Can Destination-Based Cash Flow Taxes Arise in Equilibrium?*

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Abstract

We examine the effects of unilateral changes in a country's tax parameters in a two country model when both countries are part of a destination-based cash flow taxation (DBCFT) system. We consider deviations from a globally efficient DBCFT system by allowing each country to vary its corporate tax rate, degree of taxation of capital income, and level of border adjustment. We decompose the effect of policy changes into fiscal effects and price effects, and show that regardless of the differences between the two countries, at least one country has an incentive to move toward taxation of capital income. If countries are identical, each country has an incentive to move toward source-based taxation. In contrast, changes in corporate tax rates have neither fiscal or price effects, and thus can be set unilaterally. Our results show that an international agreement to establish multilateral DBCFT requires a commitment mechanism to prevent deviations from cash flow taxation and full border adjustments.

Keywords: destination-based taxes, source-based taxes, cash-flow taxes

JEL Classifications: H73, H21, F23

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1 Introduction

Two key dimensions of corporate income tax policy specify the tax rate applied to net export income relative to domestic income and the extent to which capital expenses are tax deductible. Both dimensions were at play leading up to the passage of the Tax Cuts and Jobs Act (TCJA) (U.S. Congress 2017)[1], which prompted general discussion by tax policy experts.[2] One particular policy that has been shown to have desirable global efficiency properties is destination-based cash flow taxation (DBCFT). The destination-based component of DBCFT involves a border adjustment that exempts export revenue from taxation and does not allow a tax deduction for imported inputs, while the cash flow component allows firms to fully deduct capital expenses from taxable income in the year the expenses are incurred.[3] In contrast, source-based income taxation (SBIT), the policy observed in most countries, taxes net export and domestic income equally and allows a tax deduction for capital expenses based on economic depreciation.

Auerbach and Devereux (2018) use a two-country model with competitive multinationals to argue that if every country adopts DBCFT, each country's corporate tax rate becomes a pure profit tax that eliminates production and pricing distortions and eliminates income shifting incentives. They also address the question of whether a country that is using a source-based cash flow tax (SBCFT) would gain from unilaterally moving toward DBCFT. However, this leaves open the question of whether multilateral adoption of DBCFT would be a stable equilibrium. If two countries have reached a cooperative agreement to adopt DBCFT and globally efficient tax rates, would individual countries have an incentive to alter their tax parameters in the absence of a commitment mechanism in the agreement?

In this paper, we use the Auerbach and Devereux (hence AD) model to ask whether countries have a unilateral incentive to deviate from a multilateral DBCFT system. We address this question by analyzing a country's incentives in varying three tax policy parameters: the corporate tax rate, the share of capital costs that can be deducted for tax purposes, and the degree of border

[1] See Tax Reform Task Force (2017).

[2] For instance, see Auerbach and Holtz-Eakin (2016), Auerbach et al (2017), Becker and Englisch (2017), and Benzell, Kotlikoff and LaGarda (2017).

[3] Cash flow taxation also has implications for how debt and interest payments are taxed. We abstract from these issues in this paper.

adjustment. We focus on whether the spillovers from tax policy changes would result in an incentive for a country to unilaterally deviate from multilateral DBCFT. We identify two types of spillover effects of policy changes that affect a country's incentive to deviate from multilateral DBCFT: a fiscal effect and a price effect. The fiscal effect arises when a change in a policy parameter results in the the collection of revenues from foreign residents at given prices. The price effect captures how price changes resulting from a change in a tax parameter redistribute income between the countries.

We have three main results. We first show that if the countries are committed to DBCFT, the non-cooperative setting of tax rates will result in an efficient outcome. There is no price effect from the tax policy change because the corporate tax is effectively a lump sum tax under DBCFT. More surprisingly, there is no fiscal effect between countries either. The gain in tax revenue that is obtained from increasing the tax rate on multinationals when foreigners own a share of firm profits is offset by changes in the tax revenue on trade in goods. As a result, a country's tax revenue depends only on the share of revenue that is held by local residents.[4]

In contrast, we show that at least one country has an incentive to tax the use of capital by departing from the full deductibility of capital expenses for firms. Increasing the tax on capital benefits a country by shifting part of the tax burden onto foreign shareholders. However, there are also price effects that arise because increasing the tax raises the price of multinational firm output in both countries. If countries are perfectly symmetric, the effect of price changes in the two countries cancel out and both will have an incentive to reduce the deductibility of capital expenses. In the asymmetric country case, the price effect is more likely to be harmful to a country when it has a small ownership share in multinationals and when its consumption of the multinational firm output is relatively small. However, we show that if one country is harmed by the price effects, the other must necessarily gain and will therefore have an unambiguous incentive to deviate from DBCFT.

Finally, we consider the effect of departing from DBCFT by reducing the full border adjustment on export and import transactions. As with the capital tax, we show that reducing the border

[4] AD consider the optimal tax policy when the foreign country uses SBCFT and find that the marginal product of the public good equals the price of the input. In addition to having a different assumption on the foreign tax system, they assume that the price of the input is unaffected by the tax rate, which will not hold in equilibrium. They also examine a Nash equilibrium in which countries choose both destination- and source-based taxes simultaneously using simulations that do not allow multinational choices nor prices to vary and that do not account for capital taxes.

adjustment has both fiscal effects and price effects. The fiscal effects arise from the taxing of local sales revenue and the taxing of intra-firm trade in intermediate goods, which benefits (harms) a country that is exporting (importing) the intermediate good. The price effects arise from the changes in the terms of trade in the capital good and changes in the price of the multinational's good in each country. We show that in the case of countries that are symmetric in terms of technologies, preferences, and ownership of multinational firms, each country will gain from a marginal reduction in its border adjustment.

Our work is related to several strands in the literature. There is an extensive literature on tax competition with public good provision when productive factors are mobile between locations. However, we believe that our result on the efficiency of tax competition when both countries are committed to DBCFT is new. The most similar result to ours is Sinn (1997), who shows that tax competition can lead to efficient provision of public infrastructure when capital is mobile. However, his model considers source-based taxation of capital and public goods that benefit capital owners, whereas we consider destination-based taxes and public goods that benefit households.

As noted above, the existing literature on the introduction of DBCFT has tended to focus on the benefits of multilateral adoption with just a few exceptions. Auerbach and Devereux (2018) establish the benefits of multilateral adoption of DBCFT relative to multilateral SBCFT, and they derive an analytic condition based on endogenous variables that holds prices and government spending fixed to assess unilateral deviation incentives from SBCFT. Becker and Englisch (2020) also consider the incentives for a country to deviate towards DBCFT from SBCFT in the same model developed in AD. Their main results (Propositions 3 and 4) are also stated in terms of endogenous variables, especially with regard to public good expenditures, which necessitates the use of simulations to establish unilateral incentives to deviate from SBCFT.

Bond and Gresik (2020) consider the incentives for unilateral changes in tax policy parameters in a North/South model of heterogeneous firms where the decision on whether to become multinational is endogenous and the South country uses a source-based income tax. In that model, spillovers between countries arise from changes in the number of varieties in a monopolistic competition model. With perfect competition, the price spillovers take a different form. In contrast, the present model focuses on a North/North setting where both countries start with DBCFT and ownership of multinationals is divided between countries.

The present paper differs from the literature on unilateral policy changes by considering whether the choice of DBCFT in both countries would be an equilibrium in a game where countries can unilaterally set tax policy parameters, and thus provides insights about what types of policy commitments would be required to sustain globally efficient corporate tax policy. This approach is similar to the international trade literature on the potential for multilateral institutions to sustain an efficient free trade equilibrium. In the international trade literature, terms of trade externalities make an efficient free trade equilibrium unsustainable in a one shot tariff setting game (see Bagwell and Staiger (2002)). The incentives for deviation from multilateral DBCFT differ in that tariffs are border instruments that discriminate between domestic and foreign suppliers of traded goods, whereas the tax policy parameters we consider involve a mix of border instruments and non-discriminatory instruments. As a result, the question of whether or not a particular country wants to deviate from DBCFT can differ for each instrument depending on preferences, technologies, and ownership shares of the multinational.

Studies of the economic effects of the tax deductibility of capital expenses include Brown (1948), Sandmo (1979), Shome and Schutte (1993), and Bond and Devereux (2002). These papers have tended to focus on efficiency, and not tax competition equilibrium. Gordon and Hines (2002) and Keen and Konrad (2013) provide surveys of the fiscal spillovers that can arise when countries or regions set policies unilaterally.

The question of whether the border adjustments under a DBCFT have spillover effects to other countries is related to the literature on whether a destination-based Value Added Tax (VAT) system distorts international trade. Grossman (1980) and Feldstein and Krugman (1990) have shown that VAT border adjustments raise prices of importables and exportables by the same percentage, and thus have no effects on domestic resource allocation in a model without multinational firms. Costinot and Werning (2019) show that the result can be extended to border adjustments with multinational firms if the productions sets of the affiliates in different countries are independent. The neutrality of border adjustments breaks down in the model we consider because the firms' production sets are linked across countries due to the presence of intra-firm trade in intermediate goods and intra-firm mobility of managerial inputs.[5]

Section 2 characterizes the equilibrium of the AD model when preferences, technologies, and ownership shares can differ across countries, and introduces the three tax policy parameters that we analyze. Section 3 examines the effects of deviations in each of the policy parameters from an initial globally efficient cooperative setting where both countries adopt DBCFT. Section 4 offers some concluding remarks.

2 The model

We study the AD model, which provides a simple structure for capturing the effects of corporate tax policy on a multinational firm's decisions regarding capital investment and the allocation of its capital and "managerial capital" between production facilities in different countries.[6] There are two countries, denoted Home and Foreign, each with a representative consumer that consumes two consumption goods and the services of a public good funded out of tax revenues. The Home (Foreign) household begins with L (L^*) divisible units of an endowment good which we refer to as labor, with Foreign variables being denoted by *. Labor can be converted into good 2 under conditions of constant returns to scale and perfect competition, and we choose units of labor in each country such that one unit of labor is required to produce a unit of good 2. Good 2 can be used as a (non-tradeable) consumption good, c_2, a traded capital good, k, or a public good, g.

Good 1 is a non-traded consumption good that is produced by multinational firms using units of an intermediate good that can be produced by a multinational in its affiliates in either country. It is assumed that there is a fixed number of homogeneous multinational firms that are price takers in input and output markets, so that we can characterize their behavior using that of a representative firm. The intermediate good is produced by the representative firm using inputs of capital (k) and managerial skill (m) according to the production function $f(k, m)$ in its Home affiliate and $f^*(k^*, m^*)$ in its Foreign affiliate, with both production functions exhibiting decreasing returns to

[5] Some recent macroeconomic papers focus on how exchange rates and prices adjust in response to border adjustments, e.g. Baumann, Dieppe, and Dizioli (2017), Barro and Furman (2018) and Barbiero et al (2018). Barbiero et al derive a neutrality condition in a macroeconomic model without multinational firms that requires restrictions on monetary policy, pricing policy and the form of international asset holdings. We abstract from these short run effects and focus on long run adjustments.

[6] The model in Becker and Englisch (2020) is essentially the same model as in AD.

scale. The firm's aggregate purchase of the capital input is denoted by K, which is purchased from good 2 firms and can be allocated between countries. The firm is endowed with M units of managerial skill that is perfectly mobile between countries. Let x (x^*) denote the quantity of the intermediate good used for production of the final good in Home (Foreign). The fact that the intermediate good can be traded between locations yields

$$x_1 + x_1^* = f(k, m) + f^*(K - k, M - m). \tag{1}$$

The firm produces the non-traded final consumption good from the intermediate input and a fixed factor according to the technology $c_1 = h(x_1)$ in Home and $c_1^* = h^*(x_1^*)$ in Foreign, where $h(\cdot)$ and $h^*(\cdot)$ are strictly concave functions.

Eq. (1) allows each affiliate to sell some of its intermediate good production to the other affiliate. Net exports by Home are $e = f(k, m) - x_1$. We assume that any such trades occur at an arm's length transfer price, q, which is equal to the marginal cost of the selling affiliate. Thus, as shown in AD,

$$q = \begin{cases} 1/f_1(k, m) & if\ e > 0 \\ 1/f_1^*(K - k, M - m) & if\ e < 0, \end{cases} \tag{2}$$

where subscripts on the f and f^* functions denoted partial derivatives. The arm's length price is not manipulable by the multinational but can change with changes in either country's tax policy. Eq. (2) rules out firms manipulating their transfer price on intra-firm trade in order to reduce their total tax liability. In the case of multilateral DBCFT, the multinational will not have an incentive to manipulate transfer prices as we discuss below. For other cases, this assumption would be consistent with effective enforcement of transfer pricing by tax authorities. We will show that our results continue to hold even if the multinational has the ability to manipulate q or set a transfer price that differs from q.

Given these definitions, after-tax multinational profit from good 1 production and sales equals

$$\pi = p_1 c_1 + p_1^* c_1^* - p_2 k - p_2^*(K - k) - T_1 - T_1^* \tag{3}$$

where $p_1(p_1^*)$ is the Home (Foreign) price of good 1, $p_2(p_2^*)$ is the Home (Foreign) price of good 2 and of capital, and $T_1(T_1^*)$ is the Home (Foreign) affiliate's corporate tax bill. Firms are assumed to choose K, m, k, and x_1 to maximize global after-tax profits.

Home consumer preferences are assumed to be given by the quasi-linear utility function, $U = u(c_1) + c_2 + \nu(g)$, where $u(\cdot)$ and $\nu(\cdot)$ are increasing and strictly concave functions. Similarly, Foreign consumer preferences are $U^* = u^*(c_1^*) + c_2^* + \nu^*(g^*)$. Consumer income consists of labor income and ownership shares of the multinational. Letting w denote the wage rate and β the share of multinational profits owned by the Home consumer, Home household income is $wL + \beta\pi$ and Foreign income is $w^*L^* + \beta^*\pi$, where $\beta + \beta^* = 1$. We choose units of good 2 in the foreign country as the numeraire, so the household budget constraints for the respective countries will be

$$p_2c_2 + p_1c_1 = wL + \beta\pi \text{ and } c_2^* + p_1^*c_1^* = w^*L^* + \beta^*\pi. \tag{4}$$

Utility maximization implies that $u'(c_1) = p_1/p_2$ and $u^{*\prime}(c_1^*) = p_1^*$.

2.1 Government Tax and Spending Policy

Governments in each country impose corporate income taxes on firms selling goods 1 and 2 based on their respective definitions of taxable income. Labor costs are assumed to be deductible from corporate income in each country, while the cost of the managerial input or fixed factors in the production of consumption goods are not deductible.

For good 1 sales, the multinational is taxed in each of its production locations based on the definition of taxable income and deductible expenses in that location.[7] Home tax policy is characterized by the parameters $\{t, \lambda, \delta\}$. The corporate tax rate t is the rate that is applied to the Home definition of income for the Home affiliate. λ is the after-tax cost of a unit of capital to the firm. In the case of a cash flow tax, all capital expenses are deductible and $\lambda = 1 - t$. In an income tax system where capital costs are not deductible from taxable income, $\lambda = 1$. We treat λ as a continuous choice variable of Home, since countries can affect the after-tax cost of capital by varying depreciation allowances

[7] We assume that each country adopts an exemption or territorial system for dividend payments so that the multinational incurs no additional taxes to distribute its profit to shareholders.

The parameter $\delta \in [0,1]$ is the border adjustment parameter indicating the share of the tax rate that is imposed by the home country on exports trade in the intermediate good and the share of the imported intermediates that are deductible from Home taxable income. The tax liability to the Home government on intra-firm trade is δtqe. Under a destination-based tax system $\delta = 0$, since export sales of the intermediate good are not subject to income tax and imports from the Foreign plant are not tax deductible. In contrast, $\delta = 1$ under a source-based system because sales of intermediate goods are counted as part of local income and purchases of imported inputs from the Foreign plant are deductible from corporate income. We also treat δ as a continuous choice parameter, which allows for partial border adjustments of tax liabilities for imports and exports.[8] Foreign tax policy is similarly characterized by $\{t^*, \lambda^*, \delta^*\}$.

Given these definitions, government tax revenues from good 1 sales are

$$T_1 = t \cdot \left(p_1 c_1 + \delta qe - \frac{1-\lambda}{t} p_2 k \right) \text{ and } T_1^* = t^* \cdot \left(p_1^* c_1^* - \delta^* qe - \frac{1-\lambda^*}{t^*} p_2^* (K-k) \right) \quad (5)$$

and after-tax multinational profit is

$$\pi = (1-t) p_1 c_1 - \lambda p_2 k + (1-t^*) p_1^* c_1^* - \lambda^* p_2^* (K-k) + (\delta^* t^* - \delta t) qe. \quad (6)$$

The last term in (6) shows that the tax differential $\delta^* t^* - \delta t$ creates an income shifting incentive at the margin for intra-firm trade. If $\delta^* t^* < \delta t$, as might occur if Home has a higher corporate tax and both countries have source-based systems, the firm has an incentive to increase its Home imports of the intermediate good in order to shift income to the Foreign affiliate. If both countries adopt DBCFT, intra-firm trade has no effect on the tax bill and there is no income shifting incentive on intra-firm trade. As AD point out, if the countries are sufficiently asymmetric the actual direction of trade can be the opposite of that suggested solely by the sign of $\delta^* t^* - \delta t$. For example, Home may import the intermediate input if final good demand is significantly larger at Home, even if $\delta^* t^* > \delta t$.

[8] For example, the Tax Cuts and Jobs Act included some partial border adjustment in the form of the Base Erosion and Anti-Abuse Tax (BEAT) provision, which limits the deductibility of payments by multinationals to foreign subsidiaries in low tax locations. China's use of partial refunds of VAT payments on exports (Chandra and Long (2013)) provides an example of the use of partial border adjustments in a destination-based VAT system.

In the production of good 2, firms incur no capital expenses and are perfectly competitive. These firms can buy the endowment good from the Home (Foreign) consumer at $w(w*)$ and sell good 2 at $p_2(1)$. In order for sector 2 firms to earn zero profit on domestic sales, it must be that $p_2 = w$ and $p_2^* = w^* = 1$. Note however that the linkage between prices of good 2 between countries will depend on the deductibility of the cost of imported inputs and the tax treatment of export income. When Home is a net exporter of capital, it can sell a unit to a Foreign importer at a price of p_{2x} and earn after-tax profit of $(1 - \delta t)p_{2x} - (1 - t)w$. After-tax profit for the Foreign importer from this trade is $(1 - t^*)p_2^* - (1 - \delta^* t^*)p_{2x}$. Zero profit for the Home exporter and the Foreign importer then implies that $p_{2x} = (1 - t^*)/(1 - \delta^* t^*)$ and

$$p_2 = w = \frac{(1 - t^*)(1 - \delta t)}{(1 - t)(1 - \delta^* t^*)} = \frac{1 - \delta t}{1 - t} p_{2x}. \tag{7}$$

Similar calculations show that when Foreign is the capital exporter, one gets the same expressions for p_2 and p_2^* and the Foreign export price is $p_{2x}^* = (1 - t^*)/(1 - \delta^* t^*) = p_{2x}$.[9]

Observe from (7) that the linkage between the prices of good 2 across countries is determined by their corporate tax rates and choice of border adjustments. Our focus will be on the case where countries are initially in a situation where both have adopted DBCFT. When both countries adopt destination taxation, $\delta = \delta^* = 0$ so $p_2 = w = (1 - t^*)/(1 - t)$. Corporate tax rate changes are fully passed through to prices of good 2 at Home in this case. A reduction in Home's border adjustment in the neighborhood of $\delta = 0$ would reduce the price of good 2 in Home, as $\frac{dp_2}{d\delta} = -tp_2$, whereas a reduction in Foreign's border adjustment would raise the price of good 2 in Home, as $\frac{dp_2}{d\delta^*} = t^* p_2$.

For $\delta \in [0, 1)$, it can be seen from (7) that $p_2 > p_{2x}$. If Home imports the capital good, $p_2 - p_{2x}$ represents the border adjustment tax collected by Home due to the less than complete deductibility of imported capital goods from firm profits. If Home exports the capital good, $p_2 - p_{2x}$ is the subsidy paid by the Home government per unit of capital exports due to the exemption of profits on export sales. Home is an importer (exporter) of capital when $c_2 + k + g > (<) L$. Using a similar argument

[9] AD derive different price formulas for the destination-only cases because they let good 2 be the numeraire in each country and then use an exchange rate. The above prices imply the same relative prices as in AD.

for Foreign, the government revenue collected from taxes on capital trade will be

$$T_2 = \frac{t(1-\delta)}{1-t} p_{2x}(c_2 + k + g - L) \text{ and } T_2^* = \frac{-t^*(1-\delta^*)}{(1-t^*)} p_{2x}(L^* - c_2^* - k^* - g^*). \tag{8}$$

The exporting country effectively subsidizes the capital trade whereas the importing country earns tax revenue on it when $\delta < 1$.[10]

We assume that government spending is equal to tax revenues so $p_2 g = T_1 + T_2$ and $g^* = T_1^* + T_2^*$. Using the government budget constraint and (8), we have

$$g = \frac{T_1}{p_{2x}} + \frac{t(1-\delta)(c_2 + k - L)}{1-t} \text{ and } g^* = \frac{T_1^*}{p_{2x}} + \frac{t^*(1-\delta^*)(c_2^* + k^* - L^*)}{1-t^*}. \tag{9}$$

The labor market equilibrium condition requires that $L = c_2 + g + k + z_2$, where z_2 denotes net exports of capital. Substituting the labor market condition and (9) into the household budget constraint, (4), yields the condition for current account balance,

$$qz_2 + p_{2x}e + \beta\pi - \pi^h = 0 \tag{10}$$

where π^h is the profit generated by the Home affiliate. Current account balance requires that the value of net exports of capital and intermediate goods evaluated at border prices equal the net payment of multinational profits to foreigners.

2.2 Market Equilibrium

Holding each country's tax policy fixed, a market equilibrium satisfies profit maximization by the multinational, utility maximization by Home and Foreign consumers, and market clearing. At an interior equilibrium where the multinational produces and sells in both countries, differentiation of

[10] We simplify by assuming that when a country exports good 2, the tax authority is willing to subsidize sector 2 firms that have negative reported tax liabilities. If the government were to require tax payments to be non-negative, then firms in sector 1 would have an incentive to integrate with sector 2 firms that export capital goods in order to offset their positive tax liabilities on sales of good 1. In that case the tax collections on sector 2 activities would be the same as in (8).

(6) yields the multinational's profit-maximizing choices:

$$\pi_k = 0 \Rightarrow (1-t^*)p_1^* h^{*\prime}(x_1^*)(f_1(k,m) - f_1^*(K-k, M-m)) = \lambda p_2 - \lambda^* + (\delta t - \delta^* t^*) f_1(k,m) q, \quad (11)$$

$$\pi_m = 0 \Rightarrow (1-t^*)p_1^* h^{*\prime}(x_1^*)(f_2(k,m) - f_2^*(K-k, M-m)) + (\delta^* t^* - \delta t) f_2(k,m) q = 0, \quad (12)$$

$$\pi_K = 0 \Rightarrow (1-t^*)p_1^* h^{*\prime}(x_1^*) f_1^*(K-k, M-m) - \lambda^* = 0, \quad (13)$$

and

$$\pi_{x_1} = 0 \Rightarrow (1-t)p_1 h'(x_1) - (1-t^*)p_1^* h^{*\prime}(x_1^*) - (\delta^* t^* - \delta t) q = 0. \quad (14)$$

These necessary conditions can be used to illustrate the "tax wedges" created by the choice of tax parameters by the respective governments. Equations (11) and (12) illustrate how tax policy affects a multinational's allocation of inputs between countries. If $\lambda p_2 > \lambda^*$, the after-tax cost of capital is higher in Home than in Foreign, which creates an incentive to substitute capital investment in Foreign for that in Home. If $\delta t > \delta^* t^*$, there is an incentive for the firm to declare income in Foreign rather than in Home, which creates an incentive to shift both capital investments and the use of managerial input toward Foreign. Equation (13) shows that a multinational will equate its after-tax marginal revenue product of capital in Home to the after-tax cost of capital in Foreign. Finally, equation (14) shows that if $\delta t > \delta^* t^*$, after-tax marginal revenue will be higher in Foreign than in Home, reflecting an incentive to substitute Home sales for Foreign sales.

Observe that with multilateral DBCFT, $\lambda p_2 = \lambda^* = 1 - t^*$ and $\delta t = \delta^* t^* = 0$, so the marginal products of capital and the managerial input will be equated across countries from (11) and (12). In addition, we have from (13), (14), and the necessary conditions from consumer optimization that the marginal value of an additional unit of the intermediate good in each country will be equated to the common marginal cost of production of the intermediate, $u'(c_1)h'(x_1) = u^{*\prime}(c_1^*)h'(x_1^*) = 1/f_1(k,m)$. Thus, the quantities c_1, c_1^*, K, k and m will be invariant to the choices of tax rates by the countries. Furthermore, the fact that firm profits are independent of q with $\delta = \delta^* = 0$ means that, even if it could, the multinational has no incentive to manipulate transfer prices to reduce its tax burden.

We impose the following assumption on multinational firm technology:

Assumption 1 *At an interior multilateral DBCFT equilibrium, the multinational's production* *technology satisfies*

$$\begin{aligned}\Delta &= f^*_{11}(k^*,m^*)(f_{22}(k,m)+f^*_{22}(k^*,m^*)) - f^*_{12}(k^*,m^*)(f_{12}(k,m)+f^*_{12}(k^*,m^*)) > 0 \\ & \quad \textit{and} \qquad (15) \\ \Delta^* &= f_{11}(k,m)(f_{22}(k,m)+f^*_{22}(k^*,m^*)) - f_{12}(k,m)(f_{12}(k,m)+f^*_{12}(k^*,m^*)) > 0.\end{aligned}$$

The strict concavity of the production functions for the intermediate goods ensures that $\Delta+\Delta^* > 0$. The case where $\Delta < 0$ arises if capital in the Home affiliate is an inferior factor, in the sense that the cost minimizing quantity of capital in the Home affiliate decreases as the multinational's total production of the intermediate increases. A similar interpretation of inferiority of Foreign capital applies if $\Delta^* < 0$. Thus, Assumption 1 ensures that capital is a normal input in each of the affiliates.

Assumption 1 must hold when the intermediate good technologies are identical across countries, even if there are differences in preferences and the final good production technologies. To illustrate the restrictions imposed when the intermediate good technologies differ across locations, suppose the technologies are Cobb Douglas with $f(k,m) = k^\alpha m^\gamma$ and $f^*(k^*,m^*) = (k^*)^{\alpha^*}(m^*)^{\gamma^*}$ for $\alpha+\gamma < 1$ and $\alpha^*+\gamma^* < 1$. Assumption 1 will be satisfied if $\alpha+\gamma^* < 1$ and $\alpha^*+\gamma < 1$, regardless of any asymmetry among preferences or final good production technologies. The requirement is that the factor shares of the factors that are mobile within the firm not differ too much across locations.

3 Unilateral Tax Incentives with DBCFT in Both Countries

As AD note, the market equilibrium when both countries adopt DBCFT has desirable efficiency properties, because the choice of the corporate income tax has no effect on the location of production of intermediate or final goods. Therefore, it would be desirable for Home and Foreign to coordinate their policy choices so that both countries adopt DBCFT and set tax rates that lead to efficient global provision of public goods. Would such a system be immune to unilateral deviations by Home and Foreign in their choice of tax policy parameters, or would some form of commitment mechanism be required to sustain an equilibrium with DBCFT in each country? In this section we address this question by examining whether Home can benefit by deviating from globally efficient multilaterial DBCFT and globally efficient tax rates by changing any of the policy parameters $\{t, \delta, \lambda\}$ and similarly for Foreign.

We begin by considering Home's choice of tax rate to maximize national welfare. Evaluating profits of a representative multinational when both countries have a DBCFT using (6), (7), and the consumer optimization problem yields

$$\pi = (1 - t^*)(u'(c_1)c_1 + u^{*\prime}(c_1^*)c_1^* - K), \tag{16}$$

which is independent of Home's choice of tax rate.

To determine the tax revenue collected by Home and Home consumption of good 2, we can solve (4) and (9) simultaneously to obtain

$$g = \frac{t\beta\pi}{1 - t^*} = t\beta(u'(c_1)c_1 + u^{*\prime}(c_1^*)c_1^* - K) \tag{17}$$

and

$$c_2 = L + \frac{(1 - t)\beta\pi}{1 - t^*} - u'(h(x_1))h(x_1). \tag{18}$$

When Home raises its corporate tax rate on the multinational activity that takes place in Home, part of that tax falls on the owners of the multinational in Foreign when $\beta^* > 0$. This suggests an incentive for Home to use its corporate tax rate to capture revenue from Foreign. However, changes in the tax rate also affect the revenue collected on capital trade. Equation (17) shows that when the effect on capital tax revenues is included, the impact of an increase in the Home corporate tax rate on Home tax revenues depends on its ownership share in the multinational, and not on its share of global production revenue. Analogous expressions exist for c_2^* and g^*.

If the tax rates are set non-cooperatively, Home will set its tax rate such that $\frac{dU}{dt} = 0$. The change in Home welfare will be

$$\frac{dU}{dt} = \frac{p_1}{p_2}\frac{dc_1}{dt} + \frac{dc_2}{dt} + v'(g)\frac{dg}{dt}. \tag{19}$$

Since x_1, c_1 and π are independent of the Home tax rate, we have from (17) and (18) that $\partial c_2/\partial t =$

$-\beta\pi/(1-t^*) = -\partial g/\partial t$. Assuming that Home's share of multinational profits is sufficiently large that $\beta\pi/(1-t^*) \geq (v')^{-1}(1)$, Home's optimal policy is to choose t such that $v'(g) = 1$. In addition, because government spending in any market equilibrium under multilateral DBCFT, as in (17), is independent of the other country's tax rate, Home has the dominant strategy tax rate of

$$t = \frac{(v')^{-1}(1)}{\beta[u'(c_1)c_1 + u^{*\prime}(c_1^*)c_1^* - K]} \tag{20}$$

as long as the expression in (20) is not greater than 1. Thus, Home's unilateral choice of its tax rate results in an efficient level of Home government spending. Doing a similar evaluation for Foreign yields

Proposition 1 *If $u'(c_1)c_1 + u^{*\prime}(c_1^*)c_1^* - K \geq \min\{(v')^{-1}(1)/\beta, (v^{*\prime})^{-1}(1)/\beta^*\}$, then the non-cooperative choice of tax policies by each country will result in an efficient choice of public good expenditures in each country with $v'(g) = v^{*\prime}(g^*) = 1$.*[11]

A Unilateral Incentive to Shift Away From Full Cash Flow Taxation

Next, we examine the incentive of each country to deviate from the use of a cash flow tax, $\lambda = 1 - t$ and $\lambda^* = 1 - t^*$, while maintaining the destination-based taxation principle, $\delta = \delta^* = 0$. Such a change will leave p_2 unaffected, since the price of good 2 is determined by the border adjustment policies.

To determine the effect of an increase in a capital tax, we note from the necessary conditions in (11)-(14) that an increase in λ or λ^* increases the firm's cost of using capital in the respective location. The following comparative statics results are established in the Appendix by totally differentiating the multinational firm's necessary first-order conditions and taking into account the impact of changes in multinational firm output on market prices.

Lemma 1 *If Assumption 1 holds and multilateral DBCFT yields an interior market equilibrium, an increase in either λ or λ^* will reduce the representative firm's total capital investment and the output of good 1 in each country, and increase the price of good 1 in each country. In particular,*

[11] If lump sum transfers were feasible, neither government would have an incentive to raise more revenue because it would simply redistribute the excess amount back to its households to offset a reduction in c_2.

the price increases will satisfy

$$\frac{dp_1}{d\lambda^*} = \frac{\Delta^*}{p_2\Delta}\frac{dp_1}{d\lambda} > 0 \; and \; \frac{dp_1^*}{d\lambda^*} = \frac{\Delta^*}{p_2\Delta}\frac{dp_1^*}{d\lambda} > 0. \tag{21}$$

An increase in λ raises the cost of using capital in Home production of the intermediate, which results in the substitution of production of the intermediate from Home to Foreign and a decline in overall capital investment by the multinational. The higher cost of production of the intermediate good results in a decline in the output of good 1 and a rise in the price in each location.

To evaluate the effect of an increase in λ on Home welfare, we focus on the case where there is an interior solution with $v'(g) = 1$. From (19), the effect of an increase in the Home tax on capital on Home welfare from (19) is

$$\frac{dU}{d\lambda} = \frac{p_1}{p_2}\frac{dc_1}{d\lambda} + \frac{d(c_2+g)}{d\lambda}. \tag{22}$$

Using (4) and (9), we can express $c_2 + g$ as

$$c_2 + g = L + \frac{\beta\pi}{1-t^*} - \frac{p_1}{p_2}c_1 + \frac{k(t-(1-\lambda))}{1-t}. \tag{23}$$

Differentiating (23), using the Envelope Theorem to calculate $d\pi$, and substituting the result in (22) yields

$$\left.\frac{dU}{d\lambda}\right|_{\lambda=1-t,\lambda^*=1-t^*} = \frac{\beta^* k}{1-t} - \beta^*\frac{c_1}{p_2}\frac{dp_1}{d\lambda} + \beta c_1^*\frac{dp_1^*}{d\lambda}. \tag{24}$$

The first term in (24) represents the fiscal effect associated with exporting taxes to non-residents. Raising one's capital tax rate generates tax revenue benefits that are proportional to the ownership share of non-residents, since the tax is being collected on the profits held by Foreign residents. The remaining two terms in each expression represent the price effects through changes in the prices for good 1. An increase in p_1 transfers income from Home consumers to the multinational firm, which harms Home when $\beta^* > 0$. An increase in p_1^* transfers income from Foreign consumers to the firm, which benefits Home when $\beta > 0$.

A similar expression is obtained for the effect of an increase in Foreign's capital tax on Foreign welfare:

$$\left.\frac{dU^*}{d\lambda^*}\right|_{\lambda=1-t,\lambda^*=1-t^*} = \frac{\beta k^*}{1-t^*} + \beta^* \frac{c_1}{p_2}\frac{dp_1}{d\lambda^*} - \beta c_1^* \frac{dp_1^*}{d\lambda^*}. \tag{25}$$

A unilateral increase in its capital tax will increase its welfare by collecting tax revenues from non-residents. The only question for either country is whether the resulting price effects move welfare in the opposite direction by enough to offset the fiscal effects.

In a symmetric economy with identical technologies and preferences across countries and $\beta = 1/2$, $\Delta = \Delta^* > 0$ and $\beta^* \frac{c_1}{p_2}\frac{dp_1}{d\lambda^*} = \beta c_1^* \frac{dp_1^*}{d\lambda^*}$ so the price effect for each country will be 0. In the perfectly symmetric case, each country has a unilateral incentive to increase its capital tax. When the countries are asymmetric, the value of Foreign's price effect will equal Home's price effect scaled by $-\Delta^*/(p_2\Delta)$ according to Lemma 1. Since the countries' price effects will necessarily have opposite signs, at least one country must benefit from deviating from multilateral DBCFT by raising its tax on capital. Observe that Home's gain from the change in multinational firm profit is increasing in β and in c_1^*/c_1. Thus, a Home deviation is most attractive when Home residents own a larger share of the multinational firm, and when a larger share of multinational firm sales are being collected from Foreign consumers.

This analysis implies the following proposition.

Proposition 2 *If Assumption 1 holds and multilateral DBCFT yields an interior market equilibrium, then at least one country will have a unilateral incentive to reduce the tax deduction for capital expenses.*

Proposition 2 reveals that non-cooperative multilateral adoption of DBCFT is undermined by unilateral incentives of at least one country to allow less than a full tax deduction for capital expenses. Proposition 2 holds even if the model allowed for transfer price and/or arm's length price manipulation because any incentive to shift income between the countries is eliminated when both countries adopt full destination-based taxation.

A Unilateral Incentive to Shift Away From Full Border Adjustment

In this section, we ask if a country has an incentive to offer less than a full border adjustment starting from multilateral DBCFT. Thus, we evaluate changes in a country's welfare from an increase in its border adjustment, δ or δ^*, starting from a market equilibrium where both countries have adopted DBCFT and tax rates are such that $v'(g) = v^{*\prime}(g^*) = 1$. A change in δ raises the price of the traded intermediate inputs and capital goods proportionally, so that their relative prices remain unchanged. In order for an increase in δ to be neutral, and thus have no effect on Home welfare, it must leave the Home country outputs unaffected and leave the current account (10) in balance. We show that in the presence of intra-firm trade and cross border ownership of firm profits, a change in δ will have real effects.

As was the case for a change in λ, the change in Home welfare from a change in δ will be the price weighted change in consumption of good 1 and good 2/public good consumption when there is efficient provision of the public good,

$$\left.\frac{\partial U}{\partial \delta}\right|_{\delta=\delta^*=0} = \frac{p_1}{p_2}\frac{\partial c_1}{\partial \delta} + \frac{\partial (c_2 + g)}{\partial \delta}. \tag{26}$$

To establish the effect of δ on $c_2 + g$, we obtain from (4) and (9),

$$c_2 + g = L + \frac{\beta \pi}{1 - t^*} - \frac{(1-t)p_1 c_1}{1 - t^*} + \frac{t \delta q e}{1 - t^*} - \delta t k. \tag{27}$$

Differentiating Eq. (27), applying the Envelope Theorem to π, and substituting in (26) yields

$$\left.\frac{dU}{d\delta}\right|_{\delta=\delta^*=0} = \beta^* t \left(\frac{p_1}{p_2} c_1 - k\right) + \beta^* \frac{tqe}{1 - t^*} - \beta^* c_1 u''(c_1) \frac{\partial c_1}{\partial \delta} + \beta c_1^* u^{*\prime\prime}(c_1^*) \frac{\partial c_1^*}{\partial \delta}. \tag{28}$$

Changes in δ affect good 1 prices through consumption levels and Home's good 2 price. To separate these effects, we write eq. (28) in terms of good 1 consumption changes instead of prices changes. Eq. (28) reveals that an increase in δ when both countries start with DBCFT has four effects on Home welfare. The first two terms capture the effect of the border adjustment on $c_2 + g$ at fixed outputs of the multinationals. The first term is the effect of a reduction in p_2 at fixed c_1, which increases the taxes collected on the share of multinational profit income owned by Foreign residents. This term must be positive in any interior equilibrium. The second term reflects the change in Home welfare resulting from the change in tax revenue from trade in intermediate goods, which is proportional to the share of multinationals owned by Foreign households. An increase in

δ will raise net tax revenue if Home is an exporter of the intermediate good because it reduces the Home subsidy on trade in capital. It will reduce Home tax revenue if Home imports the intermediate good. These two terms together reflect the spillovers due to cross-border ownership of firm shares at given outputs for the multinational firms.

The remaining terms in (28) capture the effects of the multinationals' reallocation of sales between markets if the border adjustment does not have a neutral effect on firm outputs. The third term is the net effect of the change in p_1/p_2 on Home welfare, which will be positive if Home consumption increases. A reduction in p_1/p_2 transfers income from the multinational to Home consumers, which is beneficial to Home to the extent that the firm is owned by Foreign households. The final term shows that a decrease in Foreign consumption raises Home welfare, since it reflects an increase in profits to Home households due to the increase in p_1^*. A similar decomposition can be obtained for the welfare change for Foreign.

In the present model, it can be seen from differentiation of the multinational's profit function (6) that a change in δ will not be neutral in its effect on firm outputs. An increase in δ creates an incentive to produce more of the intermediate good in the Foreign affiliate and ship it to the Home market. This incentive can be seen in the multinational's necessary first-order conditions for profit maximization. From (11) and (12), it can be seen that an increase in δ will create an incentive to reallocate inputs of K and M to the Foreign affiliate, while from (14) the incentive is to allocate more of the intermediate to the Home market. The latter observation suggests that as long as overall production of the input does not change by too much, the firm will have an incentive to increase sales of the final good in Home and reduce them in Foreign. An increase in Home consumption and a decrease in Foreign consumption would then have a positive effect on Home welfare.

To illustrate the effect of a deviation from destination-based taxation in a simple way, we focus on the case in which the two countries are symmetric, so that the technologies, preferences, and ownership shares of the multinationals are identical across the countries. The following result, which is proven in the Appendix, establishes the comparative static result for the case of symmetric countries.

Lemma 2 *In the case where technologies and preferences are identical across countries and $\beta = 1/2$,*

$$\frac{dK}{d\delta} = 0 \text{ and } \frac{dc_1}{d\delta} = -\frac{dc_1^*}{d\delta} > 0. \tag{29}$$

The increase in δ has no effect on the representative multinational's capital stock, but results in a reallocation of sales from the Foreign market to the Home market.

Referring to the change in Home welfare from (26), the increase in Home consumption and decrease in Foreign consumption both have positive effects on Home welfare. With symmetric countries, there is no trade in the intermediate good in the DBCFT equilibrium and the last two terms in (28) sum to 0. Therefore, Home gains unambiguously by increasing δ from an initial position of $\delta = 0$. Since the countries are symmetric, Foreign will also have an incentive to raise δ^*, which establishes the following result:

Proposition 3 *If Home and Foreign have identical preferences, technologies, and multinational ownership shares, each country has a unilateral incentive to deviate from multilateral DBCFT by reducing its border adjustment.*

If the countries are asymmetric, the second term in (28) will be positive for the country that exports the intermediate good and negative for the other country. The sign of this second term need not be the same as the sign of the net consumption effect terms. While Proposition 3 will extend to economies with small asymmetries, this fact prevents us from extending Proposition 3 to the asymmetric case in general.

4 Conclusion

Our analysis has shown that in order for a multilateral agreement on the use of DBCFT to be honored by each country, a commitment mechanism will be required to prevent countries from making unilateral deviations in their tax treatment of capital income and in their adherence to a fully destination-based tax principle. We have identified how fiscal effects and price effects resulting from these tax parameter changes create an incentive for countries to deviate from a multilateral DBCFT when there are multinational firms engaged in intra-firm trade. We also showed how the deviation incentives depend on the allocation of ownership of the multinational firms across countries and the pattern of trade when countries are asymmetric.

The fiscal effects of imposing a tax on capital usage derive from shifting part of the tax burden to Foreign owners of the multinational. Price effects do arise from a change in one country's corporate tax policy, but they must be positive for at least one country. From an equilibrium perspective, small deviations from DBCFT do not generate first-order efficiency losses because global welfare is optimized under multilateral DBCFT. Moreover, our analysis of a reduction in the deductions for capital expenses applies in both symmetric economies and asymmetric economies. Deviation incentives due to the price effect are stronger in countries that have a large share of firm ownership,

We also show that the existence of intra-firm trade and cross-border ownership of firm profits means that border adjustments will not be neutral. A change in the border adjustment has an effect on prices of traded goods that is the same as a combined import tariff and export subsidy for traded goods. In the presence of intra-firm trade in the multinational, border adjustments will result in a reallocation of capital and managerial resources between countries. In the symmetric country case, both countries have an incentive to deviate from DBCFT. When countries are asymmetric, the country whose affiliate exports the intermediate good will benefit from a reduction in the border adjustment.

5 Appendix

Proof of Lemma 1: To establish the results in Lemma 1, we calculate comparative statics using the necessary conditions in (11)-(14). We totally differentiate these conditions with respect to λ and λ^* and evaluate at $\delta = \delta^* = 0$, $\lambda = 1-t$, $\lambda^* = 1-t^*$, taking into account the impact of changes in outputs on consumer prices. Recalling that in a market equilibrium with universal DBCFT that $f_1(k,m) = f_1^*(K-k, M-m))$ and $f_2(k,m) = f_2^*(K-k, M-m)$, we have

$$\pi_{kk}dk + \pi_{km}dm + \pi_{kK}dK + \pi_{kx_1}dx_1 = p_2 d\lambda - d\lambda^*, \tag{30}$$

$$\pi_{km}dk + \pi_{mm}dm + \pi_{mK}dK + \pi_{mx_1}dx_1 = 0, \tag{31}$$

$$\pi_{kK}dk + \pi_{mK}dm + \pi_{KK}dK + \pi_{Kx_1}dx_1 + (1 - t^*)h^{*\prime}(x_1^*)f_1^*(K-k, M-m)\frac{dp_1^*}{dx_1^*}(f_1^*(K-k, M-m)dK - dx_1) = d\lambda^*, \quad (32)$$

and

$$\pi_{kx_1}dk + \pi_{mx_1}dm + \pi_{Kx_1}dK + \pi_{x_1x_1}dx_1 + (1-t)h'(x_1)\tfrac{dp_1}{dx_1}dx_1 - (1-t^*)h^{*\prime}(x_1^*)\tfrac{dp_1^*}{dx_1^*}(f_1(K-k, M-m)dK - dx_1) = 0 \quad (33)$$

as $dx_1^* = f_1^*(K-k, M-m)dK - dx_1$, $dp_1/dx_1 = p_2u''(c_1)h'(x_1)$, and $dp_1^*/dx_1^* = u^{*\prime\prime}(c_1^*)h^{*\prime}(x_1^*)$. The subscripts on π in (30)-(33) refer to derivatives of the multinational's profit function holding prices constant.

Direct calculation yields at a multilateral DBCFT market equilibrium that $\pi_{kk} = (1-t^*)p_1^*h^{*\prime}(x_1^*)(f_{11}(k,m) + f_{11}^*(K-k, M-m)) < 0$, $\pi_{km} = (1-t^*)p_1^*h^{*\prime}(x_1^*)(f_{12}(k,m) + f_{12}^*(K-k, M-m)) > 0$, $\pi_{kK} = -(1-t^*)p_1^*h^{*\prime}(x_1^*)f_{11}^*(K-k, M-m) > 0$, $\pi_{kx_1} = \pi_{mx_1} = 0$, $\pi_{mm} = (1-t^*)p_1^*h^{*\prime}(x_1^*)(f_{22}(k,m) + f_{22}^*(K-k, M-m)) < 0$, $\pi_{mK} = -(1-t^*)p_1^*h^{*\prime}(x_1^*)f_{12}^*(K-k, M-m) < 0$, $\pi_{KK} = (1-t^*)p_1^*[h^{*\prime\prime}(x_1^*)f_1^{*2}(K-k, M-m) + h^{*\prime}(x_1^*)f_{11}^*(K-k, M-m)] < 0$, $\pi_{Kx_1} = -(1-t^*)p_1^*h^{*\prime\prime}(x_1^*)f_1^*(K-k, M-m) > 0$, and $\pi_{x_1x_1} = (1-t)p_1h''(x_1) + (1-t^*)p_1^*h^{*\prime\prime}(x_1^*) < 0$. It is straightforward but tedious to show that the leading principal minors of the Hessian matrix associated with the multinational firm's optimization problem at fixed prices alternate in sign, with those of odd order negative under Assumption 1. Therefore, the Hessian is negative definite and the optimization problem of a representative firm is strictly concave in $\{k, m, K, x_1\}$.

The effect of changes in K and x_1 on prices are captured by the terms

$$\begin{aligned} a_1 &= (1-t^*)u^{*\prime\prime}(h^*(x_1^*))h^{*\prime}(x_1^*)^2 f_1^*(K-k, M-m)^2 < 0, \\ a_2 &= -(1-t^*)u^{*\prime\prime}(h^*(x_1^*))h^{*\prime}(x_1^*)^2 f_1^*(K-k, M-m) > 0, \text{and} \\ a_3 &= (1-t)u''(h(x_1))h'(x_1)^2 + (1-t^*)u^{*\prime\prime}(h^*(x_1^*))h^{*\prime}(x_1^*)^2 < 0. \end{aligned}$$

We then have

$$\begin{pmatrix} \pi_{kk} & \pi_{km} & \pi_{kK} & 0 \\ \pi_{km} & \pi_{mm} & \pi_{mK} & 0 \\ \pi_{kK} & \pi_{mK} & \pi_{KK}+a_1 & \pi_{Kx_1}+a_2 \\ 0 & 0 & \pi_{Kx_1}+a_2 & \pi_{x_1x_1}+a_3 \end{pmatrix} \begin{pmatrix} dk \\ dm \\ dK \\ dx_1 \end{pmatrix} = \begin{pmatrix} p_2 d\lambda - d\lambda^* \\ 0 \\ d\lambda^* \\ 0 \end{pmatrix}. \tag{34}$$

We can also establish using the properties of the Hessian of the firm's optimization problem and the fact that $a_1a_3 - a_2^2 > 0$ that the 4x4 matrix in (34), which we denote by $\nabla^2\Pi$, is negative definite. We thus have $|\nabla^2\Pi| > 0$.

To solve efficiently for $dK/d\lambda$ and $dx_1/d\lambda$, we define

$$|AK\lambda| = \begin{vmatrix} \pi_{kk} & \pi_{km} & p_2 & 0 \\ \pi_{km} & \pi_{mm} & 0 & 0 \\ \pi_{kK} & \pi_{mK} & 0 & \pi_{Kx_1}+a_2 \\ 0 & 0 & 0 & \pi_{x_1x_1}+a_3 \end{vmatrix} = p_2(\pi_{x_1x_1}+a_3)((1-t^*)p_1^*h^{*\prime})^2\Delta < 0 \tag{35}$$

and

$$|Ax\lambda| = \begin{vmatrix} \pi_{kk} & \pi_{km} & \pi_{kK} & p_2 \\ \pi_{km} & \pi_{mm} & \pi_{mK} & 0 \\ \pi_{kK} & \pi_{mK} & \pi_{KK}+a_1 & 0 \\ 0 & 0 & \pi_{Kx_1}+a_2 & 0 \end{vmatrix} = -p_2(\pi_{Kx_1}+a_2)((1-t^*)p_1^*h^{*\prime})^2\Delta < 0. \tag{36}$$

where $\pi_{mk}\pi_{Km} - \pi_{Kk}\pi_{mm} = ((1-t^*)p_1^*h^{*\prime})^2\Delta$ from the definition in Assumption 1. This establishes $dK/d\lambda = |AK\lambda|/|\nabla^2\Pi| < 0$ and $dx_1/d\lambda = |Ax\lambda|/|\nabla^2\Pi| < 0$. Using the fact that $\frac{dx_1^*}{d\lambda} = f_1^*(K - k, M - m)\frac{dK}{d\lambda} - \frac{dx_1}{d\lambda}$ in the neighborhood of a multilateral DBCFT market equilibrium, $dx_1^*/d\lambda$ can be shown to be negative. One can also evaluate the good 1 price changes as

$$\frac{dp_1}{dx_1}\frac{dx_1}{d\lambda} = \frac{p_2^2 u'' h'((1-t^*)p_1^*h^{*\prime})^3\Delta(h^{*\prime\prime}u^{*\prime} + u^{*\prime\prime}h^{*\prime})}{|\nabla^2\Pi|} > 0 \tag{37}$$

and

$$\frac{dp_1^*}{dx_1^*}\frac{dx_1^*}{d\lambda} = \frac{u^{*\prime\prime}((1-t^*)p_1^*)^3(h^{*\prime})^4\Delta(h''u^{*\prime}+u^{*\prime\prime}h^{*\prime})}{|\nabla^2\Pi|} > 0. \tag{38}$$

Analogously,

$$|AK\lambda^*| = \begin{vmatrix} \pi_{kk} & \pi_{km} & -1 & 0 \\ \pi_{km} & \pi_{mm} & 0 & 0 \\ \pi_{kK} & \pi_{mK} & 1 & \pi_{Kx_1}+a_2 \\ 0 & 0 & 0 & \pi_{x_1x_1}+a_3 \end{vmatrix} = (\pi_{x_1x_1}+a_3)((1-t^*)p_1^*h^{*\prime})^2\Delta^* < 0 \tag{39}$$

and

$$|Ax\lambda^*| = \begin{vmatrix} \pi_{kk} & \pi_{km} & \pi_{kK} & -1 \\ \pi_{km} & \pi_{mm} & \pi_{mK} & 0 \\ \pi_{kK} & \pi_{mK} & \pi_{KK}+a_1 & 1 \\ 0 & 0 & \pi_{Kx_1}+a_2 & 0 \end{vmatrix} = -(\pi_{Kx_1}+a_2)((1-t^*)p_1^*h^{*\prime})^2\Delta^* < 0 \tag{40}$$

where we use the fact that $\pi_{kk}\pi_{mm}-\pi_{km}^2 = (1-t^*)p_1^*(h^{*\prime})^2(\Delta+\Delta^*)$. Thus, $dK/d\lambda^* = |AK\lambda^*|/|\nabla^2\Pi| < 0$ and $dx_1/d\lambda^* = |Ax\lambda^*|/|\nabla^2\Pi| = \frac{\Delta^*}{p_2\Delta}\frac{dx_1}{d\lambda} < 0$. Similarly, we have $\frac{dx_1^*}{d\lambda^*} = f_1^*\frac{dK}{d\lambda^*} - \frac{dx_1^*}{d\lambda^*} = \frac{\Delta^*}{p_2\Delta}\frac{dx_1^*}{d\lambda} < 0$.

Combining these results, we have $\frac{dp_1^*}{d\lambda^*} = \frac{\Delta^*}{p_2\Delta}\frac{dp_1^*}{d\lambda}$ and $\frac{dp_1}{d\lambda^*} = \frac{\Delta^*}{p_2\Delta}\frac{dp_1}{d\lambda}$.

Proof of Lemma 2:

To establish the effect of a change in the border adjustments, $\{\delta, \delta^*\}$, we totally differentiate (11)-(14) and evaluate at multilateral DBCFT, which yields

$$\begin{pmatrix} \pi_{kk} & \pi_{km} & \pi_{kK} & 0 \\ \pi_{km} & \pi_{mm} & \pi_{mK} & 0 \\ \pi_{kK} & \pi_{mK} & \pi_{KK}+a_1 & \pi_{Kx_1}+a_2 \\ 0 & 0 & \pi_{Kx_1}+a_2 & \pi_{x_1x_1}+a_3 \end{pmatrix} \begin{pmatrix} dk \\ dm \\ dK \\ dx_1 \end{pmatrix} = \begin{pmatrix} tt^*d\delta-(t^*)^2d\delta^* \\ qf_2[td\delta - t^*d\delta^*] \\ 0 \\ -tt^*qd\delta+(t^*)^2qd\delta^* \end{pmatrix}. \tag{41}$$

where the left matrix on the left hand side is the negative definite matrix $\nabla^2\Pi$ from Lemma 1. The effects of a change in δ are obtained using the fact that $\frac{dp_2}{d\delta} = -\delta p_2$.

To solve efficiently for $dK/d\delta$ and $dx_1/d\delta$ define

$$AK\delta = \begin{pmatrix} \pi_{kk} & \pi_{km} & tt^* & 0 \\ \pi_{km} & \pi_{mm} & tqf_2 & 0 \\ \pi_{kK} & \pi_{mK} & 0 & \pi_{Kx_1} + a_2 \\ 0 & 0 & -tt^*q & \pi_{x_1x_1} + a_3 \end{pmatrix} \tag{42}$$

and

$$Ax\delta = \begin{pmatrix} \pi_{kk} & \pi_{km} & \pi_{kK} & tt^* \\ \pi_{km} & \pi_{mm} & \pi_{mK} & tqf_2 \\ \pi_{kK} & \pi_{mK} & \pi_{KK} + a_1 & 0 \\ 0 & 0 & \pi_{Kx_1} + a_2 & -tt^*q \end{pmatrix}. \tag{43}$$

Then, $dK/d\delta = |AK\delta|/|\nabla^2\Pi|$ and $dx_1/d\delta = |Ax\delta|/|\nabla^2\Pi|$.

In a symmetric economy, $|AK\delta| = t^2q(\pi_{Kx_1} + a_2)|\nabla_2^2\pi| + t^2(\pi_{x_1x_1} + a_3)(\pi_{km}\pi_{mK} - \pi_{kK}\pi_{mm})$, where $\nabla_k^2\pi$ is the k^{th} order principal minor of $\nabla^2\pi$ and $\pi_{kk}\pi_{mK} - \pi_{kK}\pi_{km} = 0$. Further simplification yields

$$|AK\delta| = 2t^2(1-t)^2p_1^2(h')^2\nabla^2 f[2q(\pi_{Kx_1} + a_2) + \pi_{x_1x_1} + a_3] = 0 \tag{44}$$

so, at $\delta = \delta^* = 0$ and $t = t^*$, $dK/d\delta = 0$ and $dx_1^*/d\delta = -dx_1/d\delta$. It is also the case in a symmetric economy that

$$\begin{aligned} |Ax\delta| &= -t^2(\pi_{Kx_1} + a_2)(\pi_{km}\pi_{mK} - \pi_{mm}\pi_{kK}) - t^2q|\nabla_3^2\Pi| \\ &= 2t^2(1-t)^3p_1^2(h')^2\nabla^2 f f_1[u'h'' - u''(h')^2] - t^2q|\nabla_3^2\pi| \end{aligned} \tag{45}$$

so

$$|Ax\delta| = -2t^2(1-t)^3p_1^2(h')^2\nabla^2 f \left(p_1f_1h'' + (h')^2f_1u'' + qp_1h'f_{11}\right) > 0. \tag{46}$$

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Referee Appendix - Not intended for publication

Derivation of eq. (24): $dU/d\lambda$ evaluated at $\lambda = 1-t$, $\lambda^* = 1-t^*$, and $\delta = \delta^* = 0$.

The tax rates are set at their equilibrium values under multilateral DBCFT so $dU/d\lambda = u'(c_1)dc_1/d\lambda + d(c_2+g)/d\lambda$.

When $\delta = \delta^* = 0$, $p_2 = (1-t^*)/(1-t)$, $p_{2x} = 1-t^*$, and eq. (5) implies that $T_1 = tp_1c_1 - (1-\lambda)p_2k$ and $T_1^* = t^*p_1^*c_1^* - (1-\lambda^*)k^*$. From eq. (6), $\pi = (1-t)p_1c_1 - \lambda p_2k + (1-t^*)p_1^*c_1^* - \lambda^*k^*$ so that, by the Envelope Theorem, $d\pi = (1-t)c_1dp_1 - p_2kd\lambda + (1-t^*)c_1^*dp_1^*$.

Solving eqs. (4) and (9) for c_2 and g implies that $g = t\beta\pi/(1-t^*) + k(t-1+\lambda)/(1-t)$, $c_2 = L + \beta\pi/p_2 - p_1c_1/p_2$, and $c_2 + g = L + \beta\pi/(1-t^*) - u'(c_1)c_1 + k(t-1+\lambda)/(1-t)$. Thus,

$$\frac{dc_2}{d\lambda} = \frac{\beta(1-t)}{(1-t^*)}\frac{d\pi}{d\lambda} - \frac{p_1}{p_2}\frac{dc_1}{d\lambda} - \frac{c_1}{p_2}\frac{dp_1}{d\lambda}$$

and

$$\frac{dg}{d\lambda} = \frac{\beta t}{1-t^*}\frac{d\pi}{d\lambda} + \frac{k}{1-t} + \frac{(t-1+\lambda)}{1-t}\frac{dk}{d\lambda},$$

so that, at $\lambda = 1-t$,

$$\frac{dU}{d\lambda} = \frac{\beta^*k}{1-t} - \beta^*\frac{c_1}{p_2}\frac{dp_1}{d\lambda} + \beta c_1^*\frac{dp_1^*}{d\lambda},$$

which is eq. (24). The derivation for eq. (25) is analogous.

Derivation of eq. (28): $dU/d\delta$ evaluated at $\lambda = 1-t$, $\lambda^* = 1-t^*$, and $\delta = \delta^* = 0$.

The tax rates are set at their equilibrium values under multilateral DBCFT so $dU/d\delta = u'(c_1)dc_1/d\delta + d(c_2+g)/d\delta$.

When $\lambda = 1-t$ and $\lambda^* = 1-t^*$, $p_2 = (1-t^*)(1-\delta t)/(1-t)(1-\delta^*t^*)$, $p_{2x} = (1-t^*)/(1-\delta^*t^*)$, and eq. (5) implies that $T_1 = t(p_1c_1 - p_2k + \delta qe)$ and $T_1^* = t^*(p_1^*c_1^* - k^* - \delta^*qe)$. From eq. (6), $\pi = (1-t)(p_1c_1 - p_2k) + (1-t^*)(p_1^*c_1^* - k^*) + (\delta^*t^* - \delta t)qe$ so that, by the Envelope Theorem, $d\pi = (1-t)(c_1dp_1 - kdp_2) + (1-t^*)c_1^*dp_1^* - tqed\delta$.

Solving eqs. (4) and (9) for c_2 and g implies that at $\delta^* = 0$

$$g = \frac{t}{1-t^*}(p_1c_1 - p_2k + \delta qe) + \frac{t(1-\delta)}{1-t}(c_2 + k - L),$$

$c_2 = L + \beta\pi/p_2 - p_1 c_1/p_2$, and

$$c_2 + g = L + \frac{\beta\pi}{1-t^*} - \frac{1-t}{1-t^*} p_1 c_1 + \frac{t\delta qe}{1-t^*} - \delta tk.$$

Thus, at $\delta = 0$

$$\begin{aligned}\frac{d(c_2+g)}{d\delta} &= \frac{\beta}{1-t^*}\left((1-t)c_1\frac{dp_1}{d\delta} - (1-t)k\frac{dp_2}{d\delta} + (1-t^*)c_1^*\frac{dp_1^*}{d\delta} - tqe\right) \\ &- p_1\frac{1-t}{1-t^*}\frac{dc_1}{d\delta} - \frac{(1-t)c_1}{1-t^*}\frac{dp_1}{d\delta} + \frac{tqe}{1-t^*} - tk\end{aligned}$$

where $p_1 = p_2 u'(c_1)$ and $p_1^* = u^{*\prime}(c_1^*)$ so $(1-t)p_1/(1-t^*) = u'(c_1)$, $dp_1/d\delta = u'(c_1)dp_2/d\delta + p_2 u''(c_1)dc_1/d\delta$, $dp_1^*/d\delta = u^{*\prime\prime}(c_1^*)dc_1^*/d\delta$, and $dp_2/d\delta = -t(1-t^*)/(1-t)$. Substituting this expression for $d(c_2+g)/d\delta$ into the formula for $dU/d\delta$ yields eq. (28).