Consumption and Cash-Flow Taxes in an International Setting[*]

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PEP 3

Abstract

We model the effects of consumption-type taxes which differ according to the base and location of the tax. Our model incorporates a monopolist producing and selling in two countries with three sources of rent, each in a different location: a fixed factor (located with production), mobile managerial skill, and a monopoly mark-up (located with consumption). In the general case, we show that for national governments, there are tradeoffs 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 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. In the alternative case of perfect competition, with the returns to the fixed factor accruing to domestic residents, the only distortion from the source-based tax is through the allocation of the mobile managerial skill. In this case, the source-based tax is also incident only on domestic residents, and is dominated by an equivalent tax on a destination basis, or by a sales tax.

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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 effective marginal tax rate of a source-based capital income tax in a small open economy is zero (see Gordon, 1986). Raising this tax rate increases the required pre-tax rate of return in that location; this reduces the quantity of capital located there, which in turn creates an excess burden which could be avoided by taxing immobile factors directly.

One alternative to income taxation is consumption-type taxation. This paper investigates the effects of different types of consumption-type taxation on factor allocation, production and consumption in a two-country framework. Our particular interest is in the three versions of the business cash-flow tax levied on business profit.[1] The latter three taxes differ in how the profit is allocated across the two countries. We analyze the case where aggregate profit is allocated by an apportionment factor based on the location of sales; a "destination" tax akin to VAT where exports are tax exempt, but imports are taxed; and a conventional source-based tax. We explore and compare the efficiency properties of each of these forms of taxation. We show that there are many potential distortions even when capital income is excluded from the tax base, so that the tax is based only on profit or economic rent. We also examine a game played between the two countries to consider what the non-cooperative outcome would be if the two countries chose their tax systems independently. In particular, starting from the most common form of taxation, the source-based tax, we analyze whether countries have an incentive to switch at least part of their tax system to one of the other forms.

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[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.

We model a single company which has a plant in each country, which supplies a representative consumer in each country, and which is owned equally by the two consumers. The company generates profit in three ways. First, it has the use of a fixed factor in each production location, 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. Second, the company can allocate both capital and managerial skill freely between the two countries. The profit generated from access to managerial skill, assumed to be owned by the company, is therefore mobile between the two countries. Third, in our base case, the company is a monopolist that can exploit its market power in each of the two markets. This component of profit is therefore located in the destination country, where the consumer is resident.

Within this framework, even taxes on business profits can affect economic behavior. For example, consider the effects of a source-based cash-flow tax applied to the company in each country, where the home country has a higher tax rate, and the only cross-border trade in the final good is an export from the foreign country to the home country. In this case, marginal domestic sales are supplied from the foreign country, but existing sales are supplied in part from the home country and taxed at a higher rate. With market power, the firm earns profits. Hence, even under a cash-flow tax, it will have an incentive to shift production to the foreign country, where the tax rate is lower.[2]

The monopolist's pricing decision will also be affected. Since that part of home country sales that are supplied from the home country are taxed at a higher rate, then as consumption rises and the price falls, the decline in monopoly profits on existing sales will be smaller. As a

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[2] Note that this depends on production taking place in both countries. If the company chooses to produce in only one country, then its discrete choice of which country to choose will depend on the tax rate. Bond and Devereux (2002) compare the properties of source- and destination-based taxes in this framework.

result, the monopolist has a smaller incentive to restrict sales in the home country, and consequently, marginal revenue will be lower in the home country than in the foreign country. In this case, then, production is discouraged in the country with higher tax rate, but consumption is encouraged.

A further distortion arises in the allocation of managerial skill between the two plants. Since this factor is assumed to be already owned by the company, its use does not generate tax relief, and so there is an incentive to switch its use to the lower-taxed country. This could be considered to be a transfer-pricing issue. If, for example, the home country plant charged an appropriate price for the transfer of managerial skill to the foreign plant, then this effect would disappear.

By contrast, a destination-based tax implemented in both countries along the lines of a VAT (but with labor costs deductible) would be efficient, equivalent to a lump-sum tax. This stems from the assumption that the representative consumer is immobile. A tax based solely on the revenue generated in each market cannot be avoided by switching factors of production (and trade flows) between countries.

A source-based cash-flow tax does have an attractive property, even though it does cause distortions, including to the location of production. The incidence of such a tax is on the owners of the company. As long as the company is at least partly owned by non-residents, then the source-based tax is partly incident on those non-residents. In a non-cooperative setting, then, there is a trade-off for governments in setting a source-based tax rate. On the one hand, a higher tax rate 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 generally falls on non-residents.

Beginning with the standard case in practice of only a source-based tax in each country, we ask whether the home country government has an incentive to switch part of its tax base away from the source base to either a destination base or a sales tax on the good produced by the monopolist. In the general case, it is not possible to identify whether the government should do this or not. The reason is just the tradeoff mentioned between the benefit of taxing non-residents as against the deadweight loss imposed by the source based tax.

However, this benefit of the source-based tax is not present in an alternative framework which we model. In this framework, there a number of identical companies that are price takers and the rent earned by the fixed factor accrues to domestic residents rather than to the monopolist. This generates a direct benefit to the representative resident from attracting production activity, in that the price of the fixed factor is bid up by more production. In this case, the only source of measured company profits (which we continue to assume are shared equally between jurisdictions) is the returns to managerial skill.

In this setting, it is possible to show that a switch to either the destination based tax, or the sales tax, would be beneficial. There are two key features of this result, both stemming from the assumption of perfect competition. First, there are no distortions or mark-ups arising from monopoly pricing. Second, a logical consequence of perfect competition is that the returns to the fixed factor are captured by domestic residents, rather than by the companies. In this case, there are no second-best considerations related to the pre-existing monopoly distortions, and it is no longer true that non-residents bear part of the tax burden, since the whole rent is captured by domestic residents. As a consequence, there is no tradeoff; a switch away from the source-based tax improves home country welfare.

This result appears to be at odds with several claims in the literature regarding the equivalence of destination and source-based taxes. In this model, the only remaining distortion in the perfect competition framework outlined reflects the choice of where to locate managerial skill. That in turn, reflects a transfer pricing decision, since in our model this factor can be allocated freely, and hence in effect the transfer price is zero. If instead, we assumed that the factor was wholly owned in one country, and that its transfer to the other country was appropriately priced, then even this distortion would disappear, and the two taxes would both be equivalent to lump-sum taxes. This is implicitly the framework underlying the contributions of Auerbach (1997), Bradford (2003) and others, resulting in the claim that destination-based and source-based consumption taxes are equivalent.[3] We show in this paper the nature of the assumptions that need to be made for such an equivalence to hold.

In that respect, this paper relates closely to the literature investigating the comparison between 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. 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 in the presence of perfect competition and factor immobility. This would also be true in our model, though as noted above, mobile managerial skill would not overturn this result under appropriate transfer pricing. Beyond this, Lockwood (building on Lockwood, 1993, and Keen and Lahiri, 1998) also finds that the introduction of

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[3] See also Avi-Yonah (2000), and Grubert and Newlon (1997).

imperfect competition destroys this equivalence. We discuss the comparison with these papers further below.

The remainder of the paper is organized as follows. Section 2 sets up the base case model, and analyzes the impact of the four taxes (a domestic sales tax on one good only, and a cash-flow corporation tax based on formula apportionment, a destination base, and a source base) when both countries adopt the same form of taxation. To set the scene, and for the purposes of comparison, this section also considers a lump-sum tax, and a domestic sales tax on all goods, which also amounts to a lump-sum tax in our model. Given that source-based taxes are dominant in practice, Section 3 addresses the question of whether, starting from a symmetric equilibrium in which countries impose a source-based tax at the same rate, the home country has an incentive to switch part of its tax base to either a destination basis or a sales tax on one good only. Section 4 extends the framework of the model by incorporating price-taking firms in place of the single monopolist. It also considers the case in which the return to the fixed factor accrues only to domestic residents, and not to the companies. Section 5 concludes.

2. Properties of common tax regimes

There are two countries. Each country has a representative agent with a utility function of the form

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

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. To make the model tractable, we assume that there are no income effects in the demand for good 1. In general, we allow the shape of the utility

9

function for good 1 to differ between the two countries, although we also study the symmetric case in which the utility functions are the same.

In each country there is one unit of an endowment good. Production of one unit of good 2 in each country uses one unit of endowment. The production of good 2 is therefore characterized by constant returns to scale, and is assumed to be perfectly competitive, so that there are no profits. Good 2 can be used as a public good (g) or as consumption (c_2), with the remainder supplied as capital to the world capital market. Hence, the total world supply of capital (K) is

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

where k is the amount of capital used in the home country and k^* is the amount used abroad. Good 1 is produced using two factors, capital and managerial skill (m), the overall stock of which is assumed to be in fixed supply, M. Thus

(2.3) $\qquad M = m + m^*$.

We assume that the production function for good 1 is the same in both countries, $f(k,m)$, and that there are decreasing returns to scale because of some fixed factor in each country. There are no transportation costs, so without taxes the locations of production and consumption are unrelated. Hence

(2.4) $\qquad c_1 + c_1^* = f(k,m) + f(k^*,m^*)$.

The locations of capital production and capital use are also unrelated.

As already discussed, we assume in our base case that good 1 is supplied by a single monopolist; ownership and hence profits (π) are shared equally between the two countries' representative agents. The profits have three components: returns to the fixed factor, returns to managerial skill, and monopoly mark-ups over marginal cost. The effective locations of these components differ. The return to the fixed factor is located in the country hosting the fixed

factor;[4] the return to managerial skill is mobile, and depends on the location of the managerial skill itself; and the monopoly mark-up depends on demand and hence is located in the country of consumption. The differences in location for these components of profits are important in modeling the impact of alternative taxes on profits.

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 3 we consider the incentives to deviate from a common tax base.

2.1 Lump sum tax

To set the stage, consider first the case of lump sum taxes (T and T^*) levied on the consumer in each country, and equal to government spending, $T = g; T^* = g^*$.

Individuals choose consumption of goods 1 and 2 to maximize utility, U or U^*, subject to a budget constraint:

(2.5) $$p_1 c_1 + p_2 c_2 = 1 + \frac{\pi}{2} - T ; \qquad p_1^* c_1^* + p_2^* c_2^* = 1 + \frac{\pi}{2} - T^* .$$

Without income effects and assuming that the price of good $2 \equiv 1$, this implies

(2.6) $$u'(c_1) = p_1 ; \quad u^{*'}(c_1^*) = p_1^* .$$

The profits of the monopolist are:

(2.7) $$\pi = p_1 c_1 + p_1^* c_1^* - K .$$

Substituting (2.2), (2.3), (2.4) and (2.6) into the expression for profits yields:

(2.8) $$\pi = u'(c_1)c_1 + u^{*'}(f(k,m) + f(K-k, M-m) - c_1)\{f(k,m) + f(K-k, M-m) - c_1\} - K$$

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[4] Here we assume either that the fixed factors are owned directly by the monopolist, or that the monopolist, as a monopsonist for the fixed factors, bids their prices down to zero.

Maximizing profits with respect to k, m, K, and c_1, and yields the following first-order conditions for profit maximization:

(2.9) $\qquad f_1(k,m) = f_1(k^*, m^*)$

(2.10) $\qquad f_2(k,m) = f_2(k^*, m^*)$

(2.11) $\qquad u^{*}{'}(c_1^*) + u^{*}{''}(c_1^*)c_1^* = \dfrac{1}{f_1(k^*, m^*)}$

(2.12) $\qquad u'(c_1) + u''(c_1)c_1 = u^{*}{'}(c_1^*) + u^{*}{''}(c_1^*)c_1^*$

Conditions (2.9) and (2.10) 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 (2.11) calls for setting marginal revenue equal to marginal cost. Condition (2.12) implies that marginal revenues should be independent of consumption location.

Given that production functions are the same in the two countries, then (2.9) and (2.10) imply that $k = k^* = K/2$ and $m = m^* = M/2$. In turn, this implies that these four first-order conditions imply:

(2.13) $\qquad u'(c_1) + u''(c_1)c_1 = \dfrac{1}{f_1(\frac{K}{2}, \frac{M}{2})} ; \qquad u^{*}{'}(c_1^*) + u^{*}{''}(c_1^*)c_1^* = \dfrac{1}{f_1(\frac{K}{2}, \frac{M}{2})} .$

The home government chooses the lump sum tax T to maximize utility, U, subject to its budget constraint, $T = g$. The foreign government faces the equivalent problem. This yields:

(2.14) $\qquad u'(c_1)\dfrac{\partial c_1}{\partial T} + \dfrac{\partial c_2}{\partial T} + v'(g) = 0 ; \qquad u^{*}{'}(c_1^*)\dfrac{\partial c_1^*}{\partial T^*} + \dfrac{\partial c_2^*}{\partial T^*} + v'(g^*) = 0 .$

With no income effects in the demand for good $1, \partial c_1/\partial T = \partial c_1^*/\partial T^* = 0$. Given the household

budget constraints (2.5), this implies that $\partial c_2/\partial T = \partial c_2^*/\partial T^* = -1$. Thus, $v'(g) = v'(g^*) = 1$,

which implies that the optimal value of the public goods, $\bar{g}$ and $\bar{g}^*$, are given by:

(2.15) $\bar{g} = v'^{-1}(1); \quad \bar{g}^* = v^{*'-1}(1).$

  Note that the consumer budget constraints can be rewritten as

(2.16) $$u'(c_1)c_1 + c_2 = 1 + \frac{\left(u'(c_1)c_1 + u^{*'}(c_1^*)c_1^* - K\right)}{2} - \bar{g} \; ;$$

$$u^{*'}(c_1^*)c_1^* + c_2^* = 1 + \frac{\left(u'(c_1)c_1 + u^{*'}(c_1^*)c_1^* - K\right)}{2} - \bar{g}^*$$

These two constraints represent only one new equation, given Walras' law. Equation (2.2),

combined with (2.4), (2.13) and (2.16) represent five equations in five unknowns, the four

consumption levels and the capital stock, K, that can be solved for their equilibrium values.

  Having summarized the equilibrium conditions when both countries use lump-sum taxes,

we now consider the effects of using other tax systems.

2.2. Uniform domestic consumption tax

  Suppose that the home country imposes a tax at tax-inclusive rate t on consumption of

goods 1 and 2, and the foreign country imposes a tax of the same form at rate t^*. Define p_1 and p_2

to be the home-country consumer prices, inclusive of tax, of goods 1 and 2 respectively with the

same notation convention abroad. Taxes are therefore

(2.17) $T = t\{p_1c_1 + p_2c_2\}; \quad T^* = t^*\{p_1^*c_1^* + p_2^*c_2^*\}$

As there are no taxes on production, the producer price of the numeraire good 2 remains equal to 1 in both countries. This implies that the consumer prices of good 2 become $1/(1-t)$ and $1/(1-t^*)$. With these prices, the conditions for utility maximization become:

$$(2.18) \qquad u'(c_1) = \frac{p_1}{p_2} = (1-t)p_1; \qquad u^{*'}(c_1^*) = \frac{p_1^*}{p_2^*} = (1-t^*)p_1^*.$$

After-tax profits of the monopolist are:

$$(2.19) \qquad \pi = p_1(1-t)c_1 + p_1^*(1-t^*)c_1^* - K \ .$$

Combining (2.18) and (2.19) yields the same expression for profits as above, (2.8). Thus the conditions for profit-maximization, (2.9)-(2.12), are also the same as in the case of the lump-sum tax. Finally, the household budget constraint becomes

$$(2.20) \qquad u'(c_1)c_1 + c_2 = (1-t)\left(1 + \frac{\left(u'(c_1)c_1 + u^{*'}(c_1^*)c_1^* - K\right)}{2}\right),$$

with the equivalent for the foreign country.

Since the choice of tax rate t amounts to a lump-sum tax on endowment and profits, both of which are unaffected by the tax rate, it amounts to a lump-sum tax on domestic residents. As a consequence, $g = \bar{g}$ and $g^* = \bar{g}^*$: the equilibrium is unchanged.

2.3. Domestic sales tax on good 1 only

It is useful to consider good 2 to be an untaxed good, such as leisure, so that the sales tax will have some distortionary impact, as would be realistic. With no tax on good 2 in either country, individual maximization yields the same expressions as for the lump-sum tax, (2.6). After-tax profits are therefore:

14

(2.21)
$$\pi = (1-t)u'(c_1)c_1 + (1-t^*)u^{*\prime}\left(f(k,m) + f(K-k,M-m) - c_1\right)$$
$$* \{f(k,m) + f(K-k,M-m) - c_1\} - K$$

Maximization with respect to k and m will still yield production efficiency, since all the terms in k and m are multiplied by $(1\text{-}t^*)$. However, condition (2.13) becomes:

(2.22)
$$(1-t)\left(u'(c_1) + u''(c_1)c_1\right) = \frac{1}{f_1(\dfrac{K}{2},\dfrac{M}{2})} \; ,$$

with the equivalent for the foreign country. The consumer choice of good 1 is therefore distorted in each country.

The government now faces a more complicated decision since increasing the tax will have substitution effects as well as income effects. The government chooses the tax rate t, again to maximize U, subject to the consumer's budget constraint:

(2.23)
$$u'(c_1)c_1 + c_2 = 1 + \frac{\pi}{2} = 1 + \frac{\left(u'(c_1)c_1(1-t) + u^{*\prime}(c_1^*)c_1^*(1-t^*) - K\right)}{2},$$

and the government's budget constraint

(2.24)
$$g = T = tu'(c_1)c_1 .$$

Substituting (2.23) into the expression for U, and maximizing with respect to t, implies

(2.25)
$$\frac{1}{2}\frac{d\pi}{dt} - c_1\frac{dp_1}{dt} + v'(g)\frac{dT}{dt} = 0$$

The first two terms in this expression represent the change in real income due to an increase in t, resulting from the direct change in nominal income through π, plus the change in purchasing power due to price changes. Letting Y be real income, we will define

(2.26)
$$\frac{dY}{dt} = \frac{1}{2}\frac{d\pi}{dt} - c_1\frac{dp_1}{dt} = \frac{1}{2}\frac{d\pi}{dt} - u''(c_1)c_1\frac{dc_1}{dt}$$

to indicate the effect of t on real income. Combining (2.25) and (2.26), we therefore have

15

$$(2.27) \qquad \frac{dY}{dt} + v'(g)\frac{dT}{dt} = 0 \Rightarrow g = v'^{-1}\left(-\frac{dY/dt}{dT/dt}\right).$$

To take this further, consider $d\pi/dt$. From the term for income on the extreme right-hand side of (2.23), we have:

$$(2.28) \qquad \frac{d(\pi/2)}{dt} = \frac{\left((1-t)[u"c_1 + u']\dfrac{dc_1}{dt} + (1-t^*)\left[u^{*}"c_1^* + u'\right]\dfrac{dc_1^*}{dt} - \dfrac{dK}{dt} - u'c_1 - u^{*'}c_1^*\dfrac{dt^*}{dt}\right)}{2}$$

where we include the possibility that the foreign tax rate will respond to the domestic tax rate, since the demand for good 1 is affected. Substituting using (2.22) and its equivalent for the foreign country implies that the first three terms on the right hand side sum to zero. Hence

$$(2.29) \qquad \frac{dY}{dt} = -u"(c_1)c_1\frac{dc_1}{dt} - \frac{1}{2}\left\{u'(c_1)c_1 + u^{*'}(c_1^*)c_1^*\frac{dt^*}{dt}\right\}.$$

By comparison, we have:

$$(2.30) \qquad \frac{dT}{dt} = u'(c_1)c_1 + t\left[u"(c_1)c_1 + u'(c_1)\right]\frac{dc_1}{dt}.$$

Comparing these two expressions yields:

$$(2.31) \qquad \frac{dY}{dt} = -\frac{dT}{dt} + \left[tu' - (1-t)u"c_1\right]\frac{dc_1}{dt} + \frac{u'c_1}{2} - \frac{u^{*'}c_1^*}{2}\frac{dt^*}{dt}.$$

There are three sources of deviation from equality of |dY/dt| and dT/dt on the right-hand side of this expression. The first represents the first-order deadweight cost of taxation associated with the relative consumer price of good 1 being too high. This deadweight loss term has two components: one is the loss from worsening the pre-existing tax distortion, tu'; the other is the loss from worsening the pre-existing monopoly distortion, $(1-t)u"c_1$. Note that the first component vanishes at $t = 0$, but the second does not, because the monopoly distortion is present and causes a first-order deadweight loss even starting at a tax rate of 0.

16

The second term on the right-hand side of the expression accounts for the fact that half of the tax-induced reduction in profits due to an increase in the domestic tax rate is borne by foreigners. The third accounts for the change in domestic income due to an induced increase in the foreign tax rate. The first of these adjustments, the deadweight loss, will reduce g; the second, tax exporting, will increase g; and the third will depend on the sign of dt^*/dt, but if the tax rates are strategic complements then this effect will reduce g. In a symmetric equilibrium, the second and third effects cancel and $g < \overline{g}$.[5] In summary, a sales tax only on good 1 will alter equilibrium consumption as well as public good provision, the latter because of deadweight loss and fiscal spillovers.

2.4. Business profits 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 recently 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. We therefore focus on the case where the apportionment factor is solely the destination of sales – that is, where the consumer resides, as proposed by Avi-Yonah and Clausing (2008). We further consider the case in which the tax base itself is a business cash-flow tax.[6]

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[5] Note that if t^* responds to t, then the term dc_1/dt will incorporate not only direct responses to t but also responses to the induced changes in t^*.

[6] We abstract from issues concerning debt and the treatment of interest, by implicitly assuming the monopolist is equity financed.

We assume here that the apportionment factor is based on the location of the consumption of good 1 only, rather than on goods 1 and 2. This would follow naturally if the monopolist does not also produce good 2, or if good 2 represents leisure. This assumption implies that sales of good 2 in either country have no impact on the firm's tax payments. Consequently, the equilibrium competitive price for good 2 will still be 1, and the utility maximization conditions for the lump-sum tax in (2.6) still hold. Also, the condition for pre-tax profits given in (2.8) holds. Post-tax profits are:

$$(2.32) \qquad \pi^n = \pi\left[1 - tx - t^*(1-x)\right]; \qquad \text{where } x = \frac{u'(c_1)c_1}{u'(c_1)c_1 + u^{*\prime}(c_1^*)c_1^*} \; .$$

Using (2.8) and (2.32), we can derive the firm's optimal conditions with respect to k, m, K, and c_1. For the condition with respect to k, we have:

$$(2.33) \quad \left([1 - tx - t^*(1-x)]\frac{d\pi}{du^{*\prime}(c_1^*)c_1^*} + \pi(t^* - t)\frac{dx}{du^{*\prime}(c_1^*)c_1^*}\right)\!\left(u^{*\prime}(c_1^*) + u^{*\prime\prime}(c_1^*)c_1^*\right)\!\left(f_1 - f_1^*\right) = 0$$

Hence, the term $\left(f_1 - f_1^*\right)$ must equal 0 and (2.9) still holds; likewise, so does condition (2.10), so there is still production efficiency.

The remaining two conditions, with respect to K and c_1, imply

$$(2.34) \qquad \left(1 + \frac{\pi(t - t^*)x}{u'(c_1)c_1(1-t) + u^{*\prime}(c_1^*)c_1^*(1-t^*)}\right)\!\left(u^{*\prime}(c_1^*) + u^{*\prime\prime}(c_1^*)c_1^*\right) = \frac{1}{f_1(\frac{K}{2}, \frac{M}{2})}$$

where we have here used the conditions for production efficiency. Expression (2.34) 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. So 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.

As to the choice of public goods, we again have $g = v'^{-1}\left(-\dfrac{dY/dt}{dT/dt}\right)$, with the numerator

again reflecting the changes in π^n and p_1. Following the same approach as above, and again

using the production efficiency conditions then, after some algebra, it is possible to show that

$$(2.35) \qquad \frac{dY}{dt} = -\frac{1}{2}\pi\left(x + (1-x)\frac{dt^*}{dt}\right) - c_1 u'' \frac{dc_1}{dt}$$

where π is pre-tax profits. Also, we have

$$(2.36) \qquad \frac{dT}{dt} = \pi x + t\frac{d}{dt}\left[\pi x\right]$$

Comparing these two expressions yields:

$$(2.37) \qquad \frac{dY}{dt} = -\frac{dT}{dt} + \left(t\frac{d}{dt}\left[\pi x\right] - c_1 u'' \frac{dc_1}{dt}\right) + \frac{\pi x}{2} - \frac{\pi(1-x)}{2}\frac{dt^*}{dt}$$

As in the case of the domestic sales tax on good 1 only, there is a deadweight loss term and two

fiscal externality terms in addition to dT/dt.

In summary, although a cash-flow tax in a domestic context is equivalent to a non-

distortionary lump-sum tax, apportioning a cash-flow tax internationally based on the destination

of sales will generally distort consumption in both countries, although it will not distort

production. It thus has impacts similar to sales taxes. Since sales taxes are more straightforward

to analyze, we focus on those in Section 3 of the paper.

2.5. Destination-based cash-flow tax

We now consider a tax with the same cash-flow base, but with the tax base determined

directly by the destination of sales using border adjustments, as under a VAT.

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:

$$(2.38) \qquad T_2 = t\{p_2(c_2 + k + g) - w\}$$

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:

$$(2.39) \qquad \pi_2 = (1-t)\{p_2(c_2 + k + g) - w\} + (1-t^*)\{p_2^*(1 - c_2 - k - g)\} = 0$$

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. Condition (2.18) therefore holds, as for the uniform domestic consumption tax. 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 are

$$(2.40) \qquad \pi = (1-t)\{p_1 c_1 - p_2 k\} + (1-t^*)\{p_1^* c_1^* - p_2^*(K-k)\} = u'(c_1)c_1 + u^{*'}(c_1^*)c_1^* - K$$

This is identical to the expression for lump-sum taxes in (2.8). Since the tax is all spent on g, all the results for lump-sum taxes continue to hold, though with all prices (including wages and those for government purchases) grossed up by $1-t$ in the home country and $1-t^*$ in the foreign country.

The household budget constraint is:

(2.41) $p_1 c_1 + p_2 c_2 = w + \dfrac{u'(c_1)c_1 + u^{*}{}'(c_1^{*})c_1^{*} - K}{2}$

$\Rightarrow \quad u'(c_1)c_1 + c_2 = 1 + (1-t)\left(\dfrac{u'(c_1)c_1 + u^{*}{}'(c_1^{*})c_1^{*} - K}{2}\right),$

with an equivalent condition for the foreign country.

This expression makes it clear that the destination-based tax is equivalent to a tax on the pure profits received by domestic residents. As this is a lump-sum tax on domestic residents, it has no impact on government spending, i.e., $g = \bar{g}$ and $g^{*} = \bar{g}^{*}$. In summary, a destination-based cash-flow tax acts as a lump-sum tax.

This result differs from the analysis of a destination-based VAT in Keen and Lahiri (1998) and Lockwood (2001). Keen and Lahiri assume that the tax is levied only on the imperfectly competitive sector; like a sales tax only on good 1, this would clearly would distort consumption choices in our model.[7] Lockwood assumes that consumers are internationally mobile, which would introduce a new, and distorted, margin of consumer choice under the destination-based tax.

2.6. Source-based cash-flow tax

We now consider a third version of the cash-flow tax, in this case one allocated using the source principle. Because of the complexity of the analysis in this case, we do not analyze the choice of government spending.

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[7] Note that, if one thinks of good 2 as leisure, then the lack of distortion in our model 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. With a labor-leisure trade-off, of course, a uniform VAT on market consumption expenditures would distort labor supply.

For this tax, 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 (2.6). Define e to be exports of good 1 from the home country and e^* to be exports of good 1 from the foreign country. Then revenue received by the home country plant is $p_1(c_1 - e) + p_1^* e$, since the price of a unit of good 1 depends on where the unit is sold. An equivalent expression applies to the foreign plant. Using this and (2.6) implies that after-tax profits are:

$$(2.42) \quad \pi = u'(c_1)c_1(1-t) + u^{*}{}'(c_1^*)c_1^*(1-t^*) - k(1-t) - k^*(1-t^*) + \left(u'(c_1)e^* - u^{*}{}'(c_1^*)e\right)(t-t^*).$$

Conditional on production and consumption in the two countries, $(e - e^*)$ is determined, but not the individual gross exports. This arises because there are no transportation costs, which implies that the firm can choose where to produce for each market. With production and consumption in each country given, unit increases in both e and e^* lead to a net increase in after-tax profits of $\left(u'(c_1) - u^{*}{}'(c_1^*)\right)(t-t^*)$.

As this expression implies, the firm wishes to subject the higher-margin sales to tax in the lower-tax country. Thus, if the higher-tax country has higher output prices then the firm prefers to sell the goods it produces there in the lower-tax country, and sell goods produced in the lower-tax country in the higher-tax country. That is, if $\left(u'(c_1) - u^{*}{}'(c_1^*)\right)(t-t^*) > 0$, then there is cross-hauling, with e increasing until either all of the home country's production is exported, or all of the foreign country's consumption of good 1 has been satisfied by imports, whichever comes first. That is, $e = \min\left\{f(k,m), c_1^*\right\}$. But if the higher-tax country has lower output prices, then the firm prefers to minimize gross exports. That is, if $\left(u'(c_1) - u^{*}{}'(c_1^*)\right)(t-t^*) < 0$, then one country

will not export; the home country will reduce its exports until either its exports are zero or its imports are zero. So in this case, $e = \max\{f(k,m) - c_1, 0\}$.

We therefore have four possible regimes, depending on whether or not there is cross-hauling and on which country's exports or imports are constrained. We proceed by solving for the profit-maximizing values of k, m, K and c_1, conditional on being in each regime. We analyze these conditions for each of the four cases, and discuss which regime may be likely to hold.

Case A: $e = f(k,m)$ and $e^* = c_1$; cross-hauling with all domestic consumption met by imports. In this case, the expression for profits (2.42) becomes:

(2.42A) $\qquad \pi = u'(c_1)c_1(1-t^*) + u^{*\,\prime}(c_1^*)\Big(c_1^*(1-t^*) - f(k,m)(t-t^*)\Big) - k(1-t) - k^*(1-t^*)$

As usual, we substitute for $c_1^* = f(k,m) + f(K-k, M-m) - c_1$, to find the four first order conditions for k, m, K and c_1:

(2.43A) $\qquad f_1 - f_1^* = -\dfrac{(u^{*\,\prime}f_1^* - 1)(t^* - t)}{u^{*\,\prime\prime}\Big((f(k,m))(1-t) + \big(f(K-k, M-m) - c_1\big)(1-t^*)\Big) + u^{*\,\prime}(1-t)}$

(2.44A) $\qquad f_2 - f_2^* = -\dfrac{u^{*\,\prime}f_2^*(t^* - t)}{u^{*\,\prime\prime}\Big((f(k,m))(1-t) + \big(f(K-k, M-m) - c_1\big)(1-t^*)\Big) + u^{*\,\prime}(1-t)}$

(2.45A) $\qquad u^{*\,\prime\prime}c_1^* + u^{*\,\prime} = \dfrac{1}{f_1^*} - \dfrac{u^{*\,\prime\prime}f(k,m)(t^* - t)}{1 - t^*}$

(2.46A) $\qquad \big(u''c_1 + u'\big) = \Big(u^{*\,\prime\prime}c_1^* + u^{*\,\prime}\Big) + \dfrac{u^{*\,\prime\prime}f(k,m)(t^* - t)}{(1 - t^*)}$

Clearly, in this regime unless the two tax rates are equal, the taxes affect all four decisions. Expressions (2.43A) and (2.44A) say that neither capital nor managerial rents will be allocated efficiently unless the tax rates are equal. In the first of these equations, the distortion

relates to the presence of monopoly profits on marginal investments. Even under a cash-flow tax, in this case, capital allocation is distorted because the effective tax rate on capital is not zero. The second expression, on the other hand, relates to the full return to managerial rents, since these are all subject to tax.

Expression (2.45A) implies that the required marginal revenue in the foreign country is higher than marginal cost if and only if that country's tax rate is higher than the home country's tax rate. Expression (2.46A) says that the home country's required marginal revenue will be lower than the foreign country's under the same condition. However, combining (2.45A) and (2.46A) implies that

$$(2.47) \qquad u'' c_1 + u' = \frac{1}{f_1^*}$$

which implies that taxes do not impose a wedge between domestic consumption and the foreign production that completely supports it.

Case B: $e^* = f(k^*, m^*)$ and $e = c_1^*$; cross-hauling with all foreign consumption met by imports. This case follows from case A and symmetry.

Case C: $e = 0$ and $e^* = c_1 - f(k, m)$; only the foreign country exports. In this case, the expression for profits (2.42) becomes:

$$(2.42C) \qquad \pi = u'(c_1)\Big(c_1(1-t^*) - f(k,m)(t-t^*)\Big) + u^{*'}(c_1^*)c_1^*(1-t^*) - k(1-t) - k^*(1-t^*)$$

The first order conditions are:

24

$$(2.43\text{C}) \qquad f_1 - f_1^* = \frac{(u'f_1 - 1)(t - t^*)}{\left(u^{*}{}''c_1^* + u^{*}{}'\right)(1 - t^*)}$$

$$(2.44\text{C}) \qquad f_2 - f_2^* = \frac{u'f_2(t - t^*)}{\left(u^{*}{}''c_1^* + u^{*}{}'\right)(1 - t^*)}$$

$$(2.45\text{C}) \qquad u^{*}{}''c_1^* + u^{*}{}' = \frac{1}{f_1^*}$$

$$(2.46\text{C}) \qquad (u''c_1 + u') = (u^{*}{}''c_1^* + u^{*}{}') + \frac{u'' f(k,m)(t - t^*)}{(1 - t^*)}$$

Once again, the first two conditions call for inefficient allocation of factors if the two tax rates are not equal. The third condition says that there should be no production wedge in the foreign country with respect to <u>foreign</u> consumption, which follows from the fact that, in this case, all foreign consumption is supplied by foreign production. The final condition says that marginal revenue will be <u>lower</u> in the country with the higher tax rate. This counterintuitive result, touched on above in the introduction, may be explained as follows. Suppose the home country has the higher rate. Marginal sales are supplied from the foreign country, but existing sales are supplied in part from the home country and taxed at a higher rate. Thus, the decline in profits on existing sales will be smaller as consumption rises, so the monopolist has a smaller incentive to restrict output. In this case, then, production is discouraged in the country with higher tax rates, but consumption is encouraged.

Case D: $e^* = 0$ and $e = c_1^* - f(k^*, m^*)$; only the home country exports. This case follows from case C and symmetry.

We have now considered the four possible cases for the source-based cash-flow tax, but which case will prevail? In general, it is difficult to say, but we can get some sense by considering the special case in which the curvature of the utility function, as measured by the coefficient of relative risk aversion, is equal for the two countries, i.e., $-\dfrac{u'' c_1}{u'} = -\dfrac{u^{*''} c_1^{*}}{u^{*'}}$. Let these terms have the value γ, which must be less than 1 by the assumption that the monopolist maximizes profits. Substituting into expression (2.46A) implies that $\mathrm{sgn}\left(u' - u^{*'}\right) = \mathrm{sgn}(t - t^{*})$. But this is precisely the condition for cross-hauling assumed for case A, so case A (or case B) would be an equilibrium outcome. But, under the same assumption regarding equal coefficients of relative risk aversion, expression (2.46C) implies $\mathrm{sgn}\left(u' - u^{*'}\right) = \mathrm{sgn}(t^{*} - t).$ This is precisely the condition for minimizing exports assumed for case C, so case C (or case D) would also be an equilibrium outcome.

In short, there could well be at least two equilibria when countries use source-based cash-flow taxation, one in which gross exports are maximized and one in which they are minimized, with quite different implications for output prices in the two countries. As we discuss further below, this possibility, as well as the general complexity of the analysis for the source-based tax, is to some extent attributable to the presence of monopolistic behavior in sector 1.

3. Would Countries Choose to Deviate from a Source-Based Tax?

Since source-based taxes are a standard form of taxation, it is worth asking whether an individual country would have an incentive to move to a different tax base, starting from an equilibrium in which each country relies only on a source-based tax.

Because of the complexity of the question, we will assume in analyzing it that the two countries have the same utility functions, so that there will be a symmetric equilibrium tax rate

under the initial source-based tax.[8] We also assume a Nash equilibrium, that is, that each country chooses its tax policy assuming that the policy of the other country is fixed. In this environment, we ask whether the home country would wish to deviate from the equilibrium by introducing either a small destination-based tax cash-flow tax or a small sales tax on good 1, which we showed to have similar effects to a cash-flow tax with formula apportionment. By the envelope theorem, we can ignore the benefits of changes in the level of government spending, assuming that the government always sets spending at its optimal level. Thus, we consider in each case the substitution of the new tax for the old, keeping the level of public goods fixed.

3.1. Would the home country adopt a destination-based cash-flow tax?

Suppose that we start with a symmetric equilibrium in which both countries have equal source-based taxes, levied at rates $s = s^*$ and no other taxes. 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 lump-sum tax, at rate z, on the home country's share of profits. Let ε be the experiment. Then the change in welfare with respect to ε equals $dY / d\varepsilon$, since government spending g is unchanged and hence $dT / d\varepsilon = 0$. To keep revenue the same, the changes in s and z must satisfy:

(3.1)
$$\frac{ds/d\varepsilon}{dz/d\varepsilon} = -\frac{dT/dz}{dT/ds},$$

from which it follows that $dY / d\varepsilon > 0$ if and only if

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[8] When symmetric equilibria exist we limit our attention to these and do not consider other possible equilibria.

(3.2)
$$\frac{dY/dz}{dT/dz} > \frac{dY/ds}{dT/ds}.$$

From (2.26), the effects of a change in the tax rate on real income are:

(3.3)
$$\frac{dY}{dz} = \frac{1}{2}\frac{d\pi}{dz} - c_1\frac{dp_1}{dz}; \text{ and } \frac{dY}{ds} = \frac{1}{2}\frac{d\pi}{ds} - c_1\frac{dp_1}{ds}$$

In this case, $p_1 = u'(c_1)$ and

(3.4)
$$\pi = (1-z)\{(1-s)(p_1c_1 - k) + (1-s^*)(p_1^*c_1^* - k^*) + (p_1e^* - p_1^*e)(s - s^*)\},$$

which implies

(3.5)
$$\frac{dY}{dz} = -\frac{\pi}{2} + (1-s)\left([u''(c_1)c_1 + u'(c_1)]\frac{dc_1}{dz} - \frac{dk}{dz}\right)$$
$$+ (1-s^*)\left([u^{*''}(c_1^*)c_1^* + u'(c_1^*)]\frac{dc_1^*}{dz} - \frac{dk^*}{dz}\right) - c_1u''\frac{dc_1}{dz}$$

Note that the last term in (3.4) does not influence the derivative, since we start from a symmetric equilibrium. Also, given an initial symmetric equilibrium, and given that expression (2.11) holds for a change in z, the middle two terms in (3.5) sum to zero. Thus, again using symmetry,

(3.5a)
$$\frac{dY}{dz} = -\frac{\pi}{2} - c_1u''(c_1)\frac{dc_1}{dz}.$$

By the same reasoning, we obtain:

(3.6)
$$\frac{dY}{ds} = -\frac{(p_1f(k,m) - k)}{2} - c_1u''\frac{dc_1}{ds}.$$

Now, consider the changes in T. We have:

(3.7)
$$T = z\frac{\pi}{2} + s(p_1f(k,m) - k + (p_1^* - p_1)e)$$

Before differentiating with respect to z or s, we must specify which of the four regimes apply, since even though e will be indeterminate in the initial equilibrium, it will not be indeterminate once s and z change.

Case A: $e = f(k,m)$ and $e^* = c_1$; cross-hauling with all domestic consumption met by imports. In this case,

$$(3.8A) \qquad T = z\frac{\pi}{2} + s\left(p_1^* f(k,m) - k\right)$$

and so

$$(3.9A) \qquad \frac{dT}{dz} = \frac{\pi}{2} + s\left\{\frac{f_2}{f_1}\frac{dm}{dz} + u'' c_1\left(\frac{dc_1^*}{dz} - \frac{df}{dz}\right)\right\}$$

where this derivation uses symmetry, (2.11) and that $df/dz = f_1\, dk/dz + f_2\, dm/dz$. Also

$$(3.10A) \qquad \frac{dT}{ds} = (p_1 f - k) + s\left\{\frac{f_2}{f_1}\frac{dm}{ds} + u'' c_1\left(\frac{dc_1^*}{ds} - \frac{df}{ds}\right)\right\}$$

Case C: $e = 0$ and $e^* = c_1 - f(k,m)$; only the foreign country exports. In this case,

$$(3.8C) \qquad T = z\frac{\pi}{2} + s\left(p_1 f - k\right)$$

and with similar derivations, we obtain

$$(3.9C) \qquad \frac{dT}{dz} = \frac{\pi}{2} + s\left\{\frac{f_2}{f_1}\frac{dm}{dz} + u'' c_1\left(\frac{dc_1}{dz} - \frac{df}{dz}\right)\right\}$$

and

$$(3.10C) \qquad \frac{dT}{ds} = (p_1 f - k) + s\left\{\frac{f_2}{f_1}\frac{dm}{ds} + u'' c_1\left(\frac{dc_1}{ds} - \frac{df}{ds}\right)\right\}$$

Cases B and D. As before, these generate equivalent expressions to cases A and C respectively.

Now, consider expressions (3.9A) and (3.9C). Since an increase in z is a lump-sum tax, its only impact will be to reduce g and c_2. Thus, the term multiplying s in these expressions must equal 0. Following a similar argument, the last term in (3.5a) will be zero. Thus, $-dY\big/dz = dT\big/dz = \pi\big/2$ and condition (3.2) reduces to $-dY\big/ds > dT\big/ds$: that the increase in real income from reducing the source-based tax is larger than the decline in revenue.

Substituting (3.6) and (3.10A,C) into this expression generates the following conditions for an increase in welfare under a switch to the destination-based tax, depending on which regime holds:

(3.11A) $\qquad \dfrac{(p_1 f - k)}{2} + s\left\{\dfrac{f_2}{f_1}\dfrac{dm}{ds} + u''c_1\left(\dfrac{dc_1^{*}}{ds} - \dfrac{df}{ds}\right)\right\} < u''c_1\dfrac{dc_1}{ds}$

(3.11C) $\qquad \dfrac{(p_1 f - k)}{2} + s\left\{\dfrac{f_2}{f_1}\dfrac{dm}{ds} + u''c_1\left(\dfrac{dc_1}{ds} - \dfrac{df}{ds}\right)\right\} < u''c_1\dfrac{dc_1}{ds}$

There are three terms in each of these expressions, relating (from left to right) to tax exporting, production distortions and transfer pricing, and consumption distortions. We consider them in turn.

The first term on the left hand side of these expressions reflects the benefit arising to the home country due to (in the initial equilibrium) half of the source-based tax on domestic profits being borne by foreigners. This tax exporting would be foregone by a switch to a destination-based tax, thus making a switch to the destination-based tax less attractive.

Now, consider the second term on the left-hand side, which itself has two components. The first of these components relates to tax-induced shifts in managerial skill, the second to patterns of trade, which in this model (without transportation costs or product variety) can be thought of as relating to transfer pricing issues. Begin from the two first order conditions for k and m for cases a and c, (2.43A,C) and (2.44 A,C). To begin with, hold K fixed (note that M is in any case fixed), and allow k and m to change in response to the change in s. The resulting expression can be written as Fdx, where F is the matrix of f_{ij} and dx is the vector of dk/ds and dm/ds. Since F is negative definite by the assumption of decreasing returns to scale, it follows that $dx'\ Fdx < 0$, which implies that $Fdx > 0$ if and only if $dx < 0$. Thus, both m and k shift abroad with an increase in s, which also implies not only that $dm/ds < 0$, so that the first component must be negative, but also that f declines. However, with K and M fixed, total consumption of good 1 stays fixed as well, and we may also show, using again the conditions from Section 2.6, that the second component will also be negative in each case, since consumption will be relatively higher abroad in case A if the domestic source-based tax rises, and relatively lower abroad in case C. Hence, with K fixed, both of the components in the second term in these expressions are negative.

Now, consider the general case where K changes. Start by allocating the change in K equally across countries, and the resulting change in consumption as well. Then, relative to this starting point, apply the results just derived to get overall changes in m and the levels of consumption and domestic production that will be consistent with the new equilibrium. Even though we no longer know what happens to levels of consumption and output, the sign of the change in m, and the sign of the difference between consumption and production, are still determined, so the second term on the left hand side of (3.11A) is negative. Higher source-based

taxes drive managerial skill abroad and encourage the producer of good 1 to rearrange the pattern of trade to shift reported profits abroad, both responses that hurt the home country. Hence this second term on the left-hand side favors a shift away from source-based taxation.

Finally, consider the term on the right-hand side of (3.11A). This is a "second-best" term reflecting the interaction between the pre-existing monopoly distortion and the tax change, and can be positive or negative. If the cut in the source-based tax increases home consumption, then this distortion will be lessened and this term will be positive, making the conditions more likely to hold. As already discussed, we do not have definitive results for the sign of dc_1/ds. However, it seems more likely to be negative in case A, where a reduction in s increases consumption at home more than abroad, i.e., $c_1 - c_1^*$ increases.

In summary, there are three factors at work when considering a shift from source-based taxation to destination-based taxation: a decline in tax exporting, which works against the move; shifts in the location of managerial rents and in trade patterns, which promote the move; and an interaction with the preexisting monopoly distortion, which has an uncertain effect. With terms differing in sign, we cannot in general tell whether (3.11A) or (3.11C) will be satisfied, but we can see factors that make this more or less likely. For example, the higher the initial rate of tax, s, the more important is the terms reflecting production responses, which favors the tax shift. And the interaction with the monopoly distortion is more likely to promote the tax shift in the "normal" case, A, in which consumption rises at home relative to abroad if the source-based tax is reduced. Where the monopoly distortion and the initial level of the source-based tax are both small, the potential loss of tax exporting will dominate and the shift away from source-based taxation will not occur.

3.2. Would the home country adopt a sales tax on good 1?

Suppose now that we start with the same symmetric equilibrium in which both countries have equal source-based taxes ($s=s^*$), and the home country considers introducing a sales tax on good 1 at rate t, as an equal-yield replacement for s. As in the previous case, welfare will increase if and only if

(3.12)
$$\frac{dY/dt}{dT/dt} > \frac{dY/ds}{dT/ds}.$$

Because we are starting from the same equilibrium, the changes in Y and T with respect to s are the same as in (3.6) and (3.10A,C). The discussion above for the signs of these expressions therefore holds in this case as well. Now, consider the corresponding terms for t. We have $p_1 = u'$ and profit is defined as

(3.13)
$$\pi = \left\{ (1-s)\left(p_1(1-t)c_1 - k\right) + (1-s^*)\left(p_1^* c_1^* - k^*\right) + \left(p_1 e^* - p_1^* e\right)(s - s^*) \right\}$$

The effect of a change in t on real income is therefore

(3.14)
$$\frac{dY}{dt} = \frac{1}{2}\frac{d\pi}{dt} - c_1\frac{dp_1}{dz} = -\frac{(1-s)p_1 c_1}{2} - c_1 u'' \frac{dc_1}{dt}$$

where we have here used a similar approach to the derivation of (3.5a). Note that, as for the source-based tax, the sales tax burden is partially shifted onto foreign owners of the firm that produces good 1. As we discuss below, this particular result relates to the fact that the producer of good 1 is a monopolist. Under perfect competition, the shifting analysis is different.

Now consider the changes in T. In general, we have:

(3.15)
$$T = tp_1 c_1 + s\left(p_1(1-t)f(k,m) - k + (p_1^* - p_1(1-t))e\right)$$

and must consider the effects of t in each of the four regimes.

Case A: $e = f(k,m)$ and $e^* = c_1$; cross-hauling with all domestic consumption met by imports. In this case,

(3.15A) $T = t(1-s)p_1c_1 + s\left(p_1^* f(k,m) - k\right)$

and:

(3.16A) $\dfrac{dT}{dt} = (1-s)p_1c_1 + su''c_1\left(\dfrac{dc_1^*}{dt} - \dfrac{df}{dt}\right)$

where the derivation is similar to that for (3.9A).

Case C: $e = 0$ and $e^* = c_1 - f(k,m)$; only the foreign country exports. In this case,

(3.15C) $T = t(1-s)p_1c_1 + s\left(p_1 f - k\right)$

and

(3.16C) $\dfrac{dT}{dt} = (1-s)p_1c_1 + su''c_1\left(\dfrac{dc_1}{dt} - \dfrac{df}{dt}\right)$

Cases B and D. As before, these generate equivalent expressions to cases A and C respectively.

Expressions (3.16A,C) depend on the relative changes in consumption and production in the two countries. But, since a change in t will leave production equal across the two countries (though not necessarily equal to the original levels of production in each), the signs of the second terms in these two expressions are opposite each other. That is, if $\left(\dfrac{dc_1}{dt} - \dfrac{df}{dt}\right) > 0$, then

$\left(\dfrac{dc_1^*}{dt} - \dfrac{df}{dt}\right) < 0$ and vice versa. Also, either $\dfrac{dc_1^*}{dt} > \dfrac{df}{dt} > \dfrac{dc_1}{dt}$ or $\dfrac{dc_1^*}{dt} < \dfrac{df}{dt} < \dfrac{dc_1}{dt}$, so we can

determine the signs of the two opposing terms by determining the sign of $\dfrac{dc_1^*}{dt} - \dfrac{dc_1}{dt}$.

To determine this sign, rewrite expression (2.22) and its equivalent for the foreign

country, as $(1-t)Af_1 = 1$ and $A^*f_1^* = 1$, where $A = u''(c_1)c_1 + u'(c_1)$ and similarly for A^*.

Differentiate these two expressions with respect to t and subtract the second from the first, and

then use the fact that $A = A^*$ initially and that k and k^* remain equal as t changes. This implies:

(3.17) $\qquad \dfrac{dc_1}{dt} - \dfrac{dc_1^*}{dt} = \dfrac{A}{dA/dc_1}$

Since the numerator of the right-hand side of (3.17) is positive, the sign of $\dfrac{dc_1}{dt} - \dfrac{dc_1^*}{dt}$ equals the

sign of dA/dc_1, which is negative assuming that there is declining marginal revenue. With this

assumption, home consumption decreases relative to foreign consumption when the sales tax is

applied at home, a quite reasonable result. This implies that the signs of the second terms in

(3.16A) and (3.16C) are opposite.

The condition in (3.12) for an increase in welfare from a switch from a source-based tax

to a sales tax on good 1 is the following, for the two cases A and C:

(3.12A) $\qquad \dfrac{-\dfrac{(1-s)p_1c_1}{2} - c_1u''\dfrac{dc_1}{dt}}{(1-s)p_1c_1 + su''c_1\left(\dfrac{dc_1^*}{dt} - \dfrac{df}{dt}\right)} > \dfrac{-\dfrac{(p_1f-k)}{2} - c_1u''\dfrac{dc_1}{ds}}{(p_1f-k) + s\left\{\dfrac{f_2}{f_1}\dfrac{dm}{ds} + u''c_1\left(\dfrac{dc_1^*}{ds} - \dfrac{df}{ds}\right)\right\}}$

(3.12C) $\qquad \dfrac{-\dfrac{(1-s)p_1c_1}{2} - c_1u''\dfrac{dc_1}{dt}}{(1-s)p_1c_1 + su''c_1\left(\dfrac{dc_1}{dt} - \dfrac{df}{dt}\right)} > \dfrac{-\dfrac{(p_1f-k)}{2} - c_1u''\dfrac{dc_1}{ds}}{(p_1f-k) + s\left\{\dfrac{f_2}{f_1}\dfrac{dm}{ds} + u''c_1\left(\dfrac{dc_1}{ds} - \dfrac{df}{ds}\right)\right\}}$

As in the case of a potential shift to the destination-based tax, the signs of these expressions are not in general determined, but we can see some of the same influences as before. For the "second-best" consumption terms (relating to the monopoly distortion) in the numerators of both sides of these expressions being sufficiently small, then the inequality will be satisfied for case C, since as these terms approach zero the left hand side approaches a number greater than -1/2 and the right-hand side approaches a number less than -1/2. But note that, unlike in case of the destination-based tax, there is tax exporting under both tax bases here, so that factor, alone, does not work against the tax shift. That is, if the second-best term and the initial source-based tax rate were both ignored, the country would be indifferent to the tax shift. Again, this depends very much on the assumption that good 1 is produced by a monopolist; as we discuss below, the incidence of the sales tax is quite different under perfect competition.

In summary, there are three main factors that influence a country's decision whether to shift unilaterally away from the source-based tax: tax exporting, producer responses, and interactions with the preexisting consumption distortion. The relative importance of these factors varies according to the alternative tax base being considered, and also with respect to initial conditions.

4. Perfect competition and ownership of the fixed factor

We now modify the model in two ways. First, we assume that good 1 is produced in a perfectly competitive manner, with many firms engaging in price-taking behavior. Second, we assume that the rents accruing to the fixed factor accrue to domestic residents instead of to the single monopolist. These modifications are related: the single monopolist would be a monopsonist with respect to using the fixed factor and would be able to drive its price down to zero. However, with many firms, the owner of the fixed factor can claim the rents accruing.

To develop intuition we consider these two changes in stages. First, we introduce perfect competition while continuing to assume that the fixed factor rents accrue to good-1 producers.[9] We then consider what happens when the returns to the fixed factor accrue to domestic residents.

4.1. Price-taking behavior

Introducing price-taking behavior by good 1 producers generates only small changes to the characterizations of equilibria in Section 2. In particular, the definition of profit does not change. The only change is that the terms in u'' disappear from the conditions relating marginal revenue to marginal cost for good 1. This is most significant for the source-based cash-flow tax, since the four cases now collapse to one, as the price of good 1 would have to be the same in both countries. In that one regime, the first-order conditions for k, m, K and c_1 simplify to:

(4.1) $\qquad f_1 = f_1^*$

(4.2) $\qquad f_2(1-s) = f_2^*(1-s^*)$

(4.3) $\qquad u^{*'} = \dfrac{1}{f_1^*}$

(4.4) $\qquad u' = u^{*'}$

Here, with no monopoly mark-ups, the only distortion is with respect to the allocation of managerial skill, it being shifted too much to the low-tax country.

As to the incentives for countries to shift away from the source-based tax equilibrium, consider first the case of a destination-based tax alternative. Since the destination-based tax is still a non-distortionary lump-sum tax, it will still be the case that $-dY/dz = dT/dz$. For the effects of the change in the source-based tax rate, s, on real income, we now have:

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[9] In this case, consider each good-1 producer being endowed not only with a unit of managerial skill, but also with a comparable share of the fixed factor in each country.

$$(4.5) \qquad \frac{dY}{ds} = -\frac{(p_1 f - k)}{2} - su''(c_1)c_1 \frac{dc_1}{ds}$$

where the derivation uses (4.3), (4.4) and the symmetry of the initial equilibrium. This condition implies that the only "second-best" component associated with a change in s is the pre-existing tax itself, since there is no pre-existing monopoly distortion. Following the same approach as above, the effect on tax revenue is

$$(4.6) \qquad \frac{dT}{ds} = (p_1 c_1 - k) + s\left(\frac{f_2}{f_1}\frac{dm}{ds} + u''(c_1)c_1 \frac{dc_1}{ds} \right)$$

Combining these two conditions, the condition for the switch to destination-based taxes to be welfare improving is:

$$(4.7) \qquad s\frac{f_2}{f_1}\frac{dm}{ds} < -\frac{(p_1 f - k)}{2}$$

Comparing this to the conditions in (3.11), we observe that all of the terms relating to the monopoly mark-up have disappeared. This is now a simple condition that the gain in revenue from increasing the domestic location of managerial skill exceeds the loss in revenue from the reduction in tax exporting. The larger is the initial source-based tax, s, the more likely this condition is to hold, *ceteris paribus*.

Now, consider the potential shift from source-based taxation to a sales tax on good 1. Conditions (4.5) and (4.6) still apply for the source-based tax. For the sales tax, we have:

$$(4.8) \qquad \frac{dY}{dt} = -(1 - s)p_1 c_1 - su''(c_1)c_1 \frac{dc_1}{dt}$$

where we again make use of symmetry and production efficiency. We also make use of the fact that $u''\dfrac{dc_1}{dt} - u' = u^{*''}\dfrac{dc_1^*}{dt}$, which follows from differentiating $(1 - t)u' = u^{*'}$, evaluated at $t{=}0$, where this is implied by (2.22) and the equivalent condition for the foreign country.

The change in tax revenues is:

$$(4.9) \qquad \frac{dT}{dt} = (1-s)p_1 c_1 + su''(c_1)c_1 \frac{dc_1}{dt}$$

These two conditions imply that $-\frac{dY}{dt} = \frac{dT}{dt}$, just as with the destination-based tax. Hence with perfect competition there is no longer any exporting of the sales tax, and the absence of a monopoly distortion means that the deadweight loss from this tax is zero starting at a zero sales tax rate. Hence, the condition for switching to a sales tax is the same as that for a destination-based tax in (4.7).

4.2. Domestic ownership of fixed factor

To identify the effects of introducing domestic ownership of the fixed factor, we can consider what conditions will change under the assumption that domestic individuals, rather than all individuals, receive a country's fixed factor rents. Most obviously, the share of profits in each country will now be different. In the absence of taxes, the profits to be shared are now

$$(4.10) \qquad \pi = \tilde{p}_1 \left(f_1 k + f_2 m \right) + \tilde{p}_1^* \left(f_1^* k^* + f_2^* m^* \right) - K$$

where the tilde indicates the price at which goods produced in the respective countries are sold. The corresponding domestic income is:

$$(4.11) \qquad 1 + \frac{\left(\tilde{p}_1 \left(f_1 k + f_2 m \right) + \tilde{p}_1^* \left(f_1^* k^* + f_2^* m^* \right) - K \right)}{2} + \tilde{p}_1 \left(f - f_1 k - f_2 m \right)$$

The first-order conditions for the sales tax, destination-based and source-based cash-flow taxes continue to hold, since the marginal conditions for using capital and managerial skill in the two countries will not change. The only impact on equilibria will thus be through the effects on income and tax revenue. For simplicity, assume further that there is no change in the tax treatment of the fixed rents in this case, i.e., that they are still subject to the cash-flow tax even

though the recipients are not the owners of the firms producing good 1. Then the only impact on equilibria comes through the distribution of before-tax rents between the two countries, and the associated revenue effects of these income differences.

With all this in mind, let us now reconsider the tax-base choices under perfect competition.

For the destination-based tax, the tax is still effectively a tax on the non-labor income of domestic residents, so there is no change in the analysis of it under perfect competition. Likewise, for the sales tax, since production efficiency is maintained with equal factor returns in both countries, the change in the assumption regarding the distribution of fixed factor rents has no effect. Thus, we need consider only the source-based tax. Indeed, we need to consider only the change in income under the source-based tax, since the tax revenue will not be affected either: since demand for good 1 is unresponsive to income changes, there will be no feedback effect of on taxes of the changed distribution of after-tax income in the two countries.

So, let us consider the change in taxes under the source-based tax, keeping in mind that the prices of good 1 remain equal in the two countries. After some manipulation, we can show that the effect of a change in s on real income, equivalent to expression (4.5), is

(4.12) $$\frac{dY}{ds} = -(p_1 f - k) - s c_1 u''(c_1) \frac{dc_1}{ds}$$

Here we have used (4.1) and (4.2), which implies that $\left(\frac{df_2^*}{ds} - \frac{df_2}{ds} \right) = -\frac{f_2}{(1-s)}$, (4.3), and the fact that changes in domestic output equal changes due to capital and managerial skill (since the remaining factor is fixed).

Comparing (4.12) with (4.5), the switch in ownership of the fixed factor has the effect of eliminating all of the tax exporting under the source-based tax. This result is straightforward for

the fixed factor rents, since these now accrue only to domestic owners. But it also holds for the other source of rents in this case of perfect competition, returns to managerial skill. One might think that the tax on these would be partially shifted to foreign owners, but with a fixed factor present all of the tax is shifted to it. Thus, the potential benefit of the source-based tax disappears, and the condition for adopting either a destination-based tax or a sales tax becomes simply:

$$(4.13) \qquad s\frac{f_2}{f_1}\frac{dm}{ds} < 0$$

which must be satisfied. Thus, countries will wish to shift at least partially away from a source-based tax. Note that another way of interpreting this result is that, when fixed factors are domestically owned, the benefit of moving away from a source-based tax is greater because it enhances the return to domestic factors.

5. Conclusions

This paper models the effects of alternative forms of consumption-type taxes in a two-country model with trade of final goods and mobile factors of production.

In our base case, we consider a monopolist that produces and sells in each of the two countries and allocates capital and managerial skill between the two countries for production. There are three sources of rents for the monopolist: a fixed factor in each country of production; managerial skill, owned by the company, and mobile between the two countries; and monopoly pricing, effectively located in the country of consumption. 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 monopolist on a source basis, the equivalent tax levied on a destination basis, and one whose base is allocated using sales-only formula apportionment (the effects of which can be

studied by analyzing a sales tax levied on the good produced by the monopolist.) We describe the forms of distortion to production and consumption generated by these taxes.

We investigate whether there is an incentive for a national government to move away from a symmetric equilibrium in which both countries use only the source-based tax. We show that the government faces a trade-off. One the one hand, movement away from a source-based tax to a destination-based tax reduces distortions and improves welfare. On the other hand, part of the tax is incident on non-residents, which improves the welfare of domestic residents.

However, the source-based tax is dominated by the destination-based tax and a sales tax if two elements of the model are changed: if there are many price-taking firms in place of the single monopolist, and if that part of the economic rent due to a fixed factor of production accrues not to the firms, but to domestic residents. In this case, the source-based tax is incident only on domestic residents, and so its main benefit for the national government is no longer present. This tax does, however, continue to distort the choice of where to locate mobile managerial skill. This distortion reduces welfare, and can be reduced by a substitution away from the source-based tax in the direction of the destination-based tax, or a sales tax.

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