# Cash-Flow Taxes in an International Setting

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*This version: December 1, 2015*

## Abstract

We model the effects of cash flow taxes on company profit which differ according to the location of the tax. Our model incorporates a multinational producing and selling in two countries with three sources of rent, each in a different location: a fixed basic production factor (located with initial production), mobile managerial skill, and a fixed final production factor (located with consumption). In the general case, we show that for national governments, there are trade-offs in choosing between alternative taxes. In particular, a cash-flow tax on a source basis creates welfare-impairing distortions to production and consumption, but is partially incident on the owners of domestic production who may be non-resident. By contrast, a destination-based cash-flow tax does not distort behavior, but is incident only on domestic residents.

Keywords: Profit-shifting, destination-based taxation, transfer pricing

## Acknowledgements

We would like to thank Steve Bond, seminar participants at the Centre for Business Taxation, the Oxford University Economics department, the IFS-STICERD public economics seminar, Goethe University, Norwegian Business School and Stanford University for helpful comments. Devereux acknowledges the financial support of the ESRC under grant RES-060-25-0033.

## 1. Introduction

It is generally understood that the distortionary effects of capital income taxation are magnified in open economies. For example, the standard theoretical model suggests that the optimal rate of a source-based capital income tax in a small open economy is zero (see Gordon, 1986). Imposing a positive tax rate raises the required pre-tax rate of return in that location, reducing the domestic capital stock and in turn creating an excess burden, borne by domestic residents, which could be avoided by taxing immobile factors directly.

In light of these effects, a potential alternative to an income tax is a cash-flow tax that, by allowing an immediate deduction of capital purchases, falls only on business profit or economic rent. This paper investigates the effects of three types of cash-flow taxes,[1] differing in how profit is allocated across countries, on factor allocation, production and consumption in a two-country framework. We explore and compare the efficiency and incidence of a cash-flow tax in a conventional source-based setting, with profit taxed based on the location of production, and under two alternatives: where aggregate profit is allocated by an apportionment factor based on the location of sales;[2] and a "destination-based" tax which, like the common VAT, exempts exports but taxes imports.

We identify precisely the different channels by which even taxes on pure profits can affect economic behavior. For example, consider the effects of source-based cash-flow taxes applied to a company in both countries, where the home country has a higher tax rate. Other things being equal, the company would prefer to shift production to the foreign,

[1] These three can be thought of, for example, as variants of the R-based tax of Meade et al. (1978), although since we do not include debt in our model, this would be equivalent to the R+F based tax.

[2] This factor is increasingly used for the allocation of profit for tax purposes among US states, and forms part of the European Commission's proposals for a formula apportionment system in the EU.

lower-taxed country, and export the good back to the home country to serve the domestic market. In addition, the company will have an incentive to inflate the reported internal transfer price at which the good is "sold" back to its domestic operation, since this will raise taxable profit in the foreign country and reduce it in the home country. This in turn creates a further incentive to shift production to the foreign country. So, even under a cash-flow tax, the company will have an incentive to shift production to the foreign country, where the tax rate is lower.[3] This prediction is consistent with empirical evidence that discrete location choices and flows of foreign direct investment depend on an average effective tax rate which – unlike a marginal effective tax rate on additional capital investment - is non-zero in the presence of a cash flow tax.[4]

By contrast, a destination-based tax implemented in both countries along the lines of a VAT (but with labor costs deductible) would be efficient. This stems from the assumption that the representative consumer is immobile. A tax based solely on the sales revenue generated in each market cannot be avoided by moving production between countries. An apportionment system based on sales would also not distort the location of production. But in contrast to the destination-based tax, and as shown below, sales apportionment would distort consumption patterns. If the home country has the higher tax rate, for example, then the multinational has an incentive to reduce sales at home and raise sales abroad, thereby shifting the location of profit for tax purposes.

[3] An earlier unpublished paper, co-authored by one of the authors of this paper (Bond and Devereux, 2002) compares the properties of source- and destination-based taxes when the company locates its production in only one country. This paper goes beyond the model used in the earlier paper in several directions, including specifying alternative sources of the firm's profit and explicitly modeling transfers between different parts of the company located in different countries. We also explicitly consider the welfare effects of a switch from a source-based tax.

[4] See Devereux and Griffith (1998) and the meta analysis of de Mooij and Ederveen (2008).

International tax reform is likely to occur only when it is in the national interest of individual governments, so it is useful to consider whether a unilateral deviation from a common tax system would benefit the adopting country. A natural starting point for this analysis is where both countries have a source-based tax, which is closest to the existing system. Starting from this we investigate whether a country would have an incentive to switch at least part of its tax system to one of the other two forms. Two factors need to be considered. One is the welfare cost borne at home of the distortions induced by each form of taxation. The second is incidence. The source-based cash flow tax does have an attractive property for a national government: its incidence may fall to an extent on the owners of the company, some of whom may be non-resident. By contrast, a destination-based cash flow tax is incident on spending by domestic shareholders from worldwide economic rent.[5]

In a non-cooperative setting, then, relative to a destination-based tax, there is generally a trade-off for governments in relying on source-based taxation. On the one hand, a higher tax rate on a source base induces a deadweight cost due to distortions induced by a switch of production between countries; on the other hand the country benefits since part of the incidence of the tax falls on non-residents. The same factors arise in considering the switch from a source-based tax to a sales-apportioned tax. However, both features of the source-based tax – the deadweight costs arising from distortions, and the exporting of the tax to non-residents – may also arise in the case of the sales-apportioned tax. The case for switching therefore depends on the relative sizes of these two factors.

These differences between source-based and destination-based taxes may appear to be at odds with several claims in the literature regarding the equivalence of destination

[5] It is therefore equivalent to a residence-based version of the Meade Committee's (1978) S-based tax.

and source-based taxes, but the apparent inconsistency simply reflects differences in assumptions.[6] We show in this paper the nature of the assumptions that need to be made for such an equivalence to hold.[7]

The remainder of the paper is organized as follows. Section 2 sets up the base case model. Section 3 analyzes the impact of different taxes when both countries adopt the same form of taxation. Section 4 addresses the question of whether, starting from the case in which both countries impose a same type of tax, the home country has an incentive to switch part of its tax base to one of the alternatives. Section 5 considers the effects of various extensions to the model, and Section 6 concludes. The Appendix collects several derivations. In our analysis, we also discuss the potential effects and desirability of alternative approaches to tax reform, notably the recent proposals by the OECD aimed at limiting "Base Erosion and Profit Shifting" through a modification of transfer-pricing rules.

## 2. The Model

For our analysis, we construct a model that incorporates the important elements of differences among tax systems, including firm-specific factors of production, intangible assets, the international location of activities and cross-country ownership. In this model, a representative multinational company takes all prices as given, and is owned by

[6] In particular, where the rent accruing to fixed factors is captured by local residents and there is no manipulation of transfer prices, production distortions would disappear and the source-based cash-flow tax would be equivalent to a lump-sum tax. This is implicitly the framework underlying the contributions of Auerbach (1997), Bradford (2003), Avi-Yonah (2000), Grubert and Newlon (1997) and others, resulting in the claim of equivalence.

[7] Our analysis also relates closely to the literature comparing a VAT levied on a destination or origin (i.e. source) basis. A comprehensive analysis of alternative locations of the VAT base was provided by Lockwood (2001), who synthesized a number of earlier contributions, including Lockwood (1993) and Keen and Lahiri (1998). Our model differs substantially, focusing particularly on firm-level decisions and several variations in tax structure as opposed to modeling the consumption side in more detail. Nevertheless, the results are broadly consistent: Lockwood finds that destination and origin bases are only equivalent with factor immobility. This would also be true in our model. Beyond this, Lockwood also finds that imperfect competition destroys this equivalence.

representative consumers in each country. The company has a production plant in each country that supplies an intermediate good to a second plant in either or both countries. The intermediate good is completed and turned into the final good in the country in which it is sold and consumed. This second process may reflect the fact that the final good differs between countries depending on local conditions – for example, a car must be prepared as right- or left-hand drive – or it may reflect advertising, distribution, and other activities that take place in the proximity of consumption.

The company generates profit in three ways, and in three locations. First, it has the use of a fixed factor in each production location of the intermediate good, which implies that there are decreasing returns to scale in the other two factors, capital and managerial skill. The existence of the fixed factor generates profit in the country of production. This factor can be thought of, for example, as a local supply network that has been built up in each country, and which is available to the multinational to support production. Second, we also assume that there is a fixed factor in the process of adjusting the intermediate good for the local market, which generates profit in the country of consumption. Third, the company owns a fixed supply of a factor that can move freely between the two countries. We refer to this factor as managerial skill, but one can also think of it as a stock of intangible assets. The profit generated from access to this asset is mobile between the two countries.

Note that we do not rely on imperfect competition to generate profit, primarily because our main goal is to compare the welfare effects of the alternative tax bases. This comparison is clearer in a model in which there are no inefficiencies in the absence of taxation, which is generally not the case in the presence of imperfect competition. Note also that allowing for profit to arise from production taking place in each country naturally

introduces a transfer of the intermediate good between countries. This permits analysis of the incentives for transfer prices to be manipulated under the alternative tax bases.

Each of two countries has a representative agent with a utility function of the form:

$$(2.1) \qquad U = u(c_1) + c_2 + v(g); \qquad U^* = u^*(c_1) + c_2^* + v^*(g^*)$$

where $c_1$ and $c_2$ represent consumption of goods 1 and 2 respectively, $g$ is a local public good, and the asterisk denotes the foreign country. In general, the utility functions for good 1 and the public good may differ between the two countries.[8] The public good is funded entirely by a cash flow tax on firms, described below.

In each country there is one unit of an endowment good. Production of one unit of good 2 uses one unit of this endowment, and is therefore characterized by constant returns to scale; we assume this production to be perfectly competitive and hence to generate no profits. Good 2 can be used as a public good ($g$) or as consumption ($c_2$), with the remainder supplied as capital. Hence, the total world supply of capital ($K$) is

$$(2.2) \qquad K = (1 - c_2 - g) + (1 - c_2^* - g^*) = k + k^*$$

where $k$ is the amount of capital used in the home country and $k^*$ is the amount used abroad. One may think of good 2 as labor, in which case $c_2$ represents the consumption of leisure by the representative individual.[9]

Good 1 is produced by a single representative multinational, which takes all prices as given. The production of good 1 occurs in two stages. In the first stage, the multinational

[8] We assume that there are no income effects in the demand for good 1 to make the model tractable.

[9] Note that this expression relating capital to the other uses of good 2 holds on a worldwide basis, rather than on a national basis, as countries may import or export good 2; they will also trade in good 1, as discussed below.

produces a basic good in both countries, and in its production has access to capital and two additional factors, both in fixed supply. One factor is located in the place of production, and might represent, for example, a local supply network that has been built up in each country, and which is available to the multinational to support production. The second is access to a factor, $M$, which can be used for production in either location, so

(2.3) $$M = m + m^*$$

where $m$ is the amount of this factor used in the home country and $m^*$ is the amount used abroad. One may think of this factor as managerial skill, or some other firm-specific asset. The key, for our purposes, is that its location is not fixed in either jurisdiction.[10]

We assume that the basic production function used by the multinational is the same in both countries, $f(k, m)$, and that there are decreasing returns to scale because of the local fixed factor. There are no transportation costs, so without taxes the locations of production and consumption are unrelated. Hence,

(2.4) $$x_1 + x_1^* = f(k, m) + f(k^*, m^*)$$

where $x_1$ and $x_1^*$ are the output from the production processes consumed in the home and foreign country respectively.

The second stage of good-1 production involves making a final product tailored to consumption in the respective countries. For example, cars must be adjusted to be left-hand or right-hand drive, depending on local law. Alternatively, one can think of this final

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[10] However, in order to allow this source of rent to be mobile between countries, we do assume that this asset cannot be used simultaneously in both countries – i.e., it has no public good aspects within the firm. This corresponds to the fixed management capacity approach in the model of Becker and Fuest (2010), for example. Becker and Fuest also consider the case in which management is a public good within the firm, and Devereux et al (2013) consider a more flexible approach. In Section 5 we consider the effects of changing this assumption, along with other extensions.

production stage as including advertising, distribution, and other activities that take place in the proximity of consumption. This links consumption of good 1 in each country with the basic output sold in that country, according to a common second stage production function, $h(\cdot)$,

$$c_1 = h(x_1)\,;\, c_1^* = h(x_1^*) \tag{2.5}$$

where $c_1$ and $c_1^*$ are the quantity of final sales of the multinational in each country, and $h(\cdot)$ is assumed to be characterized by decreasing returns to scale.

Although modeling one company, we assume that there are many such companies which determine equilibrium prices, with any single company taking output prices as given. Conditional on the consumer price in each country, decreasing returns to scale of $h(\cdot)$ leads to determinate and potentially different values of $x$ in the two countries. If, for example, the home country has a stronger demand for good 1, then this will lead to more consumption and higher rents accruing to the firm associated with consumption there.

The two countries' representative agents own shares $\beta$ and $\beta^*$ ($\beta + \beta^* = 1$) of the multinational, and hence its profits ($\pi$),[11] which have three components: returns to the fixed factor in basic production, returns to managerial skill, and returns to the fixed factor in final production. The effective locations of these components differ. The return to the basic-production fixed factor is located in the country hosting that factor; the return to managerial skill is mobile, based on the location of managerial skill itself; and the return to the fixed factor in final production is located in the country of consumption. Because governments cannot accurately distinguish these three components separately, they cannot impose non-distortionary profits taxes, even where the rents are location-specific.

[11] Without any loss of generality, one can think of there being several identical multinationals with different ownership shares at home and abroad that aggregate to these shares of domestic and foreign ownership.

We now consider the effects of using different types of taxes to raise revenue to finance public goods. Initially, we consider only cases in which both governments adopt the same tax base; in Section 4 we consider the incentives to deviate from a common tax base.

## 3. Alternative Tax Regimes

We consider three variants of taxes on cash flows, which fall only on pure profits and which exempt from tax the normal return to capital, $K$.[12] While much of the literature on multinationals has focused on capital taxation, our focus here is on the taxation of rents.

It is useful to begin by characterizing equilibrium in the absence of taxes and public goods. Letting good 2 be the numeraire commodity, conditions for utility maximization are:

$$(3.1) \qquad u'(c_1) = \frac{p_1}{p_2} = p_1; \qquad u^{*'}(c_1^*) = \frac{p_1^*}{p_2^*} = p_1^*,$$

and profits of the multinational are:

$$(3.2) \quad \pi = p_1 c_1 + p_1^* c_1^* - K = u'(c_1)h(x_1) + u^{*'}(c_1^*)h\{f(k,m) + f(K-k, M-m) - x_1\} - K.$$

Maximizing profit with respect to $k$, $m$, $K$, and $x_1$ yields the firm's first-order conditions:

$$(3.3) \qquad k: \quad f_1(k,m) = f_1(k^*, m^*)$$

$$(3.4) \qquad m: \quad f_2(k,m) = f_2(k^*, m^*)$$

$$(3.5) \qquad K: \quad u^{*'}(c_1^*)h'(x_1^*) = \frac{1}{f_1(k^*, m^*)}$$

$$(3.6) \qquad x_1: \quad u'(c_1)h'(x_1) = u^{*'}(c_1^*)h'(x_1^*)$$

[12] Note that, while we refer specifically to cash-flow taxes, the results depend only on the full investment cost being deductible, which in a multi-period model would not require immediate expensing, but could be accomplished, e.g., under an ACE system, as discussed in Devereux and Freeman (1991). For all three taxes, we abstract from issues concerning debt and the treatment of interest, by implicitly assuming the multinational is equity financed.

Conditions (3.3) and (3.4) call for production efficiency, with the marginal product of capital equal across the two countries, and also the marginal product of managerial skill equal across the two countries. Condition (3.5) calls for setting marginal revenue equal to marginal cost. Condition (3.6) implies that marginal revenues, in this case equal to marginal consumer valuation, should be independent of consumption location.

Finally, the household budget constraint becomes (with the equivalent abroad):

$$u'(c_1)c_1 + c_2 = 1 + \beta\left(u'(c_1)c_1 + u^{*\prime}(c_1^*)c_1^* - K\right) \tag{3.7}$$

We now consider alternative forms of cash flow taxes, used to finance the public good.

### *3.1. Source-based cash-flow tax*

We begin with a cash-flow tax based on the source principle, the standard approach of the existing international tax system. It is well-known that a traditional source-based income tax encourages shifting of both real activities and accounting profits to lower-tax countries. We show below that these two distortions remain under a cash-flow tax, and analyze the interactions between them.

There would be no taxes in the competitive sector 2, so $p_2 = 1$. Hence, the prices of good 1 in the two countries are governed by expression (3.1). Define $e$ to be exports of the unfinished good 1 (i.e., $x$) from the home country plant to the foreign country plant at price $q$ and $e^*$ to be exports of the unfinished good 1 from the foreign country plant to the home country plant at price $q^*$. Then the home country plant's profit is $(1-t)\{p_1 h(f(k,m) - e + e^*) + qe - q^*e^* - k\}$, the foreign plant earns $(1-t^*)\{p_1^* h(f(k^*,m^*) - e^* + e) + q^*e^* - qe - k^*\}$, and total after-tax profit is:

(3.8) $$\pi = (p_1 c_1 - k)(1-t) + (p_1^* c_1^* - k^*)(1-t^*) + (q^* e^* - qe)(t - t^*).$$

Conditional on the two countries' production and consumption, net exports $(e - e^*)$ are determined, but not gross exports. Offsetting unit increases in $e$ and $e^*$ lead to a net increase in after-tax profits of $(q^* - q)(t - t^*)$, where $q$ and $q^*$ are the multinational company's internal transfer prices used for tax purposes. As we discuss below, it may be open to the company to manipulate these internal prices to reduce its tax liability. But it is useful to consider as a benchmark the price that would arise if transactions were among independent companies. Imagine that the multinational has four independent, price-taking plants, two in each country. In each case plant A uses $k$ to produce $x$ and plant B uses $x$ to produce the final good *c.* Consider the case where there are no exports, in which case the profits of the two home country plants are $\pi_A = (1-t)\{qf(k,m) - k\}$ and $\pi_B = (1-t)\{p_1 h(x_1) - qx_1\}$. Plant A chooses $k$ to maximize its profit and plant B chooses $x_1 = f(k,m)$ to maximize its profit. What value of $q$ would yield the same outputs as in the case where these two plants were combined, i.e., the value of $k = \hat{k}$ for which $p_1 h'(x_1) f_1(\hat{k}, m) = 1$? The answer is $q = 1/f_1(k,m)$, the marginal cost of producing *x*. That is, if the transfer price is set equal to the marginal cost of plant A, then outputs would not be affected by splitting the home plant into two parts. The same applies to the case in which the intermediate good is exported, and holds even in the presence of the cash-flow tax analyzed here, so in addition we have as a benchmark $q^* = 1/f_1(k^*, m^*)$.

The multinational may exploit the absence of an arms' length price to manipulate its transfer prices in order to shift profit between the two countries. But even with considerable latitude in its choice of transfer prices $q$ and $q^*$, we assume that tax enforcement is sufficiently effective that the firm cannot choose different values for the

two, for example exporting at a high price from the low-tax country and then importing the same good back from the high-tax country at a low price. This means that the firm can gain no benefit from cross-hauling, so without loss of generality we can assume that at most one country exports. That is, with $q = q^*$ in expression (3.8), there are four possible regimes:

| | | | |
|---|---|---|---|
| **Case A**: | $e^* = 0$ and $t < t^*$ | **Case B**: | $e = 0$ and $t > t^*$ |
| **Case C:** | $e^* = 0$ and $t > t^*$ | **Case D:** | $e = 0$ and $t < t^*$ |

In cases A and B, the high-tax country is importing, so the firm will wish to maximize $q$. In cases C and D, the high-tax country is exporting, and the firm will wish to minimize $q$.

As modeling the firm's choice of its transfer price is potentially quite complex, we analyze behavior under the simplifying assumption that there is some range of observed comparable prices, exogenous from the firm's perspective, which would be acceptable to the tax authorities of both countries. The firm can choose prices within this range without cost, but beyond it would be challenged by tax authorities to provide additional documentation to justify its chosen price and might also face negotiation between the two tax authorities.[13] This would introduce high costs that the firm would prefer to avoid, so that it will never find it optimal to choose a transfer price outside the observed range. That is, we assume that the firm chooses the transfer price $q \, \epsilon [q_L, q_u]$ that maximizes profits. Specifically, to shift profit to the lower taxed country, in cases A and B the firm chooses a high $q = q_u$ and in cases C and D it chooses a low $q = q_L$.

Note also that in all four cases, net imports are $e^* - e = x_1 - f(k, m)$. This generates general first order conditions as follows:

[13] Becker and Davies (2014) develop a more detailed model of transfer pricing based on this approach.

$$(3.9) \qquad x_1: \qquad (1-t)\left(p_1 h' - q\right) - (1-t^*)(p_1^* h^{*\prime} - q) = 0$$

$$(3.10) \qquad K: \qquad p_1^* h^{*'} = \frac{1}{f_1^*}$$

$$(3.11) \qquad k: \qquad p_1^* h^{*'}(f_1 - f_1^*)(1-t^*) + (1 - qf_1)(t - t^*) = 0$$

$$(3.12) \qquad m: \qquad p_1^* h^{*'}(f_2 - f_2^*)(1-t^*) - qf_2(t - t^*) = 0$$

where the value of $q$ depends on the case, as described above, and where for ease of notation we have dropped the arguments for the functions $h(.)$ and $f(.)$ and replaced the derivatives of the utility functions with price terms. In the limiting situation where the firm's latitude for transfer-pricing manipulation completely vanishes and the interval $[q_L, q_u]$ collapses to the firm's actual marginal cost transfer price (which will then turn out to be equal across the two countries, i.e., $q = \frac{1}{f_1^*} = \frac{1}{f_1}$), these conditions simplify to:

$$(3.9') \qquad p_1 h' = \frac{1}{f_1}$$

$$(3.10') \qquad p_1^* h^{*'} = \frac{1}{f_1^*}$$

$$(3.11') \qquad f_1 = f_1^*$$

$$(3.12') \qquad f_2(1-t) = f_2^*(1-t^*)$$

In this instance, unlike under source-based capital *income* taxes, there is no distortion to the marginal condition for capital because the normal return to capital is tax-exempt under a cash-flow tax.[14] Likewise, there is no distortion in the second stage of production, where consumption rents are generated. But returns to managerial skill are taxed where this factor is used in production, so the firm is deterred from using it where the tax rate is high.

[14] Taxes will still affect the allocation of capital indirectly, through the distortion of the location choice of $M$, which in turn affects the marginal product of capital in the two locations.

More generally, though, the opportunity to manipulate transfer prices not only benefits the firm, but also further distorts its production decisions. Consider first Case A, with $t < t^*$, where the home plant is exporting, and where the firm wishes to maximize $q$. From (3.11), $q = q_u > \frac{1}{f_1}$ implies that $f_1 < f_1^*$. That is, with transfer pricing manipulation, the firm shifts production from the foreign country to the home country, reducing $f_1$ and increasing $f_1^*$. Relative to the marginal cost pricing case, in this case one can also show that $q > \frac{1}{f_1}$ would also increase $f_2^* - f_2$, pushing more intellectual property to the home country. Thus, exports from the home country increase. By symmetry, the same result, that exports from the low-tax country increase, will hold for Case B. Now consider Case C, with $t > t^*$, where again the home firm is exporting, but now the firm wishes to minimize $q$. From (3.11), $q = q_L < \frac{1}{f_1}$ implies that $f_1 < f_1^*$. That is, with transfer pricing manipulation, production is again shifted from the foreign country to the home country, reducing $f_1$ and increasing $f_1^*$. Relative to the marginal cost pricing case, in this case $q < \frac{1}{f_1}$ would reduce $f_2 - f_2^* > 0$, again pushing more intellectual property to the home country. Thus, transfer-pricing manipulation again increases exports from the home country. By symmetry, the same result, that exports from the high-tax country increase, will hold for Case D.

Thus, we have the interesting result that, whether the high-tax or low-tax country exports, the ability to manipulate transfer prices causes the firm to adjust the location of production to the country from which it exports. Contrary to a common view on the subject, the firm's ability to manipulate transfer prices does not necessarily lead to a shift in *production* to the low-tax country, unless the firm would export from the low-tax country in the absence of transfer pricing manipulation. Certainly, by expression (3.12'), other

things being equal the firm already will have the tendency to locate one of its production factors, managerial skill, in the low-tax country, increasing that country's production level and making it more likely to export. But the low-tax country might also have a stronger demand for good 1, and so still might import.

This result – that transfer-pricing manipulation could sustain production in a high-tax country – is relevant when one considers the potential effects of policies to tighten transfer-pricing rules, as recommended by the OECD (2015), which in our framework can be interpreted as a narrowing of the size of the interval $[q_L, q_u]$. While such an approach would result in more accurate measurement of the income generated in each location, it could also reduce the level of such income generated in a high-tax country.

Also of note is how the production distortions due to transfer pricing manipulation interact with the basic ones of the source-based system. The capital-allocation distortion is clearly worsened by transfer pricing manipulation, since there is no other distortion present on this margin. However, the effect on the managerial skill margin could go either way. In particular, in cases C and D, where transfer pricing manipulation leads the high-tax country to increase its exports, this pushes more managerial skill to the high-tax country, thereby offsetting the initial distortion observed in expression (3.12').

### *3.2. Cash-flow tax with apportionment by sales*

Formula apportionment has often been considered as a solution to the difficulty of determining the location of the tax base, and has been proposed by the European Commission as a replacement for existing corporation taxes in Europe. Its properties have been analyzed by Gordon and Wilson (1986), who demonstrated that for a standard

corporate income tax, a three-factor formula based on the location of property, payroll and sales could be examined as, in effect, three forms of distortionary taxation. It is clear that a formula based on property or payroll would affect location incentives, so we focus on the case where apportionment of the cash-flow tax relies solely on the destination of sales – that is, where the consumer resides, as is increasingly used among US states and has been proposed for the international level by Avi-Yonah and Clausing (2008).

We assume here that the apportionment factor is based on the location of the consumption of good 1 only. This would follow naturally if the multinational does not also produce good 2, and implies that sales of good 2 have no impact on the firm's tax payments.[15] Consequently, the equilibrium competitive price for good 2 will still be 1, and the utility maximization conditions in expression (3.1) still holds. Post-tax profits are:

$$\pi = (p_1 c_1 + p_1^* c_1^* - K)[1 - ta - t^*(1 - a)], \tag{3.13}$$

where $a = \frac{p_1 h(x_1)}{p_1 h(x_1) + p_1^* h(x_1^*)} = \frac{p_1 c_1}{p_1 c_1 + p_1^* c_1^*}$.

Using (3.13), we can derive the firm's optimal conditions with respect to $k$, $m$, $K$, and $x_1$. For the condition with respect to $k$, we have:

$$[1 - ta - t^*(1 - a) + \frac{a(t - t^*)\pi^G}{p_1 c_1 + p_1^* c_1^*}] p_1^* h'(x_1^*)[f_1(k, m) - f_1(k^*, m^*)] = 0 \tag{3.14}$$

[15] If sales of good 2 were included in the apportionment formula, for example if the multinational were an integrated producer of goods 1 and 2, this would lead to an additional distortion. The firm would be encouraged to shift sales of low-margin products, in this model good 2, from the high-tax country to the low-tax country, to reduce the share of its overall sales in the high-tax country. In a more general model with sales of intermediate production inputs (absent from our model because the two stages of good-1 production occur within the same firm), there would be a second additional distortion, to production, through the implicit taxation of intermediate sales along the lines of the implicit taxation of final goods sales described in expression (3.15). See Auerbach (2011) for further discussion.

where $\pi^G$ equals pre-tax profits. Hence, the term $\left(f_1 - f_1^*\right)$ must equal 0 and (3.3) still holds; likewise, from a similar first-order condition with respect to $m$, so does condition (3.4), so there is still production efficiency.

As shown in Appendix A, the condition with respect to $K$ yields:

$$(3.15) \qquad \left[1 + \frac{a(t-t^*)\pi^G}{(1-ta-t^*(1-a))(p_1c_1+p_1^*c_1^*)}\right] p_1^* h'(x_1^*) = \frac{1}{f_1(\frac{K}{2},\frac{M}{2})}.$$

A similar condition for the home country follows from the first-order condition for $x_1$. Expression (3.15) indicates that there will be an effective tax or a subsidy on consumption according to whether the home tax rate is higher or lower than the tax rate abroad. If $t > t^*$, for example, sales are discouraged at home and encouraged abroad by the incentive to shift the location of profits for tax purposes. Apportioning a cash-flow tax based on sales will generally distort consumption in both countries, although not production.

### *3.3. Destination-based cash-flow tax*

We now consider a cash-flow tax with the tax liability in each country determined by the destination of sales, as under a VAT. More precisely, we consider the same tax base as the source-based tax analyzed in Section 3.1, but with the difference that we add border adjustments along the lines of VAT, so that exports are not taxed, but imports are taxed.

Consider first the tax treatment of sector 2. In the absence of any trade in good 2, profits are zero and tax from this sector is zero. But with trade then an import of good 2 would be subject to the import tax at rate $t$ or $t^*$. The price of the domestically produced good 2 must be the same as for imported goods. Further, if the sector is a net exporter, then its tax will be negative. The tax liability in sector 2 and on imports together is:

$$T_2 = t\{p_2(c_2 + k + g) - w\} \tag{3.16}$$

where $w$ is the producer price of the endowment. If $(c_2 + k + g) < 1$ then the home country exports good 2 (or capital) and $T_2 < 0$. If $(c_2 + k + g) > 1$ then $T_2 > 0$ is a tax on imports. The opposite holds for the foreign country. If $(c_2 + k + g) < 1$, the post-tax zero-profits condition is:

$$\pi_2 = (1 - t)\{p_2(c_2 + k - g) - w\} + (1 - t^*)p_2^*(1 - c_2 + k - g) = 0 \tag{3.17}$$

which is solved by $p_2 = w = 1/(1 - t)$ and $p_2^* = 1/(1 - t^*)$. That is, the prices of good 2 and the endowment good are grossed up by $(1 - t)$ in the home country and $(1 - t^*)$ in the foreign country. The goods exported to the foreign country are taxed at rate $t^*$, and so are the same price as domestically produced goods in that country. Therefore,

$$u'(c_1) = \frac{p_1}{p_2} = (1 - t)p_1; \qquad u^{*'}(c_1^*) = \frac{p_1^*}{p_2^*} = (1 - t^*)p_1^*. \tag{3.18}$$

If $c_2 + k + g > 1$, post-tax profit is zero, but the price of good 2 must reflect the import tax and so is again grossed up.

After tax profits in sector 1 (and hence overall as well) are:

$$\pi = (1 - t)\{p_1 c_1 - p_2 k\} + (1 - t^*)\{p_1^* c_1^* - p_2^*(K - k)\} = u'(c_1)c_1 + u^{*'}(c_1^*)c_1^* - K \tag{3.19}$$

This expression is the same as (3.2) in the absence of tax, which implies that the tax has no effect on firm behavior.

The household budget constraint (with an equivalent condition for the foreign country) is:

(3.20) $$p_1 c_1 + p_2 c_2 = w + \beta\left(u^{'}(c_1)c_1 + u^{*'}(c_1^*)c_1^* - K\right)$$

$$\Rightarrow u^{'}(c_1)c_1 + c_2 = 1 + (1-t)\beta\left(u^{'}(c_1)c_1 + u^{*'}(c_1^*)c_1^* - K\right).$$

This expression makes it clear that the destination-based tax is equivalent to a tax on the pure profits received by domestic residents.[16] Note that if one thinks of good 2 as leisure, then the lack of distortion here can also be thought of a relating to the fact that our destination-based cash-flow tax excludes labor from the tax base, unlike a standard VAT.

## 4. Incentives for Tax Competition and Tax Reform

We have discussed the effects on firm behavior of different tax systems, but a critical question is what tax systems, and tax rates, countries should have incentives to adopt. The incentives for tax competition through rate reductions under source-based taxation are well established both theoretically and empirically. But what are the incentives for competition via changes in tax *systems*? Ideally, one would like to identify each country's optimal strategy in terms of tax system and tax rate, but this is generally not possible without specific functional form and parameter assumptions. Still, we can learn a lot by considering incentives for different marginal policy changes. Specifically, starting from an assumed equilibrium with common tax systems, we can ask whether the home country will wish to make an incremental substitution of one of the alternative tax systems, holding fixed the other country's tax policy.

In our approach, we consider the incremental substitution of a new tax for the old, keeping the level of public goods spending, and hence tax revenue, fixed. (By the envelope

[16] The equivalence between cash-flow taxes and taxes on shareholder distributions – in this case, the firm's profits – was first noted by Meade et al. (1978), although that equivalence was derived in a closed-economy context.

theorem, changes in spending would have no first order effects on welfare, assuming that the level of spending was initially optimal.) Also, under any particular tax system, for a government seeking to maximize the representative resident's utility, as given in expression (2.1), with respect to the tax rate, $t$, the first-order condition will be that the derivative of the resident's indirect utility function with respect to $t$ equals 0. That is, incorporating the government's budget constraint that $g = T$, the government's first-order condition is:

(4.1) $$\frac{dy}{dt} - c_1 \frac{dp_1}{dt} - c_2 \frac{dp_2}{dt} + v'(g) \frac{dT}{dt} = 0 \Rightarrow g = v'^{-1}\left(-\frac{dY/dt}{dT/dt}\right)$$

where $y$ is the resident's nominal income – its share of the multinational's after-tax profits, $\beta\pi$ – and $dY/dt$ may be interpreted as the change in real income due to an increase in $t$, resulting from the direct change in nominal income plus the change in purchasing power due to price changes:

(4.2) $$\frac{dY}{dt} = \beta \frac{d\pi}{dt} - c_1 \frac{dp_1}{dt} - c_2 \frac{dp_2}{dt}.$$

The term $-\frac{dY/dt}{dT/dt}$ measures the *marginal cost of public funds*, accounting for the full cost, from the country's perspective, of raising an extra dollar of revenue. When we consider incremental changes that keep overall revenue fixed, a necessary and sufficient condition for increasing the real income and hence the well-being of the country's representative agent will be that the policy change reduces the marginal cost of public funds. That is, suppose we reduce the tax rate, $s$, under one system and increase the tax rate, $z$, under an alternative system. This would generate an increase in welfare if the marginal cost of public funds were higher under the first system, that is, if:

(4.3) $$-\frac{dY/dz}{dT/dz} < -\frac{dY/ds}{dT/ds}.$$

Two factors will play a role in determining whether this condition is met. First, as in a domestic context, the marginal cost of public funds will be higher as the deadweight loss from taxation is higher. This factor will encourage a shift to less distortionary taxes. Second, taxes may differ in the extent to which they can be exported – that is borne by non-residents – which increases the real income of *domestic* residents.

### *4.1. The choice between source-based and destination-based cash flow taxes*

Since source-based taxes are a standard form of taxation, we begin by asking whether an individual country would have an incentive to move to a destination base, starting from an equilibrium in which each country relies only on a source-based tax. We then consider the case in which both countries start with a destination-based tax.

To begin, we assume that the two countries have source-based cash flow taxes at rates $s$ and $s^*$. The home country then makes a marginal switch to a destination-based cash flow tax at rate $z$, holding tax revenue constant. However, so that we do not have to keep track of associated prices changes, we assume for simplicity that the destination-based tax is implemented in its equivalent form of a pure profits tax, at rate $z$, on the home country's share of profits (see expression (3.20)). In this case, the tax does not affect $p_2$ and hence expression (3.1) holds.

From (4.2), the effects of changes in the two tax rates on real income are:

(4.4) $$\frac{dY}{dz} = \beta\frac{d\pi}{dz} - c_1\frac{dp_1}{dz}\ ; \quad \text{and} \quad \frac{dY}{ds} = \beta\frac{d\pi}{ds} - c_1\frac{dp_1}{ds}$$

since the price of good 2 equals 1 under both tax systems. In this case, $p_1 = u'(c_1)$. Since an increase in $z$ is nondistortionary, its only behavioral impact will be to reduce $g$ and $c_2$; prices, consumption of good 1 and capital are all unaffected. As a result,

$$\frac{dY}{dz} = -\beta\pi = -\frac{dT}{dz} \tag{4.5}$$

and so condition (4.3) therefore reduces to $\frac{dY}{ds} + \frac{dT}{ds} < 0$; that is, the increase in real income from reducing the source-based tax must be larger than the decline in revenue. Put another way, the marginal cost of public funds in the initial equilibrium must exceed 1, since there is neither tax exporting nor distortion under the destination-based tax.

To identify the effects of a change in the source-based tax, we first specify the profit of the multinational as in (3.8), as

$$\pi = [(p_1c_1 - k)(1 - s) + (p_1^*c_1^* - k^*)(1 - s^*) - q(e - e^*)(s - s^*)] \tag{4.6}$$

The effect of a change in the source-based tax rate on real income is then:

$$\frac{dY}{ds} = \beta\left\{-p_1c_1 + k - q(e - e^*) + (1 - s)c_1\frac{dp_1}{ds} + (1 - s^*)c_1^*\frac{dp_1^*}{ds}\right\} - c_1\frac{dp_1}{ds}, \tag{4.7}$$

where other terms in $d\pi/ds$ are zero by the envelope theorem. Total tax levied is

$$T = z\beta\pi + s(p_1c_1 - k + q(e - e^*)). \tag{4.8}$$

Using $c_1 = h(x_1), e - e^* = f(k, m) - x_1$ and $\frac{df}{ds} = f_1\frac{dk}{ds} + f_2\frac{dm}{ds}$, this implies that

$$\frac{dT}{ds} = p_1c_1 - k + q(e - e^*) + s\left(c_1\frac{dp_1}{ds} + \left(p_1h' - q\right)\frac{dx_1}{ds} - (1 - qf_1)\frac{dk}{ds} + qf_2\frac{dm}{ds}\right) \tag{4.9}$$

Combining these expressions, rearranging and using $\beta + \beta^* = 1$ and $p_1 h^{'} = 1/f_1$ (from (3.10)[17]), we can write the condition for welfare improvement as:

$$(4.10) \quad -s\left(\frac{f_2}{f_1}\frac{dm}{ds}\right) - s\left(q - \frac{1}{f_1}\right)\left(\frac{d(e-e^*)}{ds}\right)$$

$$> \beta^*[p_1 c_1 + q(e-e^*) - k] + \beta(1-s^*)c_1^* \frac{dp_1^*}{ds} - \beta^*(1-s)c_1 \frac{dp_1}{ds}$$

To interpret this condition, consider first the three terms on the right-hand side. All reflect the division of profits between the two countries, and account for the reduction in tax exporting in shifting to the destination-based tax, under which there is no tax exporting. The first term is the direct incidence on foreign shareholders of a change in the tax rate on domestic profits. Lowering $s$ reduces this tax exporting effect. The second and third terms account for further shifting through induced changes in domestic and foreign output prices. These terms have different signs; an increase in the foreign consumer price benefits domestic residents by increasing their share of world-wide profits, while an increase in the domestic consumer price lowers domestic consumers' real income to the extent that the resulting domestic profits go to foreigners. Assuming that lowering $s$ reduces consumer prices, these two terms are, respectively, positive and negative, the first reducing the attractiveness of a shift from source-based taxation and the second increasing it.

The terms on the left-hand side of (4.10) are associated with the distortions of source-based taxation that a shift to a destination-based tax may lessen. The first, which will be positive, represents the increased revenue generated from attracting managerial capital by reducing the source-based tax. The second adjusts the change in tax revenue

[17] While (3.10) refers to the foreign country, symmetry implies that it holds for the home country as well.

associated with a change in exports for the fact that revenue is based on the reported transfer price rather than marginal cost. Assuming that net exports fall with an increase in $s$ (i.e., $\frac{d(e-e^*)}{ds} < 0$),[18] this term will also be positive (making adoption of the tax reform more likely) if the transfer price is overstated, i.e., in the "normal" cases A and B in which the low-tax country is the exporting country. In case A, the low-tax domestic country, by lowering its source-based tax, increases its gain via transfer pricing by expanding its exports. In Case B, the high-tax domestic country, by lowering its source-based tax, reduces its loss via transfer pricing by shrinking its imports.[19] Thus, both terms take the familiar form of marginal deadweight loss expressions, equal to a tax wedge multiplied by the change in quantity to which the wedge applies, although in this case the distortions are measured in terms of the welfare of the home country only.

Note that in cases C and D, where the high-tax country exports, the second term on the left-hand side of (4.10) will be negative, still assuming that net exports fall with an increase in $s$, and hence the presence of transfer-pricing manipulation *reduces* the country's likelihood of shifting away from a source-based tax. The intuition for this result is that, as discussed in Section 3, firms will export more when they can manipulate transfer prices to take advantage of a tax differential, even when exporting from a high-tax country. This promotes production in the high-tax country, and hence lessens the real behavioral response away from production there that would otherwise occur. Thus, for a high-tax

[18] This is shown in Appendix A for the case where the transfer price is set at marginal cost, preferences are the same in the two countries and the tax rates are initially equal.

[19] As discussed in the Introduction, one may think of the incentive to shift managerial capital as reflecting a failure of transfer pricing, in the sense that moving the factor from one country to the other requires no payment by the second country to the first. Under this interpretation, each factor on the left hand-side of expression (4.10) equals a transfer-pricing wedge (respectively, the marginal revenue product of managerial capital, since $1/f_1$ is the arm's length price of the intermediate good, and the transfer-pricing gap associated with trade in intermediate goods) multiplied by the applicable tax rate, $s$, and the associated behavioral response to the tax reform being considered.

exporting country (case C) or a low-tax importing country (case D) reducing its source-based tax, there will be less of a gain in domestic production activity.

For most of our remaining discussion, we will consider the special case in which countries have common preferences for good 1, common ownership shares, and equal initial tax rates. With equal tax rates, production will be the same in the two countries, and with equal preferences so will consumption of good 1 (since there are no income effects), so there will also be no net exports of good 1, and hence no incentive initially for a deviation from marginal-cost transfer pricing. For this case, Appendix A shows that consumer prices will be the same in the two countries, so that (4.10) reduces to:

$$(4.11) \qquad -s\left(\frac{f_2}{f_1}\frac{dm}{ds}\right) > \ \beta^*(p_1 c_1 - k)$$

(where in this case $\beta^*$= ½.) As both terms in (4.11) are positive, there is a trade-off between attracting managerial capital and the direct tax exporting effect. However, a higher initial value of $s$ would, c*eteris paribus*, make the shift more likely, with the nonlinearity of the efficiency term causing this effect to dominate the tax exporting term.

As this last point highlights, the attractiveness of a shift away from source-based taxation depends crucially on the initial source-based tax rate, $s$. For very low tax rates, distortions are small, and we would expect tax exporting to dominate. To illustrate this point, consider the alternative case in which both countries start with a destination-based tax and contemplate the *introduction* of a source-based tax. In this case, it is straightforward to show that conditions (4.10) and (4.11) still hold, evaluated at $s$ = 0. The terms on the left-hand sides of both expressions disappear – there is no first-order deadweight loss starting from a zero tax rate – and a sufficient condition for introducing

the source-based tax is that tax exporting increases with the tax, which must be the case in the symmetric initial equilibrium for which (4.11) applies. Thus, the appeal of the source-based tax depends on how high the rate is, and it is quite possible that countries will wish to shift away from a high source-based cash flow tax but not to eschew it entirely.

### *4.2. The choice between source-based and sales-apportioned cash flow taxes*

We now consider a shift from a source-based tax towards a sales-apportioned tax, continuing to focus on the simple case of a symmetric initial equilibrium. From the previous logic, home-country welfare will increase with the introduction of a sales-apportioned tax at rate $t$ as an equal-yield replacement for a source-based tax at rate $s$ if and only if:

$$(4.12) \qquad -\frac{dY/dt}{dT/dt} < -\frac{dY/ds}{dT/ds},$$

that is, if the marginal cost of funds is lower for the sales-apportioned tax upon its introduction than for the existing source-based tax. Since the right-hand of (4.12) – the marginal cost of funds for the source-based tax – will be the same as before, we need only consider the left-hand side of the expression. After-tax profits are:

$$(4.13) \qquad \pi = (1 - ta - t^*(1-a)) \begin{Bmatrix} (1-s)(p_1 c_1 - k) \\ +(1-s^*)(p_1^* c_1^* - k^*) + q(e^* - e)(s - s^*) \end{Bmatrix}.$$

where $a$ is the apportionment share defined in (3.13). The effect of a change in $t$ on real income, starting at $t$ = 0 in the symmetric equilibrium, is therefore:

$$(4.14) \ \frac{dY}{dt} = \beta \frac{d\pi}{dt} - c_1 \frac{dp_1}{dt} = -\beta(1-s)(p_1 c_1 - k) - (1 - \beta(1-s)) c_1 \frac{dp_1}{dt} + \beta(1-s^*) c_1^* \frac{dp_1^*}{dt}.$$

Now consider the changes in *T.* Using the definition of net exports, we have:

$$(4.15)\quad T = at\big((1-s)(p_1c_1-k)+(1-s^*)(p_1^*c_1^*-k^*)\big)+s\big(p_1c_1-k-qx_1+qf(k,m)\big)$$

and

$$(4.16)\qquad \frac{dT}{dt} = (1-s)(p_1c_1-k)+s\left(c_1\frac{dp_1}{dt}+qf_2\frac{dm}{dt}\right) = (1-s)(p_1c_1-k)+sc_1\frac{dp_1}{dt},$$

where the last equality comes from the fact, discussed above, that the sales-apportioned tax does not distort the location of *M*. Using the fact that $c_1 = c_1^*$, $\beta = \beta^*$, and $s = s^*$in the initial symmetric equilibrium, we therefore may express the left-hand side of (4.12) as:

$$(4.17)\qquad \frac{-\left(\frac{1}{2}(1-s)(p_1c_1-k)+\left(1-\frac{1}{2}(1-s)\right)c_1\frac{dp_1}{dt}-\frac{1}{2}(1-s)c_1\frac{dp_1^*}{dt}\right)}{(1-s)(p_1c_1-k)+sc_1\frac{dp_1}{dt}}$$

To evaluate this expression, we use (3.15) for the home and foreign country, from which we obtain, at $t = 0$,

$$(4.18)\qquad -\frac{(p_1c_1-k)p_1h'}{p_1c_1}+\frac{d(p_1h')}{dt}=\frac{d(p_1^*h^{*'})}{dt}$$

Consider first the special case with no consumption rents, i.e., $h'$ is constant and equal across the two countries. Then (4.18) reduces to $-\frac{(p_1c_1-k)}{c_1}+\frac{dp_1}{dt}=\frac{dp_1^*}{dt}$ and the marginal cost of funds in (4.17) equals 1; that is, *dY/dt = -dT/dt* in this case, because there is no tax exporting (and no first-order distortion). This is precisely the condition that holds for the destination-based tax, and therefore the condition from that analysis, (4.11), holds in this case as well; when there is no tax exporting under the sales-apportioned tax, the decision is the same as under the destination-based tax.

However, if there are consumption rents, then $-\frac{(p_1 c_1 - k) p_1}{p_1 c_1} + \frac{dp_1}{dt} < \frac{dp_1^*}{dt}$, since some of the tax wedge will show up in a reduced final-goods producer price as the demand for good 1 falls in the home country. This reduces the numerator of (4.17), because of tax exporting: with consumption rents, some of the burden of the sales-apportioned tax falls on producers, and some of this burden on producers is borne by foreign owners.

Note that this differs from the case of the destination-based tax because there is no substitution away from consumption of good 1 in that case. While the substitution effect results in a distortion here, the introduction of a small tax has only second-order deadweight loss (which does not show up in (4.17)) but first-order incidence effects. Thus, for a small shift away from source-based taxation, sales apportionment may be preferable to a destination-based approach, as the more favorable incidence effects may outweigh the small distortions to domestic consumption. But this trade-off would presumably be less favorable for a larger tax shift because of the nonlinearity of deadweight loss, and also does not account for the additional distortions of sales-apportioned taxes, already discussed above, which are not in the model.

## 5. Extensions

In this section, we discuss how various changes in assumptions would affect our results.

### *5.1. Different country sizes*

In the tax competition literature, a standard finding is that the optimal behavior of small and large countries differs. How would differences in country size affect our results? Intuitively, the smaller the country's relative size, the greater the responsiveness of the multinational to

changes in its tax policy. But a smaller country may also own a smaller share of the multinational's shares, and so may see a greater opportunity to export taxes to foreign shareholders.

As shown in Appendix B, both of these effects, which work in opposite directions, are present as a country's size falls. However, at least where the country's ownership share is proportional to its size, the effects exactly cancel and changes in relative size have no effect on the choice between source-based and destination-based taxes. This somewhat surprising result may be specific to our model, but it does illustrate that the direction of the net impact of a change in relative size is not clear.

### *5.2. Local ownership of fixed factors*

We have assumed that all three sources of rents accrue to multinationals. How would our results change if a greater share of these rents accrued exclusively to domestic factors, rather than to shareholders (some foreign) of the multinational? Intuition suggests that this would reduce the scope for tax exporting and make adoption of destination-based taxation more attractive, but is this actually the case?

In Appendix C, we consider the case in which only the rents to a mobile factor, managerial rents, accrue to the multinational. Again starting at the symmetric initial equilibrium with source-based taxation, condition (4.11) becomes:

(5.1) $$-s\left(\frac{f_2}{f_1}\frac{dm}{ds}\right) > 0$$

Thus, unlike in the symmetric equilibrium in which all earnings go to the multinational, the home country will definitely wish to move away from the source-based tax. In this

situation, with a smaller component of earnings going to the multinational and its shareholders worldwide, there are no opportunities for tax exporting because there are no domestic production or consumption rents accruing to foreigners.

### *5.3 Multinational's advantage as a public good*

We have treated the multinational as possessing a firm-specific mobile factor, managerial capital, which is in fixed supply. But some firm-specific factors, such as patents and other intangible assets, might be better characterized as having at least some public good aspects, their use in one location not fully precluding their use in the other. How might this affect our results?

The answer depends on what assumptions we maintain about other factor inputs. To the extent that the firm still utilizes the factors of production assumed in our model, the addition of a public input would have little impact on the analysis, effectively reducing costs in both countries by increasing output given the levels of the other factors, but not altering the incentives. There would still be local decreasing returns to the use of capital and managerial capital, and still the same equilibrium conditions. On the other hand, if the firm had a public input but did not use managerial capital in production, the only remaining distortion would be to the internal transfer price used in the export of the firm's first-stage output from one country to the other.

As this discussion highlights, attributing rents to specific factors of production is not straightforward. A firm with fixed inputs in both production and consumption locations will earn rents due to these factors as well as whatever overall cost advantages it may have relative to competing firms that determine prices for final output and purchased inputs, in this case capital. The rents are clearly specific to the firm, but they are a joint product of location-specific and non-location-specific factors.

## 6. Conclusions

This paper models the effects of cash-flow taxes in a two-country model with trade of semi-finished goods and a representative multinational that produces and sells in each of the countries and allocates capital and managerial skill between them for production. There are three sources of rents assumed to accrue the multinational: a fixed factor in each country of basic production; managerial skill, mobile between the two countries; and a fixed factor in the country of consumption, associated with preparing the semi-finished good for the local market. We consider three main forms of cash-flow taxation, all of which would be equivalent in a closed economy: a cash-flow tax levied on the multinational on a source basis, the equivalent tax levied on a destination basis, and one whose base is allocated using sales-only formula apportionment. We describe the production and consumption distortions these taxes generate.

We also investigate whether there is an incentive for a national government to move away from an equilibrium in which both countries use only the standard source-based tax. We show that the government faces a trade-off. On the one hand, movement from a source-based tax to a destination-based tax reduces distortions and improves welfare. On the other hand, the source-based cash-flow tax is partially incident on the owners of the multinational; since some of them may be non-residents, the tax can improve the welfare of domestic residents, if its distortions are small relative to this shifting. For a shift to the sales-apportioned tax, the calculus is somewhat more complicated, as the apportioned tax may also partially be shifted to non-residents, but also introduces various distortions that are absent under the destination-based tax.

However, even if countries may wish to shift away partially from source-based cash-low taxation, there may be limits, for as reliance on source-based taxation falls, the cost of its distortions falls faster than the benefits of tax exporting. The degree of tax exporting and hence the attractiveness of source-based taxation will depend on other factors as well, such as the extent to which rents accrue to local factors rather than multinationals, and the pattern of multinational ownership across nations. While this variety of factors rules out any definitive conclusion about the likelihood of an eventual switch away from source-based taxation, the intensive search among policy makers for alternatives to existing systems for the taxation of multinationals is at the least very suggestive. Of course, evaluation of alternative systems would also need to take into account factors that we have not included in our model, such as partial mobility of consumers through cross-border shopping, and more general issues of implementation and enforcement.[20]

[20] See Devereux and de la Feria (2013) for a discussion of issues of implementation of a destination-based tax.

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## APPENDIX A: Derivations of various results in the main text

### 1. Derivation of expression (3.15)

From (3.13), profits are:

(A.1) $\pi = (p_1 h(x_1) + p_1^* h(f(k,m) + f(K-k, M-m) - x_1) - K)[1 - ta - t^*(1-a)]$,

where $a = \frac{p_1 h(x_1)}{p_1 h(x_1) + p_1^* h(f(k,m) + f(K-k, M-m) - x_1)}$.

Differentiating with respect to $K$ yields:

(A.2) $$\left(p_1^* h'(x_1^*) f_1(k^*, m^*) - 1\right)[1 - ta - t^*(1-a)] - \pi(t - t^*)\frac{da}{dK} = 0.$$

But $\frac{da}{dK} = -\frac{a}{p_1 c_1 + p_1^* c_1^*} p_1^* h'(x_1^*) f_1(k^*, m^*)$, so (A.2) simplifies to:

(A.3) $$\left[1 + \frac{a\pi^G (t-t^*)}{[1 - ta - t^*(1-a)](p_1 c_1 + p_1^* c_1^*)}\right] p_1^* h'(x_1^*) = \frac{1}{f_1(k^*, m^*)}$$

Expression (3.15) follows from the fact that there is production efficiency. A similar expression for the home country follows from the first-order condition with respect to $x_1$.

### 2. Derivation of results around (4.11) that (1) $\frac{d(e-e^*)}{ds} < 0$; and (2) consumer prices are the same for an initial symmetric equilibrium with marginal cost pricing:

Combining expressions (3.10) and (3.11) and then taking the derivative with respect to *s*,

(A.4) $$\frac{1}{f_1^*}(f_1 - f_1^*)(1 - s^*) + (1 - q f_1)(s - s^*) = 0$$

(A.5) $$\frac{1}{f_1^*}(1 - s^*)\frac{df_1}{ds} - \frac{f_1}{f_1^{*2}}(1 - s^*)\frac{df_1^*}{ds} + (1 - q f_1) - q(s - s^*)\frac{df_1}{ds} = 0$$

With initial marginal cost pricing, $q = 1/f_1^* = 1/f_1$, so (A.5) reduces to

(A.6) $$(1-s)\frac{df_1}{ds} = (1-s^*)\frac{df_1^*}{ds}$$

Combining expressions (3.10) and (3.12) and then differentiating with respect to *s* yields,

(A.7) $$\frac{1}{f_1^*}(f_2 - f_2^*)(1-s^*) - qf_2(s-s^*) = 0$$

(A.8) $$\frac{1}{f_1^*}(1-s^*)\frac{df_2}{ds} - \frac{1}{f_1^*}(1-s^*)\frac{df_2^*}{ds} - \frac{(f_2-f_2^*)}{{f_1^*}^2}(1-s^*)\frac{df_1^*}{ds} + -qf_2 - q(s-s^*)\frac{df_2}{ds} = 0$$

Using initial marginal cost pricing, $q = \frac{1}{f_1^*}$, and using (A.7) to substitute for $(f_2 - f_2^*)$ yields:

(A.9) $$(1-s^*)\frac{df_2}{ds} - (1-s^*)\frac{df_2^*}{ds} - \frac{f_2}{f_1^*}(s-s^*)\frac{df_1^*}{ds} + -f_2 - (s-s^*)\frac{df_2}{ds} = 0$$

Starting from an equilibrium in which $s = s^*$, expressions (A.6) and (A.9) reduce to:

(A.10) $$\frac{df_1}{ds} = \frac{df_1^*}{ds}$$

and

(A.11) $$\frac{df_2}{ds} - \frac{df_2^*}{ds} = \frac{f_2}{1-s}$$

Combining (A.10) and (A.11) and noting that starting from a symmetric equilibrium the second derivatives of the production functions are the same across countries, we obtain:

(A.12) $$\frac{dm^*}{ds} - \frac{dm}{ds} = -\frac{f_{11}}{D}\frac{f_2}{(1-s)} > 0$$

(A.13) $$\frac{dk^*}{ds} - \frac{dk}{ds} = \frac{f_{12}}{D}\frac{f_2}{(1-s)} > 0$$

where $D = f_{11}f_{22} - f_{12}f_{21} > 0$ is the determinant of the Hessian of the production function. Since both *m* and *k* shift abroad with an increase in *s*, so must the first stage of production.

Note that (3.9')-(3.11') imply that $p_1 h'$=$p_1^* h^{*'}$. Since marginal utility equals the price in each country, this implies that $u'(h(x_1))h'(x_1)$=$u^{*'}(h(x_1^*))h'(x_1^*)$, where we have used the fact that the *functions* $h(.)$ and $h'(.)$ are the same in the two countries. Thus, if preferences are the same in the two countries, we have $u'(h(x_1))h'(x_1)$=$u'(h(x_1^*))h'(x_1^*)$. This expression is satisfied if $x_1 = x_1^*$, and the solution is unique: since both $h''$ and $u''$ are negative, the derivative of either side with respect to its argument is negative, so the equality cannot hold for $x_1 \neq x_1^*$. Hence the increase in *s* decreases domestic production but does not change relative consumption. Therefore, domestic exports fall with *s*.

Note also that, because consumption of good 1 remains the same in the two countries, so must the price of good 1, again under the assumption of common preferences, equal initial tax rates, and marginal cost pricing.

**APPENDIX B: The impact of variations in relative country size**

We suppose that, rather than there being one individual with unit endowment in each country, there are $\alpha$ and $\alpha^*$, with $\alpha + \alpha^* = 1$. Also assume that the shares of ownership in the multinational are the same, i.e., that $\beta = \alpha$ and $\beta^* = \alpha^*$. In order to scale the location-specific fixed factors to country size, let the production functions $f(\cdot)$ and $h(\cdot)$ be expressed in per capita terms, with $f(\cdot)$ the same across countries and $h(\cdot)$ the same as well when preferences are identical. For this case, it may be shown that expression (4.11) still holds, with $c_1$, $k$, and $m$ all now interpreted in per capita rather than absolute terms. Thus, as the country's size falls, tax exporting increases and this makes keeping the source-based tax more attractive. As to the left-hand side of (4.11), note that the expression accounting for the use of $M$ is now

(2.3’) $M = \beta m + \beta^* m^*$

Thus, $\beta^* \frac{dm^*}{ds} + \beta \frac{dm}{ds} = 0$, so (A.12) implies that $\frac{dm}{ds} = \beta^* \frac{f_{11}}{D} \frac{f_2}{(1-s)}$, which increases in size as the home country’s relative size decreases, i.e., as $\beta^*$ increases. Thus, the left- and right-hand sides of (4.11) are both scaled by $\beta^*$ and the effects of country size on the tax-exporting and distortion effects cancel.

**APPENDIX C: The impact of local ownership of fixed factors**

We now modify the model, assuming that rents to fixed factors accrue to domestic residents instead of to the multinational. There are two fixed factors implicit in the production functions $f(k,m)$ and $h(x_1)$. To make these explicit, we can rewrite the intermediate production function $f(\cdot)$ and the final production function $h(\cdot)$ each as having an additional argument, e.g., $f(k,m,r)$ and $h(x_1,\rho)$, with constant returns to scale and (assuming the multinational is a price-taker with respect to these fixed factors) with the corresponding competitive returns to these arguments denoted by $q_r$ and $q_\rho$ in the home country and likewise with an asterisk in the foreign country.

With these additional factors taken into account, the firm’s objective is to maximize profits as given in expression (3.8) minus $(q_r r + q_\rho \rho)(1-s) + (q_r^* r^* + q_\rho^* \rho^*)(1-s^*)$, assuming that the fixed-factor rents are taxed at the same tax rate in each country as the multinational is. With this modification of its objective, the firm’s first-order conditions given in (3.9)-(3.12) are unchanged, and there are four new first-order conditions for the use of each of the fixed factors:

(C.1) $\rho$: $p_1 h_2 = q_\rho$

(C.2) $\rho^*$: $p_1^* h_2^* = q_\rho^*$

(C.3) $r$: $p_1^* h^{*'} f_3(1-s^*) - q f_3(s-s^*) = q_r(1-s)$

(C.4) $r^*$: $p_1^* h^{*'} f_3^* = q_r^*$

where $h_2 = c_1 - h' x_1$ and $f_3 = f - f_1 k - f_2 m$ (and similarly for the foreign country). Note that by the symmetry of the set-up, it also follows that $p_1 h' f_3 = q_r$. In equilibrium, of course, the four fixed factor prices will be determined by the market clearing conditions that demand for each of the fixed factors equals its unit supply.

With this modification, consider again the issue of whether the home country will wish to shift from a source-based tax to a destination-based tax. In place of equation (4.6), the income of domestic residents is

$$\text{(C.5)} \qquad y = (1-z)[\beta\pi + \beta^* D(1-s) - \beta F(1-s^*)]$$

where $\pi$ is as defined in expression (3.8), $D = q_r r + q_\rho \rho$ and $F = q_r^* r^* + q_\rho^* \rho^*$ (and each rent quantity equals 1 in equilibrium).

Based on (C.5), the change in domestic income with respect to $s$ is now:

$$\text{(C.6)} \quad \frac{dY}{ds} = \frac{dy}{ds} - c_1\frac{dp_1}{ds} = \begin{Bmatrix} -\beta\big(p_1 c_1 + k - q(e-e^*)\big) - \beta^* D + \\ (1-s)\left(\beta c_1 \frac{dp_1}{ds} + \beta^* \frac{dD}{ds}\right) + (1-s^*)\left(\beta c_1^* \frac{dp_1^*}{ds} - \beta\frac{dF}{ds}\right) \end{Bmatrix} - c_1\frac{dp_1}{ds}$$

where the remaining terms vanish due to the envelope theorem, from the firm's maximization of $\pi - D(1-s) - F(1-s^*)$. Adding this expression to $dT/ds$ as defined in (4.9) yields, after some algebra:

$$\text{(C.7)} \quad -s\left(\frac{f_2}{f_1}\frac{dm}{ds}\right) - s(q-\bar{q})\left(\frac{d(e-e^*)}{ds}\right) > \quad \beta^*(p_1 c_1 + q(e-e^*) - k - D)$$

$$+(1-s^*)\beta\left(\mathrm{c}_1^*\frac{\mathrm{dp}_1^*}{\mathrm{ds}} - \frac{\mathrm{dF}}{\mathrm{ds}}\right) - (1-s)\beta^*\left(c_1\frac{dp_1}{ds} - \frac{dD}{ds}\right)$$

where $\bar{q} = 1/f_1$ is the marginal cost of the intermediate good produced at home (likewise for $\bar{q}^*$ abroad).

Once again assuming a symmetric initial equilibrium, this expression reduces to:

$$\text{(C.8)} \quad -s\left(\frac{f_2}{f_1}\frac{dm}{ds}\right) > \ \tfrac{1}{2}(p_1 c_1 - k - D) + \frac{(1-s)}{2}\left(\frac{dD}{ds} - \frac{\mathrm{dF}}{\mathrm{ds}}\right).$$

Since, in the symmetric equilibrium, domestic and foreign fixed factor returns are profits in each country excluding returns to managerial capital (by assumption measured at true marginal cost),

$$\text{(C.9)} \quad D = p_1 c_1 - k - \bar{q} f_2 m\,; \qquad F = p_1 c_1 - k^* - \bar{q} f_2^* m^*,$$

it may be also be shown (again using the envelope theorem) that

$$\text{(C.10)} \ \frac{dD}{ds} = c_1\frac{dp_1}{ds} - \ m\frac{d(\bar{q}f_2)}{ds}\,; \qquad \frac{dF}{ds} = c_1\frac{dp_1}{ds} - \ m^*\frac{d(\bar{q}^* f_2^*)}{ds}$$

But, using (A.10) – which implies that $\frac{d\bar{q}}{ds} = \frac{d\bar{q}^*}{ds}$ – and (A.11),

$$(1-s)\left(\frac{dD}{ds} - \frac{dF}{ds}\right) = (1-s)\left(m^*\frac{d(\bar{q}^* f_2^*)}{ds} - m\frac{d(\bar{q}f_2)}{ds}\right)$$

$$= (1-s)f_2(m^* - m)\frac{d\bar{q}}{ds} + \bar{q}\left[m^*\left(-f_2 + (1-\mathrm{s})\frac{df_2}{ds}\right) - m(1-s)\frac{df_2}{ds}\right] = -\bar{q}f_2 m^*,$$

so (C.8) may be rewritten

$$\text{(C.11)} \ -s\left(\frac{f_2}{f_1}\frac{dm}{ds}\right) > \ \tfrac{1}{2}(p_1 c_1 - k - (p_1 c_1 - k - \bar{q}f_2 m) - \bar{q}f_2 m^*) = \tfrac{1}{2}\big(\bar{q}f_2(m - m^*)\big) = 0\,.$$