$) and an increase foreign production ($\partial X/\partial \tau > 0$). The relative change in production and exports implies – by the same mechanism as above – that domestic sales increase ($\partial y/\partial \tau > 0$) and foreign sales fall ($\partial Y/\partial \tau < 0$).

Two striking insights emerge from these results. First, trade policy by the foreign country is a very potent policy tool. The foreign country can identify the sign and magnitude of the effects of its tax policy without relying on information about the firm's first order condition for exports. Second, lacking information about the firm, the clarity of trade policy means that the foreign country gains the upper hand in any tax–setting game irrespective of tax scheme in place. This result is quite strong and

depends on the assumption that we have one importing and one exporting country where only the importing country can use trade policy as a strategic tool.

7. Concluding Remarks

We have examined how different ways of alleviating international double taxation affects production decisions and intra–firm trade by a multinational firm. An important result – emerging from a numerical example – is that the tax deduction scheme by imposing double taxation on foreign source income, does not necessarily yield an anti trade bias and, thus, reduce tax arbitrage. The analysis shows – contrary to popular belief – that results are indeterminate.

Another result of the paper is that under the tax deduction system, domestic tax policy does not affect the behavior of the multinational firm, only foreign tax policy does. In contrast, under the tax credit system, both domestic and foreign tax policy have real effects. The neutrality of the tax deduction scheme induces a fiscal externality on the home country as opposed to the tax credit scheme since the former allows the foreign country to solely influence the profit shifting behavior of the firm.

The paper finds that when tax policy has real effects, its impact depends on the first order condition for trade between the parent firm and its foreign subsidiary. Lacking this knowledge, governments cannot identify the sign or magnitude of the effects of its tax policy. This is in stark contrast to the effects of trade policy. By changing its ad valorem tariff, the foreign country can predict the behavior of the firm unambiguously. The implication of this result is that trade policy is a superior policy tool. It gives the foreign country the upper hand in any tax game played by the two countries irrespective of the tax scheme in place. Obviously, this conclusion is reached in a model

with one exporting and one importing firm. An interesting expansion of the model would be to include more than one traded good. In such a setting each country could be made to import at least one good. This leads to a more complicated pattern of trade in which the tax–setting game is not as easily determined.

Appendix A

Tax Credit Case:

Differentiating (7), (8) and (9), we obtain

(A1)

$$\begin{bmatrix} (1-t)(r''-c'') & 0 & -(1-t)r'' \\ 0 & (1-T)(R''-C'') & (1-T)R'' \\ -(1-t)r'' & (1-T)R'' & (1-t)r''+(1-T)R'' \end{bmatrix} \begin{bmatrix} dx \\ dX \\ dz \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ D \end{bmatrix}$$

where $D \equiv \left[p - r'(y)\right]dt + \left[R'(S) - p(1+\tau)\right]dT + \left[(1+\tau)(1-T) - (1-t)\right]dp + (1-T)p\,d\tau$.

$$dx = \frac{1}{H}(1-t)(1-T)r''(R''-C'')D.$$

$$dX = -\frac{1}{H}(1-t)(1-T)(r''-c'')R''D.$$

$$dz = \frac{1}{H}(1-t)(1-T)(r''-c'')(R''-C'')D.$$

Note that H is the determinant to the matrix on the left hand side of (A1). It follows from the second order conditions that $H < 0$.

$$H = -(1-t)^2(1-T)(R''-C'')r''c'' - (1-t)(r''-c'')(1-T)^2R''C'' < 0.$$

If $(r''-c'') < 0$, $(R''-C'') < 0$, $(r'', R'') < 0$, and $(c'', C'') > 0$, H will always be negative and a maximum is assured.

The change in production and export levels when the tax parameters change are

$$\frac{dx}{dt} = \frac{1}{H}(1-t)(1-T)r''(R''-C'')(p-r').$$

$$\frac{dx}{dT} = \frac{1}{H}(1-t)(1-T)r''(R''-C'')(R'-p(1+\tau)).$$

$$\frac{dx}{d\tau} = \frac{1}{H}(1-t)(1-T)r''(R''-C'')(1-T)p.$$

$$\frac{dX}{dt} = -\frac{1}{H}(1-t)(1-T)R''(r''-c'')(p-r').$$

$$\frac{dX}{dT} = -\frac{1}{H}(1-t)(1-T)R''(r''-c'')(R'-p(1+\tau)).$$

$$\frac{dX}{d\tau} = -\frac{1}{H}(1-t)(1-T)R''(r''-c'')(1-T)p.$$

$$\frac{dz}{dt} = \frac{1}{H}(1-t)(1-T)(R''-C'')(r''-c'')(p-r').$$

$$\frac{dz}{dT} = \frac{1}{H}(1-t)(1-T)(R''-C'')(r''-c'')(R'-p(1+\tau)).$$

$$\frac{dz}{d\tau} = \frac{1}{H}(1-t)(1-T)(R''-C'')(r''-c'')(1-T)p.$$

$$\frac{dy}{dt} = \frac{dx}{dt} - \frac{dz}{dt} = \frac{1}{H}(1-t)(1-T)(R''-C'')(p-r')c''.$$

$$\frac{dy}{dT} = \frac{dx}{dT} - \frac{dz}{dT} = \frac{1}{H}(1-t)(1-T)(R''-C'')(R'-p(1+\tau))c''.$$

$$\frac{dy}{d\tau} = \frac{dx}{d\tau} - \frac{dz}{d\tau} = \frac{1}{H}(1-t)(1-T)^2p(R''-C'')c''.$$

$$\frac{dY}{dt} = \frac{dX}{dt} - \frac{dz}{dt} = \frac{1}{H}(1-t)(1-T)(r''-c'')(p-r')(-C'').$$

$$\frac{dY}{dT} = \frac{dX}{dT} + \frac{dz}{dT} = \frac{1}{H}(1-t)(1-T)(R' - p(1+\tau))(r'' - c'')(-C').$$

$$\frac{dY}{d\tau} = \frac{dX}{d\tau} + \frac{dz}{d\tau} = \frac{1}{H}(1-t)(1-T)^2(r'' - c'')p(-C').$$

Appendix B

Tax Deduction Case;

Differentiating (11), (12) and (13)

(B1)

$$\begin{bmatrix} (r'' - c'') & 0 & -r'' \\ 0 & (1-T)(R'' - C'') & (1-T)R'' \\ -r'' & (1-T)R'' & r'' + (1-T)R'' \end{bmatrix} \begin{bmatrix} dx \\ dX \\ dz \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ G \end{bmatrix}$$

where $G = \left[R'(S) - p(1+\tau)\right]dT + \left[(1+\tau)(1-T) - 1\right]dp + (1-T)p d\tau.$

$$dx = \frac{1}{E}(1-T)r''(R'' - C'')G.$$

$$dX = -\frac{1}{E}(1-T)(r'' - c'')R''G.$$

$$dz = \frac{1}{E}(1-T)(r'' - c'')(R'' - C'')G.$$

The number E denotes the determinant to the matrix on the left hand side of (B1) and is negative from the second order conditions to the maximization problem.

$$E = -(1-T)(R'' - C'')r''c'' - (1-T)^2(r'' - c'')R''C'' < 0.$$

For a discussion of the second order condition see appendix A.

The change in production and export levels when the tax parameters change are

$$\frac{dx}{dt} = 0.$$

$$\frac{\mathrm{d}x}{\mathrm{d}T} = \frac{1}{E}(1-T)r''(R''-C'')(R'-p(1+\tau)).$$

$$\frac{\mathrm{d}x}{\mathrm{d}\tau} = \frac{1}{E}(1-T)r''(R''-C'')(1-T)p.$$

$$\frac{\mathrm{d}X}{\mathrm{d}t} = 0.$$

$$\frac{\mathrm{d}X}{\mathrm{d}T} = -\frac{1}{E}(1-T)R''(r''-c'')(R'-p(1+\tau)).$$

$$\frac{\mathrm{d}X}{\mathrm{d}\tau} = -\frac{1}{E}(1-T)R''(r''-c'')(1-T)p.$$

$$\frac{\mathrm{d}z}{\mathrm{d}t} = 0.$$

$$\frac{\mathrm{d}z}{\mathrm{d}T} = \frac{1}{E}(1-T)(R''-C'')(r''-c'')(R'-p(1+\tau)).$$

$$\frac{\mathrm{d}z}{\mathrm{d}\tau} = \frac{1}{E}(1-T)(R''-C'')(r''-c'')(1-T)p.$$

$$\frac{\mathrm{d}y}{\mathrm{d}t} = \frac{\mathrm{d}x}{\mathrm{d}t} - \frac{\mathrm{d}z}{\mathrm{d}t} = 0.$$

$$\frac{\mathrm{d}y}{\mathrm{d}T} = \frac{\mathrm{d}x}{\mathrm{d}T} - \frac{\mathrm{d}z}{\mathrm{d}T} = \frac{1}{E}(1-T)(R''-C'')(R'-p(1+\tau))c''.$$

$$\frac{\mathrm{d}y}{\mathrm{d}\tau} = \frac{\mathrm{d}x}{\mathrm{d}\tau} - \frac{\mathrm{d}z}{\mathrm{d}\tau} = \frac{1}{E}(1-T)^2p(R''-C'')c''.$$

$$\frac{\mathrm{d}Y}{\mathrm{d}t} = \frac{\mathrm{d}X}{\mathrm{d}t} - \frac{\mathrm{d}z}{\mathrm{d}t} = 0.$$

$$\frac{\mathrm{d}Y}{\mathrm{d}T} = \frac{\mathrm{d}X}{\mathrm{d}T} + \frac{\mathrm{d}z}{\mathrm{d}T} = \frac{1}{E}(1-T)(R'-p(1+\tau))(r''-c'')(-C'').$$

$$\frac{\mathrm{d}Y}{\mathrm{d}\tau} = \frac{\mathrm{d}X}{\mathrm{d}\tau} + \frac{\mathrm{d}z}{\mathrm{d}\tau} = \frac{1}{E}(1-T)^2(r''-c'')p(-C'').$$

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