Technology Capital and the Taxation of Multinational Corporations

Alexis Anagnostopoulos*, Orhan Erem Atesagaoglu†

February 15, 2016

Abstract

The US has the highest corporate tax rate among advanced economies and it uses a worldwide tax system, i.e. it taxes the profits created by its corporations on foreign soil. This paper evaluates the costs and benefits of switching from the 'worldwide' to a 'territorial' system and investigates the effects of a reduction in US corporate tax rates under each system. To achieve this, we introduce the two alternative systems into the model of McGrattan and Prescott (2010) and also augment it with heterogeneous households and incomplete markets. The resulting two-country general equilibrium model features multinational corporations employing technology capital and plant-specific intangible capital in addition to the usual tangible capital and labor inputs. We find that reducing corporate taxes under the current worldwide system stimulates investment, employment and output by US multinationals both at home and abroad, but these effects are mitigated by a reduction in the corresponding variables by foreign multinationals. In particular FDI in the US is crowded out as a result of tougher competition. If the US tax rate is reduced below the foreign tax rate, a further mitigating factor is that investment in technology capital by US firms *declines*. Intuitively, technology investment is deducted from taxable profits at home and generates returns both home and abroad, with the returns abroad taxed at a different (foreign) rate. A US tax cut raises the marginal cost of technology investment by more than the marginal benefit since the tax on the foreign return remains unchanged. This negative effect of a corporate tax cut on technology investment by US multinationals becomes even more relevant if the US switches to a territorial tax system, since it kicks in even at the current high level of US taxes. Switching to territorial taxation increases US FDI abroad considerably, but it also leads to a significant reduction in FDI by the foreign multinational in the US. These mitigating factors limit the aggregate long run benefits resulting from tax cuts and lead to negative overall welfare effects due to short run as well as distributional welfare costs.

Keywords: *Corporate Taxes, Technology capital, Worldwide versus Territorial System*

*Stony Brook University, *Email:* alexis.anagnostopoulos@stonybrook.edu.

†Stony Brook University, *Email:* eremates@gmail.com.

1 Introduction

The United States currently possesses the highest statutory corporate income tax rate among advanced economies, at 34 percent. It also stands alone among advanced economies in taxing corporate income on a worldwide, as opposed to a territorial, basis. Most countries tax only the profits earned within their borders, i.e. they use a territorial tax system. In contrast, the US government uses a worldwide system which means that, in addition to taxing the profits earned within its borders, it also taxes the profits of US multinationals on their operations in foreign countries.

In recent years, there have been several proposals for reforming the tax system arising from a perceived bipartisan consensus that the US corporate tax system needs to be fixed. In a joint report released by the White House and the Department of the Treasury, President Obama's framework for corporate tax reform states that *"America's system of business taxation is in need of reform."* and *"...the tax reform...should properly balance the need to reduce tax incentives to locate production overseas with the need for U.S. companies to be able to compete overseas...."*. In its conclusion, the report proposes to *"...lower the corporate tax rate to 28 percent, putting the United States in line with major competitor countries..."*. The proposal to reduce the corporate tax rate is in line with several other reforms proposed. Examples include the "Bipartisan Tax Fairness and Simplification Act (Wyden-Coats)" which proposes a flat rate of 24 percent, the "House Republican Tax Reform Plan (Dave Camp)" which calls for a flat rate of 25 percent and the "National Commission on Fiscal Responsibility and Reform (Bowles-Simpson)" suggesting a single tax rate between 23 and 29 percent. However, whereas the first two plans propose to maintain the current worldwide tax system, the latter two plans aim to adopt a territorial tax system. In favor of the worldwide system, President Obama's framework states that a *"...territorial system could aggravate, rather than ameliorate, many of the problems in the current tax code...firms would have even greater incentives to locate operations abroad..."*. The opposing view is that a territorial system will increase the competitiveness of US corporations since they will face the same tax rates as foreign competitors in foreign markets. Supporters of this view also point to the fact that all major competitor countries are using a territorial tax system and they have a lower tax rate.

This paper aims to contribute to the debate on corporate income taxation by offering answers to the following questions: What are the costs and benefits of switching from worldwide taxation to territorial taxation? How would a decrease in corporate taxes affect domestic investment, FDI and employment in the US under a worldwide tax system? How are these effects different under a territorial tax system? Which US households would benefit and which would lose from such changes? What would be the consequences of each proposed change for the government's budget and how do alternative ways of raising revenue compare to each other?

In order to clarify and quantify the trade-offs involved, we build a multi-country general equilibrium model which incorporates multinational corpora-

tions, heterogeneous households and incomplete markets. Each country has a representative multinational firm that operates in all countries and a continuum of households that are subject to uninsurable idiosyncratic income shocks. The production technology follows closely McGrattan and Prescott (2010), where firms use a constant returns to scale technology that combines four inputs of production - labor, tangible capital, intangible capital and *technology capital*. While multinationals make distinct investment decisions in each country for labor, tangible and intangible capital, there is a single investment decision for technology capital that affects both the home plant and the foreign plant of the firm. In each country, households differ by labor earnings and wealth due to uninsurable idiosyncratic income shocks as in Aiyagari (1994). Households supply labor and can invest in stocks and private international bonds which only provide partial (self-) insurance against uncertainty. The government in each country maintains a balanced budget and finances its expenditures by levying taxes on labor income, dividends and corporate profits.

We find that incorporating technology capital is crucial for understanding the effects of tax changes. Investment in technology capital yields returns both at the home plant and abroad. In the benchmark calibrated economy, in which the US government uses a worldwide tax system, US corporate taxes do not distort technology capital. The reason is that technology investment is deductible from taxable corporate profits. The marginal benefit of an increase in technology capital comes from the sum of the after tax marginal products in the domestic production plus the production abroad. Since both are taxed at the same rate, this marginal benefit increases in proportion to the drop in the tax wedge when the US corporate tax is reduced. The marginal cost, in the form of foregone dividends, also increases in proportion to the tax wedge drop. As a result, the tax does not distort technology capital. This, however, relies crucially on the fact that the two marginal products are taxed at the same rate which is the case because of the combination of two aspects of the tax code: first, the US tax rate is higher than the foreign one and, second, the US system is a worldwide one.

Suppose the US switches to a territorial tax system without changing its tax rate. The immediate implication is that the marginal product on the foreign plant is now taxed at a lower rate and this renders the corporate tax distortionary for technology capital. Notice, however, that the tax pushes technology capital to a level higher than the undistorted one. The US corporation invests additionally on technology capital to take advantage of the combination of deductibility at home and lower tax on the return abroad. The exact opposite situation is faced by the foreign multinational (even before the US switch) which is subject to territorial taxation. Its investment in technology capital is inefficiently low because part of its return, the one on US soil, is taxed at a higher rate. Apart from the effects on technology capital, the US switch to a territorial system induces the US multinational to increase tangible capital investment abroad since it now faces the lower corporate tax rate on foreign profits. So, overall US production abroad increases substantially but US production at home also increases because higher technology capital also induces the hiring of more inputs at home. However, the increase in home production of

the US multinational is significantly mitigated by the decrease in US production of the foreign multinational which now faces higher input prices, i.e. wages and bond returns. Thus, the US economy does not experience the large boom that US corporations are experiencing because the growth of the US firm crowds out foreign FDI in the US.

Interestingly, once the US has switched to a territorial taxation system, a decrease in the US corporate tax rate affects US technology investment negatively. This is because the policy of investing in technology at home and receiving high after tax returns abroad becomes less attractive as the home tax rate is reduced and brought closer to the foreign tax rate. The result is that technology capital falls at the same time that tangible capital increases. The technology capital reduction dominates in the sense that it creates a reduction in other intangible capital, in labor demand and in output by the US multinational at home. This is one of the most striking results arising from our experiment, namely that under a territorial tax system and in the presence of technology capital, a US corporate tax cut reduces labor demand and output of the US multinational at home.

Suppose now that the US maintains a worldwide tax system but reduces the corporate income tax rate. The effects of this tax cut are more standard for the US multinational which finds its after tax returns to tangible capital increasing. As tangible capital increases, the returns to technology capital, intangible capital and labor all increase and the US multinational increases its production both at home and abroad. For the foreign multinational, the US tax decrease implies increased incentives for technology investment. However, the crowding out effect discussed above is too strong and the foreign multinational reduces its investment and labor demand in the US. Overall, foreign FDI in the US falls substantially and this largely undoes the increase in US output.

In sum, we identify two important mechanisms that render corporate tax reform, whether in the form of lower rates or in the form of a switch to territorial taxation, much less attractive than predicted in a standard growth model. First, US multinationals can crowd out foreign multinationals implying a much smaller increase in US output than expected. Second, lowering corporate taxes can have negative effects on the investment and labor demand even of US multinationals due to their effect on technology investment.

We also provide an assessment of the welfare consequences of the various alternative reforms. We find both proposals, the switch to a territorial system and the reduction in tax rates to be welfare reducing for two reasons: first, because welfare costs associated with the short run drop in consumption dominate the long run gains from higher consumption in the aggregate; second, the corporate tax cut implies a redistribution of consumption from low wealth (high marginal utility) households to high wealth (low marginal utility) households. The latter "distributional" effect can be overturned by ensuring that the government makes up for lost revenue from the corporate profits tax cut by increasing dividend taxes as opposed to labor taxes. Even in those cases, social welfare measures (based on a utilitarian welfare function) show an overall decrease in social welfare.

Section 2 present the model and equilibrium definition, Section 3 discusses the calibration and the results from our experiments and Section 4 concludes.

2 Model

Time is discrete and indexed by $t = 0, 1, 2, ...$ There are two countries in the world economy. Each country has a representative multinational that operates in both countries and a continuum of households that are subject to uninsurable idiosyncratic income shocks. We start with the description of the production technology and the maximization problem that multinationals face. We next proceed with the description of the households' optimization problem and the government's alternative budget constraints depending on whether it uses a worldwide or territorial tax system. Finally, we provide the definition of equilibrium for the model economy.

2.1 Firms

The production technology follows closely McGrattan and Prescott (2010). Each country has a representative multinational that operates in both countries. The output of multinational j in country i at time t is represented by Y_{it}^j. In this notation, the superscript $j = 1, 2$ is used to denote the country in which a multinational firm is incorporated and the subscript $i = 1, 2$ is used to denote the location of production. Accordingly, the total output in country i is the sum of the production of the home multinational $Y_{it}^{j=i}$ and the production of the foreign multinational's subsidiary $Y_{it}^{j\neq i}$.

The output of multinational j in country i is produced by using four factors of production: labor L_{it}^j, tangible capital K_{it}^j, intangible capital A_{it}^j and technology capital M_t^j. Whereas labor, tangible capital and intangible capital are country specific, technology capital is used at multiple locations simultaneously. In other words, while multinationals invest in tangible and intangible capital in each country, technology capital is accumulated only at the home country but used in all foreign subsidiaries with no additional cost. Thus, from the perspective of the foreign subsidiaries of a multinational, technology capital is a factor of production that requires no foreign direct investment.

The output produced by multinational j in its home country ($i = j$) is given by

$$Y_{it}^i = Z_i F(N_i M_t^i, A_{it}^i, K_{it}^i, L_{it}^i),\ i = 1, 2 \tag{1}$$

where Z_i denotes the total factor productivity of country i and N_i denotes the population size of country i.[1] The production function $F(.)$ exhibits constant returns to scale and is strictly increasing, strictly concave and satisfies the Inada

[1] Population size, together with technology capital, determines the number of locations that a firm can use to open a plant in the country. See McGrattan and Prescott (2009) for a detailed discussion of the microfoundations of the production function.

conditions. Similarly, the production of the foreign subsidiary of multinational j in country $i \neq j$ is given by

$$Y_{it}^j = Z_i \sigma_i F(N_i M_t^j, A_{it}^j, K_{it}^j, L_{it}^j), \quad i = 1, 2, \, i \neq j, \tag{2}$$

where $\sigma_i \in [0, 1]$ denotes the degree of openness of country $i = 1, 2$ to foreign direct investment. Note that the term $Z_i \sigma_i$ represents the effective productivity level that the foreign subsidiaries operating in country i are subject to. If $\sigma_i = 0$, this means country i is closed to foreign direct investment. If $\sigma_i = 1$, domestic and foreign corporations have the same productivity in country i.

The capital stocks of multinationals evolve according to the following standard intertemporal accumulation equations,

$$X_{M,t}^j = M_{t+1}^j - (1 - \delta_M) M_t^j + \Phi(M_{t+1}^j, M_t^j) \quad , j = 1, 2 \tag{3}$$

$$X_{K,it}^j = K_{it+1}^j - (1 - \delta_K) K_{it}^j + \Phi(K_{it+1}^j, K_{it}^j) \quad , i = 1, 2, \, j = 1, 2 \tag{4}$$

$$X_{A,it}^j = A_{it+1}^j - (1 - \delta_A) A_{it}^j + \Phi(A_{it+1}^j, A_{it}^j) \quad , i = 1, 2, \, j = 1, 2 \tag{5}$$

where $X_{K,it}^j$ is investment in tangible capital, $X_{A,it}^j$ is investment in intangible capital, $X_{M,t}^j$ is investment in technology capital, δ_M is the depreciation rate of technology capital, δ_K is the depreciation rate of tangible capital, δ_A is the depreciation rate of intangible capital and $\Phi(.,.)$ denotes the capital adjustment cost function.

The representative multinational incorporated in country j maximizes the discounted value of after-tax worldwide dividends,

$$\sum_{t=0}^{\infty} \sum_{i=1}^{2} \rho_{jt} (1 - \tau_j^d) D_{it}^j, \tag{6}$$

where ρ_{jt} is the discount factor which is equal to the intertemporal price of consumption, τ_j^d is the tax rate on total dividends paid out by multinational j, and D_{it}^j denotes the dividends generated from operations in country i. The dividend payouts of multinational j from domestic operations ($i = j$) and foreign subsidiaries ($i \neq j$) are given respectively by

$$D_{it}^i = (1 - \tau_i^c) \left(Y_{it}^i - w_{it} L_{it}^i - X_{A,it}^i - X_{M,it} \right) + \tau_i^c \delta_K K_{it}^i - X_{K,it}^i \tag{7}$$

$$D_{it}^j = (1 - \tau_i^{jc}) \left(Y_{it}^j - w_{it} L_{it}^j - X_{A,it}^j \right) + \tau_i^{jc} \delta_K K_{it}^j - X_{K,it}^j \quad , i \neq j \tag{8}$$

where τ_i^c is the corporate tax rate in country i and τ_i^{jc}, $j \neq i$ denotes the corporate tax rate that multinational j is subject to on its foreign profits. Note that while intangible and technology capital investments are fully tax deductible, corporations can deduct only the depreciation expenses for tangible capital. In addition, recall that each multinational corporation invests in its technology capital only at the home country, which is captured by the structure of cash flow constraints (7) and (8).

Based on this setup, a multinational from country i chooses sequences of capital stocks and labor inputs to maximize the present discounted value of after-tax dividends (6) subject to the cash flow constraints (7) - (8) and the corresponding capital accumulation equations in (3) - (5).

2.2 Households

Each country i has a continuum of households, of measure N_i, indexed by η with identical preferences represented by the utility

$$E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_{it}^{\eta}\right), \tag{9}$$

where c_{it}^{η} is consumption of individual η, in country i, at time t, $\beta \in (0,1)$ is the discount factor and E_0 denotes the expectation conditional on information at date $t=0$. The period utility function $u(\cdot)$ is assumed to be strictly increasing, strictly concave and continuously differentiable.

Each household supplies a fixed amount of labor (normalized to one) and receives a labor income of $w_{it}\epsilon_{it}^{\eta}$, where ϵ_{it}^{η} denotes the idiosyncratic labor productivity shock. The productivity shock is i.i.d. across households and follows a Markov process with transition matrix $\Omega_{\epsilon}(\epsilon'|\epsilon)$. Households can also trade financial assets and earn income from their asset holdings. More specifically, a household in country i can trade shares θ_{it}^{η} of the multinational i with other households in the country at the (ex-dividend) price P_{it}.[2] It can also trade a bond internationally, with b_{it}^{η} denoting the number of bonds bought at $t-1$ and R_t denoting the corresponding gross return, which is deterministic since there is no aggregate uncertainty. Households can use their after-tax labor and asset incomes to purchase consumption goods and save. Their budget is given by

$$c_{it}^{\eta}+P_{it}\theta_{it}^{\eta}+b_{it+1}^{\eta} = (1-\tau_{it}^{l})w_{it}\epsilon_{it}^{\eta}+((1-\tau_{i}^{d})\left(D_{1t}^{i}+D_{2t}^{i}\right)+P_{it})\theta_{it-1}^{\eta}+R_t b_{it}^{\eta} \tag{10}$$

where τ_i^d and τ_{it}^l are the tax rates on dividends and labor income in country i at time t. Households in each country i are restricted to have positive wealth (no-borrowing), i.e.

$$P_{it}\theta_{it}^{\eta} + b_{it+1}^{\eta} \geq 0 \tag{11}$$

In the absence of aggregate uncertainty, the returns of the two assets are equalized in equilibrium and the household's composition of the portfolio between shares and bonds is indeterminate. The household can be equivalently thought of as choosing wealth $A_{it}^{\eta} \equiv P_{it}\theta_{it}^{\eta} + b_{it+1}^{\eta} \geq 0$. International trade in bonds allows the aggregate wealth in country i to differ from the value P_{it} of that country's multinational corporation. It also implies equalization of stock returns,

[2] It is well-known that there is a substantial bias in the data in favor of owning shares in home corporations as opposed to foreign ones (see the large literature on the equity home bias puzzle). Restricting households to buying only shares of the domestically incorporated firm allows us to specify different dividend tax rates across countries.

and intertemporal marginal rates of substitution for unconstrained households, across countries.

$$R_{t+1} = \frac{(1-\tau_i^d)\left(D_{1t+1}^i + D_{2t+1}^i\right) + P_{it+1}}{P_{it}} = \frac{u'\left(c_{it}^\eta\right)}{\beta E_t u'\left(c_{it+1}^\eta\right)} \tag{12}$$

The value maximizing firm's discount factor is simply $\rho_{it} = \rho_t = \frac{\beta E_0 u'\left(c_{it}^\eta\right)}{u'\left(c_{i0}^\eta\right)} = \prod_{s=0}^{t} \frac{1}{R_s}$.

Each household chooses consumption and assets to maximize utility (9) subject to the budget constraint (10) and the no-borrowing constraint (11).

2.3 Government

In each country i, the government consumes an exogenous, constant amount G_i which is financed by levying taxes on labor income, dividends and corporate profits at rates τ_{it}^l, τ_i^d and τ_i^c, respectively. Note that the corporate income tax rates τ_i^{jc}, $i \neq j$ that a multinational corporation from country j pays on its foreign profits depend on whether the corporate income tax system in their home country is a territorial or a worldwide system.

2.3.1 Territorial Taxation

Under a territorial tax system, country i taxes only the profits earned within its territory. In other words, country i taxes the domestic profits of multinational $j = i$ and the profits of foreign subsidiaries operating in country i at a tax rate τ_i^c. In this system, a country does not tax the foreign profits earned by its multinationals. Thus, the tax faced by a foreign subsidiary of a multinational incorporated in country j but operating in $i \neq j$ is simply the foreign tax rate $\tau_i^{jc} = \tau_i^c$ and the budget constraint of government i is given by

$$G_i = \tau_i^d \left(D_{1t}^i + D_{2t}^i\right) + \tau_{it}^l w_{it} L_{it} + \tau_i^c(\Pi_{it}^1 + \Pi_{it}^2) \tag{13}$$

where $L_{it} = L_{it}^1 + L_{it}^2$ denotes the total employment in country i and Π_{it}^1, Π_{it}^2 denote the taxable profits of multinationals 1 and 2 respectively, from their operations in country i

$$\begin{aligned} \Pi_{it}^i &= Y_{it}^i - w_{it}L_{it}^i - X_{A,it}^i - X_{M,t}^i - \delta_K K_{it}^i, \; i = 1,2 \\ \Pi_{it}^j &= Y_{it}^j - w_{it}L_{it}^j - X_{A,it}^j - \delta_K K_{it}^j, \qquad i = 1,2, \; j \neq i \end{aligned}$$

2.3.2 Worldwide Taxation

Under a worldwide tax system, country i taxes the profits earned within its territory as well as the foreign profits earned by multinational $j = i$. In this system, a country taxes its corporation's total worldwide profits regardless of the location of production. Notice that, if country i adopts a worldwide tax

system, the foreign profits of multinational $j = i$ would be taxed twice, first by the country where the profits are generated and then a second time in its home country i. To avoid double taxation, country i gives the multinational $j = i$ a tax credit for the foreign taxes that it has already paid. Based on this setup, the effective tax rate that multinational j is subject to on its foreign profits from country $i \neq j$ is $\tau_i^{jc} = \max\{\tau_i^c, \tau_j^c\}$. In terms of the government revenue, the government in country i receives tax revenue from these foreign profits only to the extend that its tax rate is higher than the foreign tax rate, i.e. it receives $\max\{\tau_i^c - \tau_j^c, 0\}\Pi_{jt}^i, \ \ j \neq i$. The budget constraint of government i is therefore

$$G_i = \tau_i^d \left(D_{1t}^i + D_{2t}^i\right) + \tau_{it}^l w_{it} L_{it} + \tau_i^c(\Pi_{it}^1 + \Pi_{it}^2) + \max\{\tau_i^c - \tau_j^c, 0\}\Pi_{jt}^i, \ \ j \neq i. \tag{14}$$

where Π_{jt}^i denotes the taxable foreign profits of multinational i.

2.3.3 Summary for benchmark model

In our quantitative exercise we choose $i = 1$ to denote the US and $i = 2$ to denote the rest of the world (ROW). Based on observed tax policies, we assume that the ROW economy is under territorial tax system and the US economy is under a worldwide tax system. In this case, the government budget for the US is given by (14) and for the ROW by (13). The tax rate paid by US foreign subsidiaries is $\tau_2^{1c} = \max\{\tau_1^c, \tau_2^c\}$ and the one paid by ROW foreign subsidiaries in the US is $\tau_1^{2c} = \tau_1^c$.

2.4 Competitive Equilibrium

Given $\left\{\left\{G_i, \tau_i^d, \tau_i^c\right\}_{i=1}^2, \tau_2^{1c}, \tau_1^{2c}\right\}$, initial capital stocks $\left\{\left\{K_{i0}^j, A_{i0}^j\right\}_{i=1}^2, M_0^j\right\}_{j=1}^2$ and initial distributions of households μ_{i0} for each country i, a competitive equilibrium is a collection of household decision rules for consumption and wealth, firms decision rules for labor, capital, investment and dividend distributions, aggregate bond holdings in country i, B_{it}, laws of motion Γ_{it} for the cross-sectional distribution in each country i and prices w_{it}, R_t, P_{it} such that:

(i) household decision rules solve the households' maximization problems given prices and dividends

(ii) firm decision rules solve the firms' maximization problems given wages and the discount factor $\rho_t = \prod_{s=0}^{t} \frac{1}{R_s}$

(iii) Markets clear. Specifically, the labor market in each country

$$L_t^i = L_{it}^i + L_{jt}^i = \int \epsilon_{it}^\eta d\mu_{it} \text{ for } i = \{1, 2\}, \ \ j \neq i \tag{15}$$

the stock market in each country

$$\int \theta_{it}^\eta d\mu_{it} = 1 \text{ for } i = \{1, 2\} \tag{16}$$

the international bond market

$$\sum_{i=1}^{2} B_{it} = 0 \tag{17}$$

and goods' market

$$\sum_{i=1}^{2} C_{it} + \sum_{i=1}^{2} G_i + \sum_{i=1}^{2}\sum_{j=1}^{2} \left[X^j_{A,it} + X^j_{K,it} \right] + \sum_{i=1}^{2} X_{M,it} = \sum_{i=1}^{2}\sum_{j=1}^{2} Y^j_{it} \tag{18}$$

where the Y^j_{it} are defined in equations (1) and (2).

(iv) The laws of motion Γ_{it}, $i = 1, 2$ are consistent with household decision rules.

3 Quantitative Analysis

3.1 Calibration

The model is calibrated on an annual basis and the full set of parameters is provided in Table 1. The momentary utility function of households has the standard CRRA form

$$u\left(c^\eta_{it}\right) = \frac{(c^\eta_{it})^{1-\gamma} - 1}{1-\gamma} \tag{19}$$

with the coefficient of relative risk aversion γ set to one. The discount factor is set to $\beta = 0.948$ so that the real interest rate is equal to 4.1%. The idiosyncratic labor productivity process follows a parsimonious Markov chain with three states and is taken from Domeij and Heathcote (2004).[3] The productivity values ϵ^η_{it} and the transition matrix $\Omega(\epsilon^\eta_{it+1}/\epsilon^\eta_{it})$ are displayed in Table 2.

The production technology of multinational j in country i is represented by the following Cobb-Douglas functional form

$$F(N_i M^j_t, A^j_{it}, K^j_{it}, L^j_{it}) = (N_i M^j_t)^{\alpha_M} (A^j_{it})^{\alpha_A} (K^j_{it})^{\alpha_K} (L^j_{it})^{\alpha_L}, \qquad i = 1, 2,\ j = 1, 2 \tag{20}$$

with $0 < \alpha_M, \alpha_A, \alpha_K, \alpha_L < 1$ and $\alpha_M + \alpha_A + \alpha_K + \alpha_L = 1$, where α_M, α_A, α_K and α_L denote, respectively, the income shares of technology capital, intangible capital, tangible capital and labor.

Technology parameters are chosen to match key features of the data taken from Bureau of Economic Analysis (BEA) as in McGrattan and Prescott (2010). The income share of labor is set to $\alpha_L = 0.651$ to match the average labor income share in the corporate sector over the post-war period. We use BEA corporate sector data for the years 1980 - 2013 to calibrate δ_K and α_K. The tangible capital depreciation rate is set to $\delta_K = 0.06$ to match the average tangible investment to capital stock ratio of 0.06 and the income share of tangible

[3] The process is constructed so that it captures the autocorrelation and standard deviation of the innovation of an AR(1) process estimated on US data as well as features of the cross-sectional wealth inequality in US data.

capital is set to $\alpha_K = 0.214$ to match the tangible capital to output ratio of 1.68. Following McGrattan and Prescott (2010) and Kapicka (2012), we set the depreciation rate of technology capital to $\delta_M = 0.08$, which is slightly lower than the BEA's estimates for depreciation of R&D investment.[4] The income share of technology capital α_M and the depreciation rate for intangible capital δ_A are calibrated jointly to match two moments: a technology capital investment rate of 5.5 percent[5] and a 'market value-to-output ratio' for the US corporate sector over the period 2000-2014 of 2.35.[6]

The population size of US is normalized to one, $N_1 = 1$. We restrict the rest of the world economy to countries that have a significant FDI relationship with the United States. We find that 19 countries receive 87% of US FDI and that 93% foreign FDI in the US comes from those same countries.[7] Accordingly, the population size of the ROW economy is set to $N_2 = 2.4$. Without loss of generality, the TFP level of the US economy is normalized by setting $Z_1 = 1$. Based on this normalization, we set $Z_2 = 0.698$ to match the GDP of the rest of the world economy relative to the US.

Recall that the extend to which countries are open to foreign direct investment is measured by the degree of openness parameters σ_1, σ_2. We choose $\sigma_2 = 0.938$ to match the US FDI position abroad as a share of domestic tangible capital stock of US multinationals, which was 40 percent in 2013 based on the BEA's International Investment Position (IIP) data. Based on the same source of data, we choose $\sigma_1 = 0.895$ to match the FDI position in the US as a share of the domestic tangible capital stock of US multinationals to be 25 percent.

Capital adjustment costs are commonly used in international macro models to avoid excessive investment volatility and to capture the fact that financial capital is more mobile than physical capital. In line with this, we assume that tangible, intangible and technology capital investments are subject to a capital adjustment cost that takes the form of $\Phi(K^j_{it+1}, K^j_{it}) = \psi(K^j_{it+1}/K^j_{it} - 1)^2$ following Mendoza, Quadrini and Rios-Rull (2007). We set the adjustment cost parameter to $\psi = 0.6$, which is the value used by Mendoza, Quadrini and Rios-Rull (2007) and Kehoe and Perri (2002) to match the investment volatility observed in the US and Europe. Note that, given the chosen functional form, adjustment costs are irrelevant for the main steady state results discussed in the following section.[8]

Finally, we choose tax rates for the US and ROW economies as follows.

[4] The BEA estimates that R&D investment depreciates at a rate of 11 precent annually. See McGrattan and Prescott (2005) for details and further discussion.

[5] This is obtained by McGrattan and Prescott (2010) from the BEA national income and product accounts by classifying three types of investment as technology capital investment: R&D expenditures, advertising expenditures and organization capital expenditures.

[6] Based on our own calculations using NIPA and Flow of Funds Accounts.

[7] The countries are the UK, Netherlands, Japan, Canada, France, Switzerland, Germany, Luxemburg, UK Caribbean Islands, Belgium, Spain, Australia, Sweden, South Korea, Ireland, Norway, Mexico, Italy, Singapore.

[8] The parameterization of the cost function does affect the speed of adjustment to steady state after a tax change and, as a result, can affect the quantitative results regarding welfare effects. We conduct sensitivity analysis with respect to the parameter ψ when discussing the welfare results.

For the US economy, we set the dividend tax rate to $\tau_1^d = 0.20$ which is the top statutory rate in effect since the American Taxpayer Relief Act of 2012. We set the corporate income tax rate to $\tau_1^c = 0.34$ which is roughly equal to the marginal statutory rate that US corporations are subject to. For the labor income tax rate, we follow McGrattan and Prescott (2010) by setting $\tau_1^l = 0.29$.

For the ROW economy, since we restrict the rest of the world to countries that have significant FDI relationship with the US, we can determine the average corporate income tax rate by looking at the foreign tax credits that the IRS affords to US corporations. Based on the IRS' Statistics of Income (SOI) data, we find that the effective tax rate that US corporations paid on their foreign earned income was quite stable and roughly equal to 25% over the period 1992 - 2010. Accordingly, we set $\tau_2^c = 0.25$. For dividend and labor income tax rates, we construct weighted averages using the statutory rates in 2013. With the weights based on GDP of each country, we find that the weighted average tax rates for dividend and labor income are equal to $\tau_2^d = 0.16$ and $\tau_2^l = 0.35$, respectively.

3.2 Reducing the corporate income tax

Table 4A presents the long run effects on both the US and the ROW economy of reducing the corporate tax rate in the US from 0.35 to several different levels down to zero. Figure 1 provides a visual summary of the same effects focusing on the three types of capital stock and output. The left panel of that figure shows the effects on capital and output in the US and the right panel shows the corresponding effects on the ROW.

It is clear from looking at the figures, that the effects of a corporate tax cuts on aggregates hinge critically on whether the US tax is reduced to a level below the tax rate in the ROW (0.25) or not. Specifically, aggregate variables increase (decrease) with a reduction of the tax rate up to 0.25 but then start decreasing (increasing) when the tax rate is reduced further below 0.25.

To explain the effects of the corporate tax cut it is helpful to clarify first which margins are distorted by corporate taxes and this depends on the type of system (worldwide vs territorial) that a multinational is subject to as well as the relative size of the tax rate in the two countries.

Consider first the region where the US (worldwide system) tax rate is higher than the ROW (territorial) tax rate, i.e. the experiments where τ_1^c is reduced but only up to $\tau_2^c = 0.25$. In this case, the US corporate tax directly distorts (i.e. it affects the corresponding Euler equation) tangible capital investment for the US multinational in both home and foreign plants and tangible capital investment of the ROW multinational in its US plant. In contrast, it does not *directly* distort intangible capital investment for any plant because this is deducted from corporate taxation. The effect on technology investment is slightly more subtle because technology investment yields two marginal products, one at the home plant and one at the foreign plant. It is straightforward to see the effects of corporate taxation by looking at the first order condition for technology capital

of multinational i[9]

$$(1-\tau_i^c) = \frac{1}{R_{t+1}}\left[(1-\tau_i^c)\left[1+MPM_{i,t+1}^i-\delta_M\right]+(1-\tau_i^{jc})MPM_{j,t+1}^i\right] \Rightarrow$$

$$R_{t+1} = \left[\left[1+MPM_{i,t+1}^i-\delta_M\right]+\frac{(1-\tau_j^{ic})}{(1-\tau_i^c)}MPM_{j,t+1}^i\right] \quad (21)$$

where MPM_j^i stands for the marginal product of technology capital of multinational i for its production/plant in country j. For $i=1$ (the US multinational), profits are taxed equally in its two plants, $\tau_2^{1c}=\tau_1^c$, and thus the deductibility of technology investment makes the corporate tax non-distortionary along that margin. In contrast, for $i=2$ (the ROW multinational) the return to technology capital at home is taxed at a different rate than the return abroad, $\tau_1^{2c}=\tau_1^c>\tau_2^c$. Therefore, when the US corporate tax rate falls, this increases the after tax return on technology investment for the foreign multinational. Note that the above discussion focuses on *direct* effects, but there will also be indirect effects on intangible investment following any changes in the tangible capital stock as well as general equilibrium effects on factor prices. We describe those in what follows, still focusing on the case where τ_1^c is reduced up to $\tau_2^c=0.25$.

For the US multinational, the tax cut increases its after tax returns on tangible capital investment both home and abroad. In turn, these raise the marginal product of intangible capital at home and abroad as well as the marginal product of technology capital and the marginal product of labor. So we should expect to see increases in all of those aggregates for the US multinational. These increases in the demand for inputs put upwards pressure on factor prices both at home and abroad. This is particularly so for US labor markets, where the US multinational commands a large share (80%, see Table 3) of the labor market and its demand increase pushes equilibrium wages up. On the other hand, the increase in labor demand by the foreign subsidiary has a small effect on ROW labor markets which are dominated by the ROW multinational which we turn to below.

The direct benefits from the US tax cut that accrue to the foreign multinational only work through its US subsidiary, which is relatively small. On the other hand, its US subsidiary faces stiff competition in labor markets in the US. Importantly, its domestic plan faces significant competition in capital markets as the US economy attracts financial capital due to its higher after tax returns. This can be seen in the form of the internationally traded bonds which allow for financial flows to the US as a result of the tax change. These competition effects dominate the smaller direct effects and the foreign multinational reduces investment in all types of capital both at home and abroad, and reduces its production. The tax cut effects on aggregate output in each country are dominated

[9] We present the steady state version where adjustment cost terms disappear due to our functional form assumption. We also replace the intertemporal marginal rate of substitution with the bond return since they are equalized in equilibrium.

by the home multinational. As a result, aggregate output goes up in the US and down in the ROW in the long run.

Before considering what happens when the US reduces the tax rate even further below 0.25, we comment briefly on welfare effects. These are presented in Table 4B (and Figure 5A). From an aggregate welfare perspective, we decompose the effects on a utilitarian social welfare function in each country to aggregate and distributional components, as in Domeij and Heathcote (2004). The aggregate component simply captures the welfare consequences of the changes in aggregate consumption along the path to the new steady state whereas the distributional component captures the effects of consumption redistribution across households and is computed as a residual. Aggregate consumption in the US increases in the long run but only at the cost of a short run investment boom and consumption drop. The short run drop dominates quantitatively making the overall path of aggregate consumption associated with welfare losses (see Table 4B, US Aggregate Component). In the ROW, there is significant disinvestment in the short run which means aggregate consumption increases in the short run. In addition, long run consumption is mostly unaffected (actually increases slightly) so the overall consumption path is always higher than the benchmark economy. As a result, the aggregate component of welfare goes up. In both countries, after tax returns to capital increase whereas the after tax wage decreases so, from a distributional perspective, welfare gains (losses) are smaller (larger) for the poorest households who earn labor income and hold little or no assets. This negative redistribution registers in Table 4B as a negative distributional effect for our utilitarian social welfare function.

We now turn to the case where the US corporate tax rate is reduced further below 0.25, making the US corporate tax rate lower than the foreign one. It is interesting to note that most of the results discussed above are reversed in the sense that many aggregate variables that increased (decreased) as the US tax rate moved from 0.34 to 0.25 now do the exact opposite as the tax rate moves from 0.25 to 0. This striking difference arises due to two important changes in the effects discussed above. First, tangible capital investment of the US multinational abroad is now taxed at the foreign rate (0.25) and the decrease in the US rate no longer has a positive effect on that. Second, and more importantly, the reduction in the corporate tax rate *reduces* the incentives for technology investment by the US multinational. This might appear counterintuitive at first glance, but it can be easily understood with reference to the optimal choice of technology capital for $i = 1$ described in equation (21). Since $\tau_2^{1c} = \max\{\tau_1^c, \tau_2^c\}$, this tax rate fell along with τ_1^c as long as $\tau_1^c \geq 0.25$, but now remains fixed and equal to $\tau_2^c = 0.25$ as τ_1^c falls. Intuitively, τ_1^c was not distortionary for values above 0.25 because the marginal cost and marginal benefit of technology investment moved exactly proportionally with changes in τ_1^c. For values of τ_1^c below 0.25, whereas the marginal cost keeps rising at the same rate, the marginal benefit does no longer rise as fast because part of the return, the one coming from the foreign plant, is taxed at the foreign rate which does not fall.

Using these direct effects of the tax cuts, we can now explain the observed

movements in the aggregates. Starting with the US multinational at home, the tax change tilts its choice of inputs towards more tangible capital and less technology capital. In turn, the decrease in technology capital reduces the marginal product of other all inputs in the foreign plant and, as a result, the inputs and production by the foreign plant fall as the corporate tax rate falls below 0.25 in the US. The ROW multinational now still has the direct benefits of higher return to its foreign tangible capital as well as higher returns to its technology capital. Contrary to before, it does not face a significant increase in competition in either market. As a result its home production increases and its US production increases by even more.

Tables 5A, 5B and Figure 2 present results for the same experiment with the difference being that the government revenue shortfall arising from lower corporate taxes is balanced by an increase in dividend taxes instead of labor taxes. This alternative policy does not have significant differences from the benchmark experiment with respect to long run aggregates. What it does achieve is to lead to a more equitable distribution of consumption so that the distributional component of social welfare in the US is now positive instead of negative. The reason is that low wealth households, which earn income mainly from labor, do not experience an increase in labor taxes anymore. Instead, it is wealthy households that now have to pay higher dividend taxes. As a result, consumption is redistributed towards the bottom of the consumption distribution, the distributional component of welfare increases (due to the utilitarian social welfare function employed) and overall social welfare losses are mitigated relative to the benchmark experiment.

3.3 Switching from Worlwide to Territorial System

An alternative approach to corporate tax reform that is often suggested (see discussion in the Introduction) is for the US to change its system of corporate taxation from a worldwide system to a territorial one, conforming to the system followed by the majority of OECD countries. A change in the system will change effective tax rates for US multinationals even if there is no change in the chosen tax rate, since the profits from foreign operations of US multinationals will now be taxed at the foreign tax rate. It will also change the revenues collected by the US government, essentially taking away its revenues from the profits of US subsidiaries abroad. We conduct this alternative experiment below and present the results in Tables 6A, 6B, and Figure 3 (Tables 7A, 7B and Figure 4 for the case where dividend taxes are used to balance the budget).

Notice that any tax change that brings the US corporate tax rate at or below the foreign rate (0.25) has the same effect regardless of whether the US follows a worldwide or territorial system. This is because the US subsidiaries abroad necessarily face the local tax and, if the US tax rate were lower, there would be nothing left for the US government to collect after tax credits are applied. Hence, our discussion focuses on the interesting part where the US switches to a territorial system and either maintains the tax rate of 0.34 or simultaneously reduces the tax rate up to 0.25.

Consider first a switch to territorial taxation with no change in the tax rate. The direct effect of such a change comes from the change in the effective tax rate that the US multinational faces on its profits abroad, i.e. τ_2^{1c} falls abruptly from 0.34 to 0.25. As explained earlier, this affects the return to tangible capital in the foreign plant and it also affects the return to technology capital. Thus, both K_{2t}^1 and M_t^1 rise by a significant amount. The increase in technology capital pushes other inputs in the domestic plant upwards. For the foreign plant, inputs rise even more strongly because the technology capital increase is combined with an increase in tangible capital, making the marginal product of intangible capital and of labor rise by a large amount. On the other hand, the foreign corporation still faces the same tax rate at its US plant but now faces stiffer competition in both labor markets as well as the capital market. With wages and returns rising, the foreign multinational reduces its production in both of its plants.

Once the US has switched to a territorial system, a decrease in the tax rate now creates disincentives for technology capital investment by the US multinational. The intuition is again that the marginal cost of investment is rising faster than the marginal benefit, since part of the benefit comes from the foreign plant profits and the tax on those remains fixed at the ROW tax rate. As a result, decreases in the US corporate tax rate under a territorial system tilt the incentives for investment away from technology capital and towards tangible capital in the US. Quantitatively, the technology capital reduction dominates and leads to decreases in intangible capital, labor and output at both the home and foreign plants of the US multinational. In turn, this reduces the pressure on the ROW multinational and increases its production. In a nutshell, the pattern of effects arising from a US tax cut when the US is already on a territorial system follows qualitatively the one observed when the US tax rate is lower than the ROW rate under a worldwide US system.

4 Conclusion

Taking into account technology capital and carefully distinguishing between worldwide and territorial tax systems are found to be important for evaluating corporate tax policy. Macroeconomic models typically abstract from these aspects and this paper has filled this gap in the literature. Long run effects on US GDP from switching to a territorial tax system can be positive because US multinationals will face lower taxes on their foreign profits which induces them to invest more in technology and this, in turn, feeds back to higher (tangible) capital and labor demand at home. Once the switch has been established, decreases in the tax rate actually have a negative effect on technology investment incentives for US multinationals. However, foreign multinational investment in the US benefits from such a decrease and as a result US production still increases in the long run.

The effects of corporate tax cuts on technology investment can be very different if the US maintains a worldwide tax system. In that case, a tax cut can increase US technology investment through an indirect effect, namely by

increasing the returns to tangible investment and, as a result of this, the marginal product of technology investment too. The negative effects of tax cuts on technology can arise also under a worldwide system, if the US tax rate is reduced to the extent that it becomes lower than foreign corporate tax rates.

Finally, despite potential benefits from tax cuts in terms of long run production, our model corroborates the results in a growing literature[10] that finds negative welfare effects of such tax cuts when the transitional and distributional costs of such a change are taken into account.

[10] See Domeij and Heathcote (2004) and Anagnostopoulos, Carceles-Poveda and Lin (2012) and the references therein.

References

[1] Aiyagari, D. R., 1994. "Uninsured Idiosyncratic Risk and Aggregate Saving." Quarterly Journal of Economics 109 (3), pp. 659-684.

[2] Anagnostopoulos, A., Carceles-Poveda, E., Lin, D., 2012. "Dividend and Capital Gains Taxation under Incomplete Markets" Journal of Monetary Economics, 59 (7), pp. 898-919.

[3] Domeij, D., Heathcote, J., 2004. "On the Distributional Effects of Reducing Capital Taxes." International Economic Review, 45 (2), pp. 523-554.

[4] Kapicka, M., 2012. "How Important is Technology Capital for the United States?" American Economic Journal: Macroeconomics, 4 (2), pp. 218-248.

[5] Kehoe, P.J., Perri, F., 2002. "International Business Cycles with Endogenous Incomplete Markets." Econometrica, 70(3), 907-928.

[6] McGrattan, E.R., Prescott, E.C., 2010. "Technology Capital and the US Current Account." American Economic Review, 100 (4), pp. 1493-1522.

[7] McGrattan, E.R., Prescott, E.C., 2009. "Openness, Technology Capital, and Development." Journal of Economic Theory, 144, pp. 2454-2476.

[8] McGrattan, E.R., Prescott, E.C., 2005. "Taxes, Regulations, and the Value of US and UK Corporations." Review of Economic Studies, 72, pp. 767-796.

[9] Mendoza, E., Quadrini, V., Rios-Rull, V., 2007. "On the Welfare Implications of Financial Globalization without Financial Development." NBER International Seminar on Macroeconomics.

Table 1. Common Parameter Values - Baseline Calibration

	Parameter	Value
Discount Factor	β	0.948
Share of Technology Capital in Production	α_m	0.070
Share of Intangible Capital in Production	α_a	0.065
Share of Tangible Capital in Production	α_k	0.214
Share of Labor in Production	α_l	0.651
Depreciation Rate - Technology Capital	δ_m	0.080
Depreciation Rate - Intangible Capital	δ_a	0.080
Depreciation Rate - Tangible Capital	δ_k	0.060
CRRA Parameter	μ	1.00
Adjustment Cost	ψ	0.60
Labor Productivity Shocks	ϵ_{it}	See Table 2
Tax Rate on Corporate Income - US	τ_{c1}	0.34
Tax Rate on Corporate Income - ROW	τ_{c2}	0.25
Tax Rate on Dividends - US	τ_{d1}	0.20
Tax Rate on Dividends - ROW	τ_{d2}	0.16
Tax Rate on Labor Income - US	τ_{l1}	0.29
Tax Rate on Labor Income - ROW	τ_{l2}	0.35
TFP - US	Z_1	1.000
TFP - ROW	Z_2	0.698
Population - US	N_1	1.00
Population - ROW	N_2	2.40
Openness - US	σ_{21}	0.895
Openness - ROW	σ_{12}	0.938

Table 2. Labor Productivity Process [*]

$$\epsilon = \begin{bmatrix} 0.167 & 0.839 & 5.087 \end{bmatrix}$$

$$\Omega(\epsilon'/\epsilon) = \begin{bmatrix} 0.900 & 0.100 & 0.000 \\ 0.005 & 0.990 & 0.005 \\ 0.000 & 0.100 & 0.900 \end{bmatrix}$$

[*] Notation: ϵ denotes the values of the labor productivity shock, and $\Omega(\epsilon'/\epsilon)$ is the Markov transition matrix.

Table 3. Capital Stocks (Model - Benchmark) [1]

(Pre-Reform Steady State)

	Notation	Value
Technology Capital Stocks		
U.S. Corporations	M_1	0.718
ROW Corporations	M_2	0.875
Tangible Capital Stocks		
U.S. Corporations at home	K_{11}	1.548
U.S. Corporations abroad	K_{12}	0.626
ROW Corporations at home	K_{22}	2.460
ROW Corporations abroad	K_{21}	0.388
Intangible Capital Stocks		
U.S. Corporations at home	A_{11}	0.475
U.S. Corporations abroad	A_{12}	0.192
ROW Corporations at home	A_{22}	0.708
ROW Corporations abroad	A_{21}	0.119
Employment		
U.S. Corporations at home	L_{11}	0.799
U.S. Corporations abroad	L_{12}	0.512
ROW Corporations at home	L_{22}	1.888
ROW Corporations abroad	L_{21}	0.201

[1] Notation :

Table 4A. Long Run Effects of Reform (τ_c vs. τ_l)

U.S. ECONOMY

τ_c	0	0.04	0.07	0.1	0.13	0.16	0.19	0.22	0.25	0.28	0.31	**0.34**
τ_l	0.349	0.342	0.337	0.331	0.326	0.321	0.315	0.310	0.305	0.300	0.295	**0.290**
Aggregates (% change)												
K_{11}	21.3	20.6	19.9	19.2	18.4	17.5	16.5	15.5	14.4	9.6	4.8	-
A_{11}	0.6	1.7	2.5	3.3	4.1	4.9	5.8	6.7	7.6	5.1	2.5	-
M_1	-6.0	-3.3	-1.1	1.3	3.9	6.8	9.9	13.4	17.3	11.2	5.4	-
Y_{11}	1.9	2.9	3.6	4.3	5.0	5.7	6.5	7.3	8.1	5.4	2.7	-
L_{11}	-2.8	-1.6	-0.7	0.2	1.1	2.1	3.1	4.1	5.2	3.4	1.7	
K_{21}	38.9	30.5	24.3	18.0	11.7	5.4	-0.9	-7.3	-13.7	-8.6	-4.0	-
A_{21}	15.2	10.1	6.2	2.3	-1.7	-5.8	-10.0	-14.3	-18.8	-12.3	-6.1	-
M_2	7.6	4.7	2.5	0.3	-1.9	-4.2	-6.5	-8.9	-11.5	-7.2	-3.4	-
Y_{21}	16.6	11.3	7.3	3.2	-0.9	-5.1	-9.4	-13.9	-18.5	-12.1	-5.9	-
L_{21}	11.2	6.5	2.9	-0.8	-4.5	-8.4	-12.3	-16.4	-20.6	-13.7	-6.8	
Y	4.9	4.6	4.3	4.1	3.8	3.6	3.3	3.0	2.8	1.9	0.9	-
C	-0.9	-0.4	-0.1	0.2	0.5	0.8	1.1	1.3	1.5	1.0	0.5	-
P	25.2	25.3	25.4	25.5	25.7	25.9	26.3	26.7	27.3	17.6	8.5	-
D	29.9	29.6	29.3	29.1	28.9	28.8	28.7	28.7	28.9	18.5	8.9	-
w	4.9	4.6	4.3	4.1	3.8	3.6	3.3	3.0	2.8	1.9	0.9	-
r	3.8	3.4	3.1	2.8	2.5	2.2	1.9	1.6	1.2	0.8	0.4	-

ROW ECONOMY

Aggregates (% change)												
K_{22}	-2.8	-3.9	-4.9	-5.8	-6.9	-8.0	-9.3	-10.6	-12.2	-7.8	-3.7	-
A_{22}	-2.3	-3.5	-4.5	-5.5	-6.6	-7.8	-9.0	-10.5	-12.0	-7.7	-3.7	-
M_2	7.6	4.7	2.5	0.3	-1.9	-4.2	-6.5	-8.9	-11.5	-7.2	-3.4	-
Y_{22}	-1.1	-2.4	-3.4	-4.6	-5.8	-7.1	-8.5	-10.0	-11.6	-7.4	-3.5	-
L_{22}	-1.2	-2.5	-3.5	-4.6	-5.7	-7.0	-8.3	-9.8	-11.5	-7.3	-3.5	
K_{12}	9.6	14.6	18.5	22.8	27.4	32.3	37.8	43.7	50.3	31.8	15.0	-
A_{12}	3.5	8.1	11.8	15.8	20.0	24.6	29.7	35.2	41.4	26.3	12.6	-
M_1	-6.0	-3.3	-1.1	1.3	3.9	6.8	9.9	13.4	17.3	11.2	5.4	-
Y_{12}	4.8	9.3	13.0	16.9	21.1	25.6	30.5	36.0	42.0	26.7	12.7	-
L_{12}	4.6	9.2	12.9	16.9	21.1	25.7	30.7	36.2	42.3	26.9	12.8	
Y	0.2	0.1	0.1	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1	-
C	3.6	3.1	2.8	2.4	2.0	1.5	1.2	0.8	0.4	0.3	0.1	-
P	4.3	2.0	0.2	-1.7	-3.6	-5.6	-7.6	-9.8	-12.1	-7.7	-3.7	-
D	8.3	5.4	3.3	1.1	-1.2	-3.5	-5.9	-8.4	-11.0	-6.9	-3.3	-
w	0.2	0.1	0.1	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1	-
r	3.8	3.4	3.1	2.8	2.5	2.2	1.9	1.6	1.2	0.8	0.4	-

Table 4B. Welfare Gains : Reform (τ_c vs. τ_l)

U.S. ECONOMY

τ_c	0	0.04	0.07	0.1	0.13	0.16	0.19	0.22	0.25	0.28	0.31	**0.34**
τ_l	0.349	0.342	0.337	0.331	0.326	0.321	0.315	0.310	0.305	0.300	0.295	**0.290**
Welfare (%)	-3.34	-2.88	-2.54	-2.23	-1.93	-1.66	-1.40	-1.18	-0.99	-0.61	-0.28	-
Aggregare Component (%)	-1.25	-1.02	-0.86	-0.71	-0.58	-0.47	-0.38	-0.31	-0.26	-0.14	-0.05	-
Distributional Component (%)	-2.12	-1.88	-1.70	-1.53	-1.36	-1.19	-1.03	-0.88	-0.73	-0.47	-0.24	-

ROW ECONOMY

Welfare (%)	0.40	0.35	0.32	0.30	0.28	0.26	0.25	0.25	0.25	0.16	0.08	-
Aggregare Component (%)	0.77	0.68	0.62	0.56	0.50	0.45	0.40	0.35	0.31	0.21	0.10	-
Distributional Component (%)	-0.37	-0.33	-0.29	-0.26	-0.22	-0.18	-0.14	-0.11	-0.07	-0.05	-0.02	-

Table 5A. Long Run Effects of Reform (τ_c vs. τ_d)

U.S. ECONOMY

τ_c	0	0.04	0.07	0.1	0.13	0.16	0.19	0.22	0.25	0.28	0.31	**0.34**
τ_d	0.467	0.435	0.410	0.386	0.361	0.337	0.313	0.289	0.265	0.246	0.224	**0.200**
Aggregates (% change)												
K_{11}	25.2	24.0	23.1	22.0	20.9	19.7	18.4	17.0	15.5	10.3	5.1	-
A_{11}	3.4	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.4	5.6	2.8	-
M_1	-3.4	-0.9	1.2	3.4	5.8	8.4	11.3	14.6	18.2	11.8	5.7	-
Y_{11}	2.9	3.8	4.4	5.1	5.7	6.4	7.0	7.7	8.4	5.6	2.8	-
L_{11}	-2.9	-1.7	-0.7	0.2	1.1	2.1	3.1	4.1	5.2	3.4	1.7	
K_{21}	43.6	34.5	27.7	20.9	14.2	7.4	0.7	-6.1	-12.8	-8.0	-3.7	-
A_{21}	18.7	13.0	8.7	4.4	0.1	-4.3	-8.9	-13.5	-18.2	-11.9	-5.9	-
M_2	10.9	7.5	5.0	2.4	-0.1	-2.7	-5.3	-8.0	-10.8	-6.8	-3.2	-
Y_{21}	18.1	12.6	8.4	4.1	-0.2	-4.5	-9.0	-13.5	-18.2	-12.0	-5.9	-
L_{21}	11.4	6.6	3.0	-0.7	-4.5	-8.4	-12.3	-16.4	-20.6	-13.7	-6.9	
Y	6.0	5.6	5.2	4.9	4.5	4.2	3.8	3.4	3.1	2.1	1.0	-
C	4.8	4.6	4.4	4.2	4.0	3.8	3.5	3.3	3.0	2.0	1.0	-
P	-14.0	-9.0	-5.2	-1.4	2.4	6.2	10.1	14.0	18.0	11.5	5.5	-
D	27.2	27.3	27.3	27.3	27.4	27.5	27.7	27.9	28.3	18.2	8.8	-
w	6.0	5.6	5.2	4.9	4.5	4.2	3.8	3.4	3.1	2.1	1.0	-
r	-1.5	-1.2	-1.0	-0.9	-0.7	-0.5	-0.4	-0.2	-0.1	0.0	0.0	-

ROW ECONOMY

Aggregates (% change)												
K_{22}	0.9	-0.8	-2.0	-3.4	-4.8	-6.2	-7.8	-9.5	-11.3	-7.2	-3.4	-
A_{22}	0.7	-0.9	-2.2	-3.5	-4.8	-6.3	-7.9	-9.5	-11.3	-7.2	-3.5	-
M_2	10.9	7.5	5.0	2.4	-0.1	-2.7	-5.3	-8.0	-10.8	-6.8	-3.2	-
Y_{22}	0.2	-1.3	-2.5	-3.7	-5.1	-6.5	-8.0	-9.6	-11.4	-7.2	-3.5	-
L_{22}	-1.2	-2.5	-3.5	-4.5	-5.7	-7.0	-8.3	-9.8	-11.5	-7.3	-3.5	
K_{12}	13.5	18.2	21.9	25.9	30.2	34.9	40.0	45.5	51.7	32.6	15.5	-
A_{12}	6.4	10.8	14.3	18.1	22.2	26.6	31.3	36.6	42.5	27.0	12.9	-
M_1	-3.4	-0.9	1.2	3.4	5.8	8.4	11.3	14.6	18.2	11.8	5.7	-
Y_{12}	5.9	10.3	13.9	17.8	21.9	26.3	31.2	36.5	42.4	27.0	12.9	-
L_{12}	4.4	9.1	12.8	16.8	21.0	25.7	30.7	36.2	42.3	26.9	12.9	
Y	1.4	1.2	1.0	0.8	0.7	0.5	0.4	0.2	0.1	0.1	0.0	-
C	1.1	0.9	0.8	0.6	0.5	0.3	0.2	0.0	-0.2	-0.1	0.0	-
P	8.0	5.1	2.9	0.7	-1.5	-3.9	-6.2	-8.7	-11.3	-7.2	-3.4	-
D	6.4	3.8	1.9	-0.1	-2.2	-4.4	-6.6	-8.9	-11.4	-7.2	-3.4	-
w	1.4	1.2	1.0	0.8	0.7	0.5	0.4	0.2	0.1	0.1	0.0	-
r	-1.5	-1.2	-1.0	-0.9	-0.7	-0.5	-0.4	-0.2	-0.1	0.0	0.0	-

Table 5B. Welfare Gains : Reform (τ_c vs. τ_d)

U.S. ECONOMY

τ_c	0	0.04	0.07	0.1	0.13	0.16	0.19	0.22	0.25	0.28	0.31	**0.34**
τ_d	0.467	0.435	0.410	0.386	0.361	0.337	0.313	0.289	0.265	0.246	0.224	**0.200**
Welfare (%)	-0.27	-0.24	-0.21	-0.19	-0.19	-0.21	-0.23	-0.28	-0.34	-0.16	-0.04	-
Aggregare Component (%)	-1.84	-1.58	-1.32	-1.12	-0.94	-0.77	-0.63	-0.50	-0.41	-0.23	-0.09	-
Distributional Component (%)	1.60	1.37	1.13	0.94	0.75	0.57	0.40	0.23	0.07	0.07	0.05	-

ROW ECONOMY

Welfare (%)	0.74	0.67	0.60	0.55	0.50	0.45	0.41	0.38	0.34	0.22	0.11	-
Aggregare Component (%)	1.06	0.96	0.85	0.77	0.69	0.61	0.54	0.47	0.40	0.26	0.12	-
Distributional Component (%)	-0.32	-0.28	-0.25	-0.22	-0.19	-0.16	-0.13	-0.09	-0.05	-0.04	-0.02	-

Table 6A. Long Run Effects of Reform (τ_c vs. τ_l) when switching to Territorial Taxation

U.S. ECONOMY

τ_c	0	0.04	0.07	0.1	0.13	0.16	0.19	0.22	0.25	0.28	0.31	0.34
τ_l	0.349	0.342	0.337	0.331	0.326	0.321	0.315	0.310	0.305	0.300	0.294	0.289
Aggregates (% change)												
K_{11}	21.3	20.6	19.9	19.2	18.4	17.5	16.5	15.5	14.4	13.2	12.0	10.7
A_{11}	0.6	1.7	2.5	3.3	4.1	4.9	5.8	6.7	7.6	8.6	9.6	10.7
M_1	-6.0	-3.3	-1.1	1.3	3.9	6.8	9.9	13.4	17.3	21.8	26.9	32.8
Y_{11}	1.9	2.9	3.6	4.3	5.0	5.7	6.5	7.3	8.1	8.9	9.8	10.8
L_{11}	-2.8	-1.6	-0.7	0.2	1.1	2.1	3.1	4.1	5.2	6.3	7.4	8.7
K_{21}	38.9	30.5	24.3	18.0	11.7	5.4	-0.9	-7.3	-13.7	-20.2	-26.7	-33.4
A_{21}	15.2	10.1	6.2	2.3	-1.7	-5.8	-10.0	-14.3	-18.8	-23.4	-28.3	-33.4
M_2	7.6	4.7	2.5	0.3	-1.9	-4.2	-6.5	-8.9	-11.5	-14.1	-17.0	-20.0
Y_{21}	16.6	11.3	7.3	3.2	-0.9	-5.1	-9.4	-13.9	-18.5	-23.2	-28.1	-33.3
L_{21}	11.2	6.5	2.9	-0.8	-4.5	-8.4	-12.3	-16.4	-20.6	-25.1	-29.7	-34.6
Y	4.9	4.6	4.3	4.1	3.8	3.6	3.3	3.0	2.8	2.5	2.2	1.9
C	-0.9	-0.4	-0.1	0.2	0.5	0.8	1.1	1.3	1.5	1.7	1.9	2.1
P	25.2	25.3	25.4	25.5	25.7	25.9	26.3	26.7	27.3	28.1	29.1	30.4
D	29.9	29.6	29.3	29.1	28.9	28.8	28.7	28.7	28.9	29.2	29.8	30.6
w	4.9	4.6	4.3	4.1	3.8	3.6	3.3	3.0	2.8	2.5	2.2	1.9
r	3.8	3.4	3.1	2.8	2.5	2.2	1.9	1.6	1.2	0.9	0.6	0.2

ROW ECONOMY

Aggregates (% change)												
K_{22}	-2.8	-3.9	-4.9	-5.8	-6.9	-8.0	-9.3	-10.6	-12.2	-13.9	-15.8	-18.1
A_{22}	-2.3	-3.5	-4.5	-5.5	-6.6	-7.8	-9.0	-10.5	-12.0	-13.8	-15.8	-18.1
M_2	7.6	4.7	2.5	0.3	-1.9	-4.2	-6.5	-8.9	-11.5	-14.1	-17.0	-20.0
Y_{22}	-1.1	-2.4	-3.4	-4.6	-5.8	-7.1	-8.5	-10.0	-11.6	-13.5	-15.6	-18.0
L_{22}	-1.2	-2.5	-3.5	-4.6	-5.7	-7.0	-8.3	-9.8	-11.5	-13.3	-15.4	-17.8
K_{12}	9.6	14.6	18.5	22.8	27.4	32.3	37.8	43.7	50.3	57.7	66.1	75.7
A_{12}	3.5	8.1	11.8	15.8	20.0	24.6	29.7	35.2	41.4	48.3	56.0	65.0
M_1	-6.0	-3.3	-1.1	1.3	3.9	6.8	9.9	13.4	17.3	21.8	26.9	32.8
Y_{12}	4.8	9.3	13.0	16.9	21.1	25.6	30.5	36.0	42.0	48.7	56.3	65.1
L_{12}	4.6	9.2	12.9	16.9	21.1	25.7	30.7	36.2	42.3	49.1	56.8	65.6
Y	0.2	0.1	0.1	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.3
C	3.6	3.1	2.8	2.4	2.0	1.5	1.2	0.8	0.4	0.1	-0.4	-0.7
P	4.3	2.0	0.2	-1.7	-3.6	-5.6	-7.6	-9.8	-12.1	-14.6	-17.2	-20.1
D	8.3	5.4	3.3	1.1	-1.2	-3.5	-5.9	-8.4	-11.0	-13.8	-16.8	-20.0
w	0.2	0.1	0.1	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.3
r	3.8	3.4	3.1	2.8	2.5	2.2	1.9	1.6	1.2	0.9	0.6	0.2

Table 6B. Welfare Gains : Reform (τ_c vs. τ_l) when switching to Territorial Taxation

U.S. ECONOMY

τ_c	0	0.04	0.07	0.1	0.13	0.16	0.19	0.22	0.25	0.28	0.31	0.34
τ_l	0.349	0.342	0.337	0.331	0.326	0.321	0.315	0.310	0.305	0.300	0.294	0.289
Welfare (%)	-3.34	-2.88	-2.54	-2.23	-1.93	-1.66	-1.40	-1.18	-0.99	-0.83	-0.71	-0.649
Aggregare Component (%)	-1.25	-1.02	-0.86	-0.71	-0.58	-0.47	-0.38	-0.31	-0.26	-0.25	-0.26	-0.330
Distributional Component (%)	-2.12	-1.88	-1.70	-1.53	-1.36	-1.19	-1.03	-0.88	-0.73	-0.59	-0.45	-0.321

ROW ECONOMY

Welfare (%)	0.40	0.35	0.32	0.30	0.28	0.26	0.25	0.25	0.25	0.26	0.27	0.30
Aggregare Component (%)	0.77	0.68	0.62	0.56	0.50	0.45	0.40	0.35	0.31	0.28	0.25	0.23
Distributional Component (%)	-0.37	-0.33	-0.29	-0.26	-0.22	-0.18	-0.14	-0.11	-0.07	-0.03	0.02	0.07

Table 7A. Long Run Effects of Reform (τ_c vs. τ_d) when switching to Territorial Taxation

U.S. ECONOMY

τ_c	0	0.04	0.07	0.1	0.13	0.16	0.19	0.22	0.25	0.28	0.31	0.34
τ_d	0.467	0.435	0.410	0.386	0.361	0.337	0.313	0.289	0.265	0.242	0.219	0.197
Aggregates (% change)												
K_{11}	25.2	24.0	23.1	22.0	20.9	19.7	18.4	17.0	15.5	14.0	12.3	10.6
A_{11}	3.4	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.4	9.1	9.9	10.7
M_1	-3.4	-0.9	1.2	3.4	5.8	8.4	11.3	14.6	18.2	22.4	27.2	32.8
Y_{11}	2.9	3.8	4.4	5.1	5.7	6.4	7.0	7.7	8.4	9.1	9.9	10.8
L_{11}	-2.9	-1.7	-0.7	0.2	1.1	2.1	3.1	4.1	5.2	6.3	7.4	8.7
K_{21}	43.6	34.5	27.7	20.9	14.2	7.4	0.7	-6.1	-12.8	-19.7	-26.5	-33.4
A_{21}	18.7	13.0	8.7	4.4	0.1	-4.3	-8.9	-13.5	-18.2	-23.1	-28.1	-33.4
M_2	10.9	7.5	5.0	2.4	-0.1	-2.7	-5.3	-8.0	-10.8	-13.7	-16.8	-20.1
Y_{21}	18.1	12.6	8.4	4.1	-0.2	-4.5	-9.0	-13.5	-18.2	-23.0	-28.1	-33.3
L_{21}	11.4	6.6	3.0	-0.7	-4.5	-8.4	-12.3	-16.4	-20.6	-25.1	-29.7	-34.6
Y	6.0	5.6	5.2	4.9	4.5	4.2	3.8	3.4	3.1	0.9	0.6	0.4
C	4.8	4.6	4.4	4.2	4.0	3.8	3.5	3.3	3.0	2.7	2.3	2.0
P	-14.0	-9.0	-5.2	-1.4	2.4	6.2	10.1	14.0	18.0	22.1	26.3	30.8
D	27.2	27.3	27.3	27.3	27.4	27.5	27.7	27.9	28.3	28.9	29.6	30.7
w	6.0	5.6	5.2	4.9	4.5	4.2	3.8	3.4	3.1	2.7	2.3	1.9
r	-1.5	-1.2	-1.0	-0.9	-0.7	-0.5	-0.4	-0.2	-0.1	0.0	0.2	0.2

ROW ECONOMY

Aggregates (% change)												
K_{22}	0.9	-0.8	-2.0	-3.4	-4.8	-6.2	-7.8	-9.5	-11.3	-13.4	-15.6	-18.1
A_{22}	0.7	-0.9	-2.2	-3.5	-4.8	-6.3	-7.9	-9.5	-11.3	-13.4	-15.6	-18.1
M_2	10.9	7.5	5.0	2.4	-0.1	-2.7	-5.3	-8.0	-10.8	-13.7	-16.8	-20.1
Y_{22}	0.2	-1.3	-2.5	-3.7	-5.1	-6.5	-8.0	-9.6	-11.4	-13.3	-15.5	-18.0
L_{22}	-1.2	-2.5	-3.5	-4.5	-5.7	-7.0	-8.3	-9.8	-11.5	-13.3	-15.4	-17.8
K_{12}	13.5	18.2	21.9	25.9	30.2	34.9	40.0	45.5	51.7	58.7	66.5	75.6
A_{12}	6.4	10.8	14.3	18.1	22.2	26.6	31.3	36.6	42.5	49.0	56.4	64.9
M_1	-3.4	-0.9	1.2	3.4	5.8	8.4	11.3	14.6	18.2	22.4	27.2	32.8
Y_{12}	5.9	10.3	13.9	17.8	21.9	26.3	31.2	36.5	42.4	49.0	56.5	65.1
L_{12}	4.4	9.1	12.8	16.8	21.0	25.7	30.7	36.2	42.3	49.1	56.8	65.6
Y	1.4	1.2	1.0	0.8	0.7	0.5	0.4	0.2	0.1	-0.1	-0.2	-0.3
C	1.1	0.9	0.8	0.6	0.5	0.3	0.2	0.0	-0.2	-0.3	-0.5	-0.7
P	8.0	5.1	2.9	0.7	-1.5	-3.9	-6.2	-8.7	-11.3	-14.1	-17.0	-20.2
D	6.4	3.8	1.9	-0.1	-2.2	-4.4	-6.6	-8.9	-11.4	-14.0	-16.9	-20.0
w	1.4	1.2	1.0	0.8	0.7	0.5	0.4	0.2	0.1	-0.1	-0.2	-0.3
r	-1.5	-1.2	-1.0	-0.9	-0.7	-0.5	-0.4	-0.2	-0.1	0.0	0.2	0.2

Table 7B. Welfare Gains : Reform (τ_c vs. τ_d) when switching to Territorial Taxation

U.S. ECONOMY

τ_c	0	0.04	0.07	0.1	0.13	0.16	0.19	0.22	0.25	0.28	0.31	0.34
τ_d	0.467	0.435	0.410	0.386	0.361	0.337	0.313	0.289	0.265	0.242	0.219	0.197
Welfare (%)	-0.27	-0.24	-0.21	-0.19	-0.19	-0.21	-0.23	-0.28	-0.34	-0.42	-0.53	-0.673
Aggregare Component (%)	-1.84	-1.58	-1.32	-1.12	-0.94	-0.77	-0.63	-0.50	-0.41	-0.34	-0.31	-0.323
Distributional Component (%)	1.60	1.37	1.13	0.94	0.75	0.57	0.40	0.23	0.07	-0.08	-0.22	-0.351

ROW ECONOMY

Welfare (%)	0.74	0.67	0.60	0.55	0.50	0.45	0.41	0.38	0.34	0.32	0.30	0.293
Aggregare Component (%)	1.06	0.96	0.85	0.77	0.69	0.61	0.54	0.47	0.40	0.34	0.28	0.228
Distributional Component (%)	-0.32	-0.28	-0.25	-0.22	-0.19	-0.16	-0.13	-0.09	-0.05	-0.02	0.02	0.065

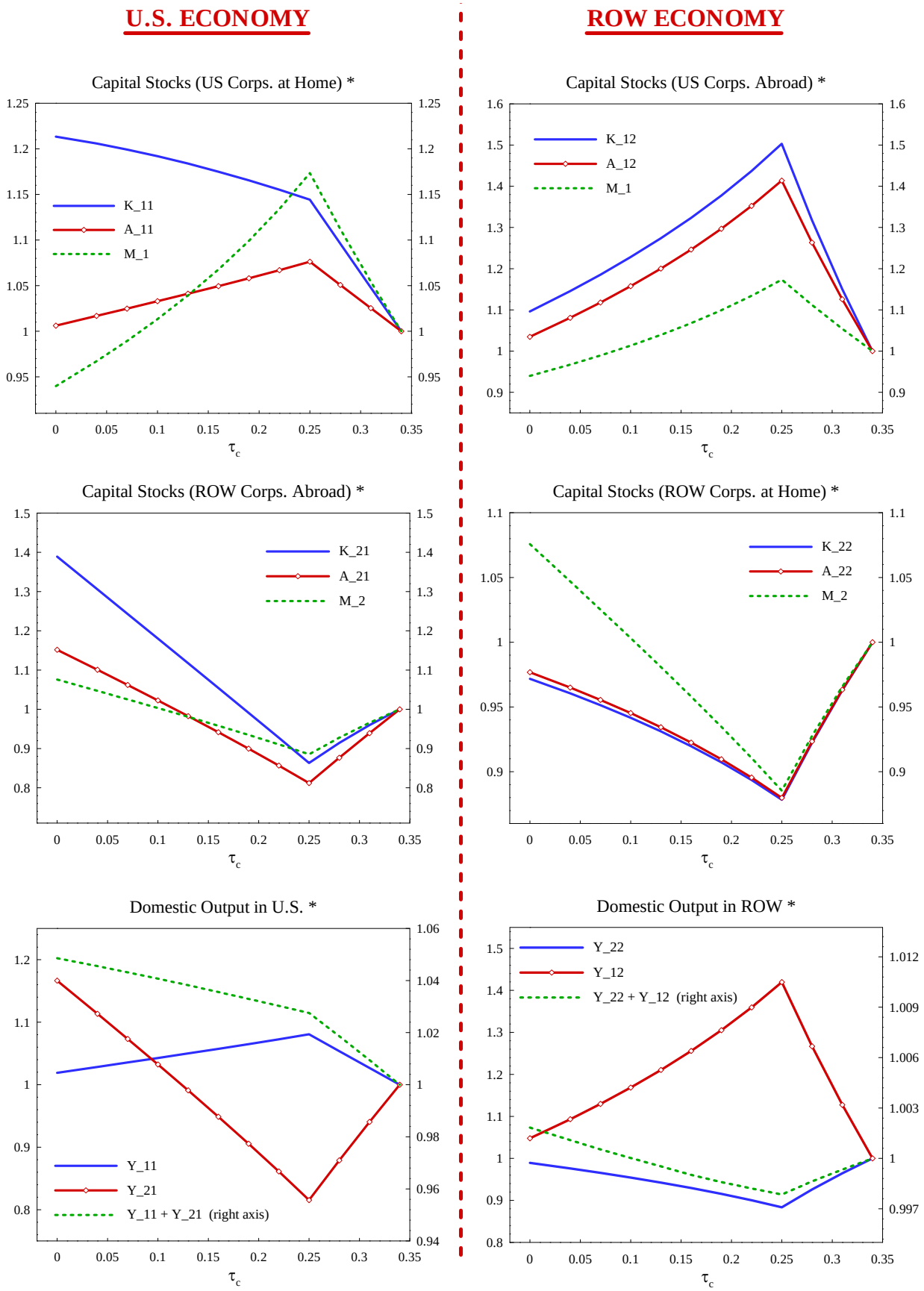


Figure 1: Capital Stocks and Outputs : Reform - (τ_c vs. τ_l)

* values relative to the pre-reform levels

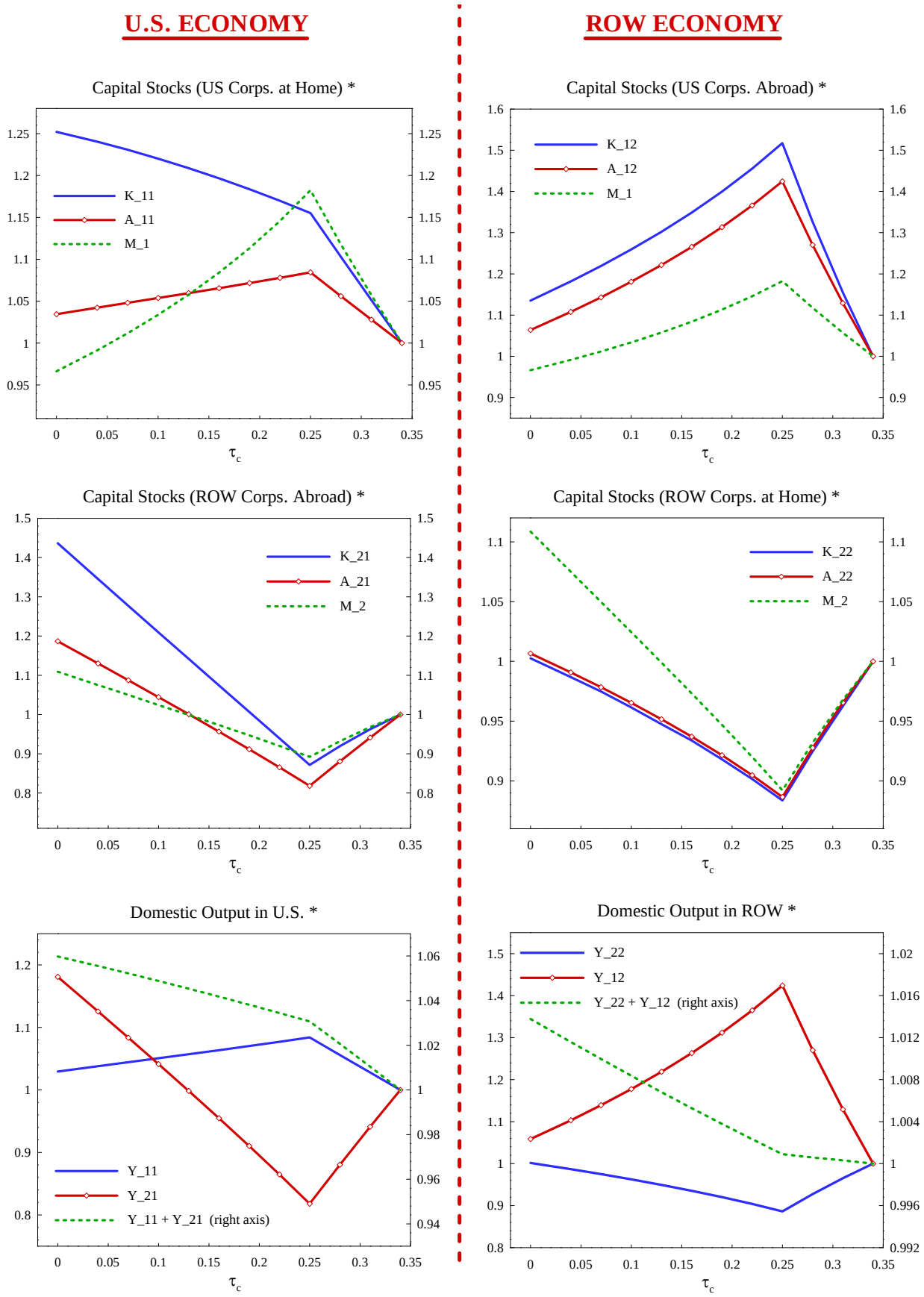


Figure 2: Capital Stocks and Outputs : Reform - (τ_c vs. τ_d)

* values relative to the pre-reform levels

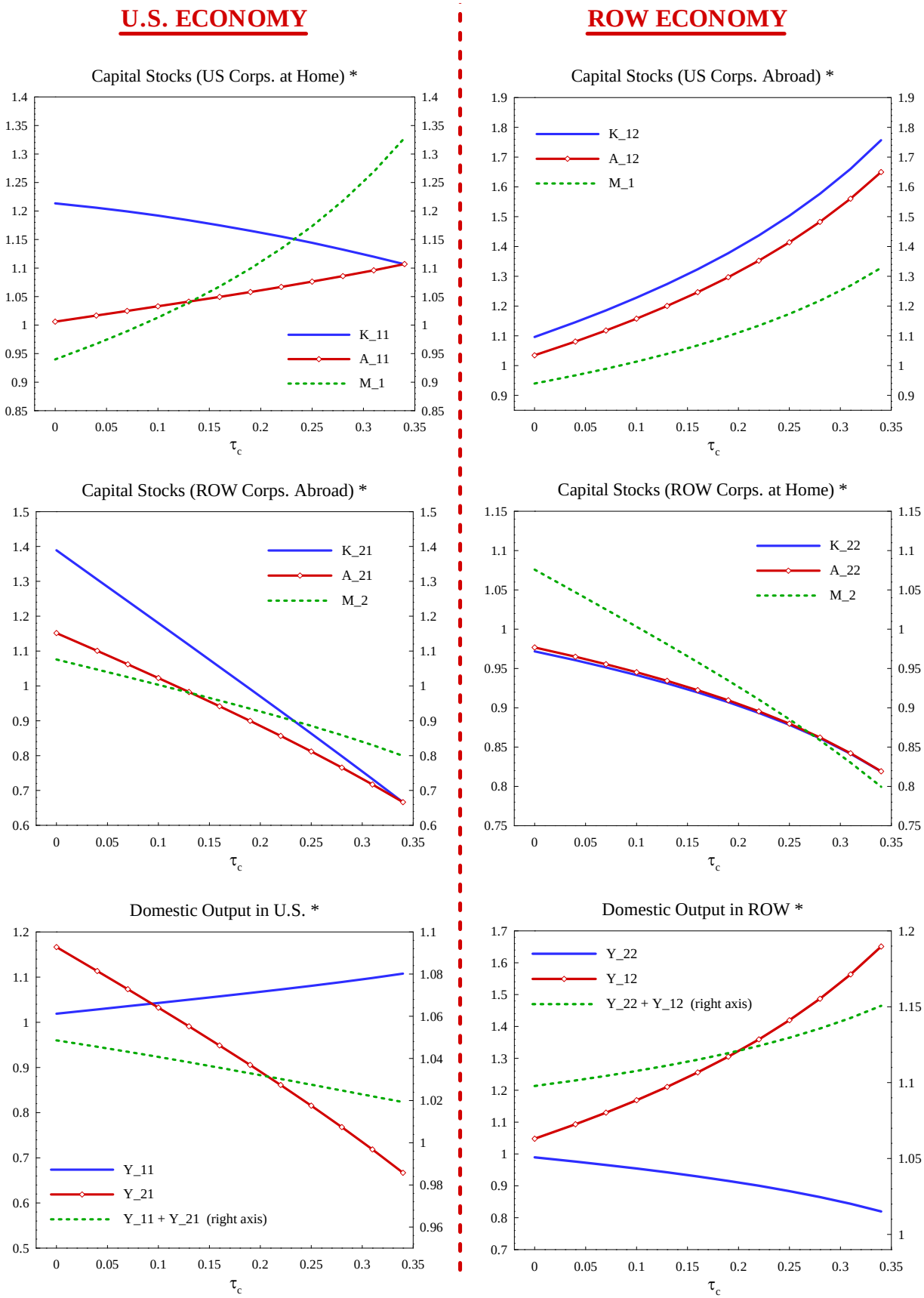


Figure 3: Capital Stocks and Outputs : Switching to Territorial Taxation (τ_c vs. τ_l)

* values relative to the pre-reform levels

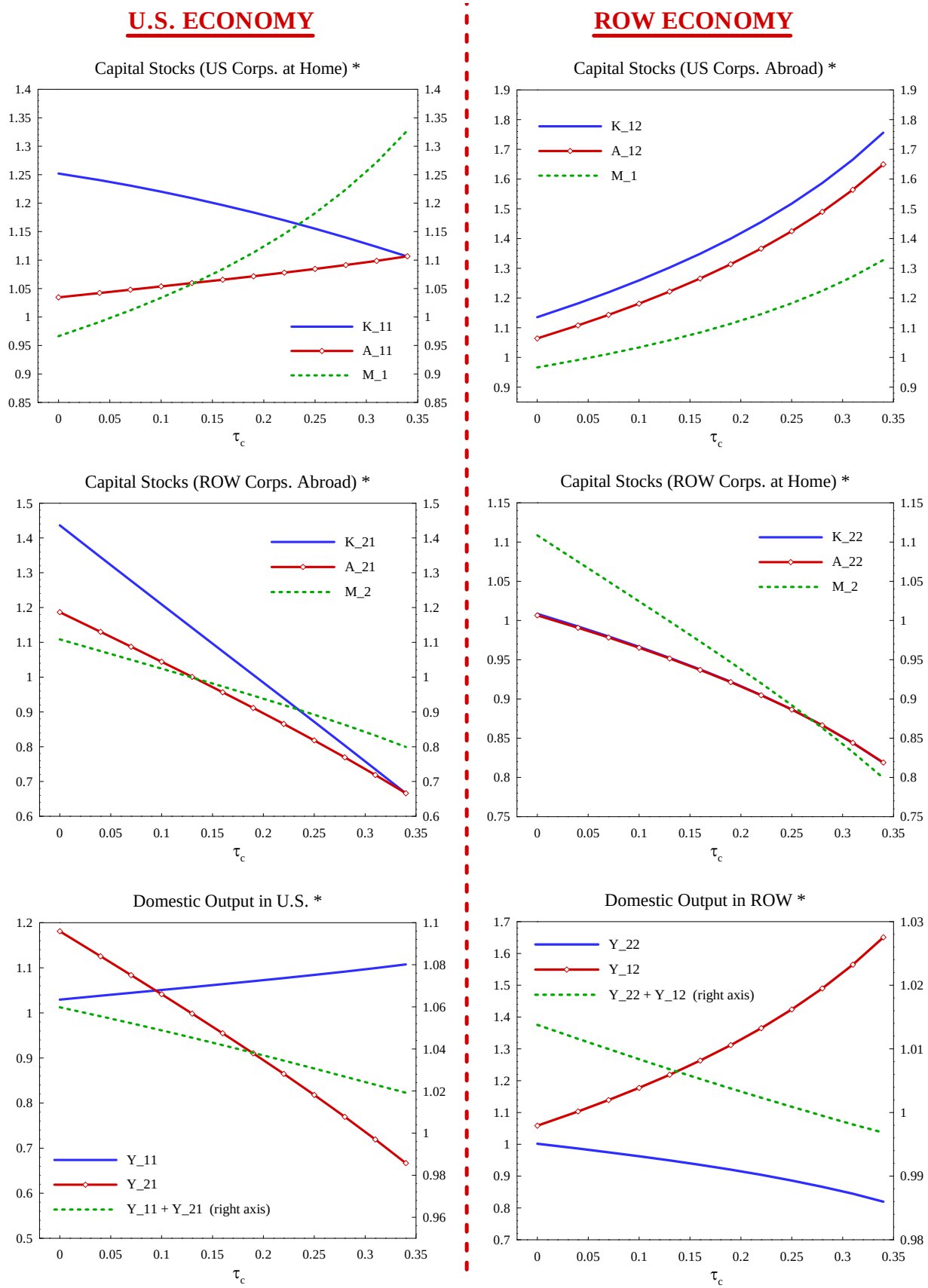


Figure 4: Capital Stocks and Outputs : Switching to Territorial Taxation (τ_c vs. τ_d)

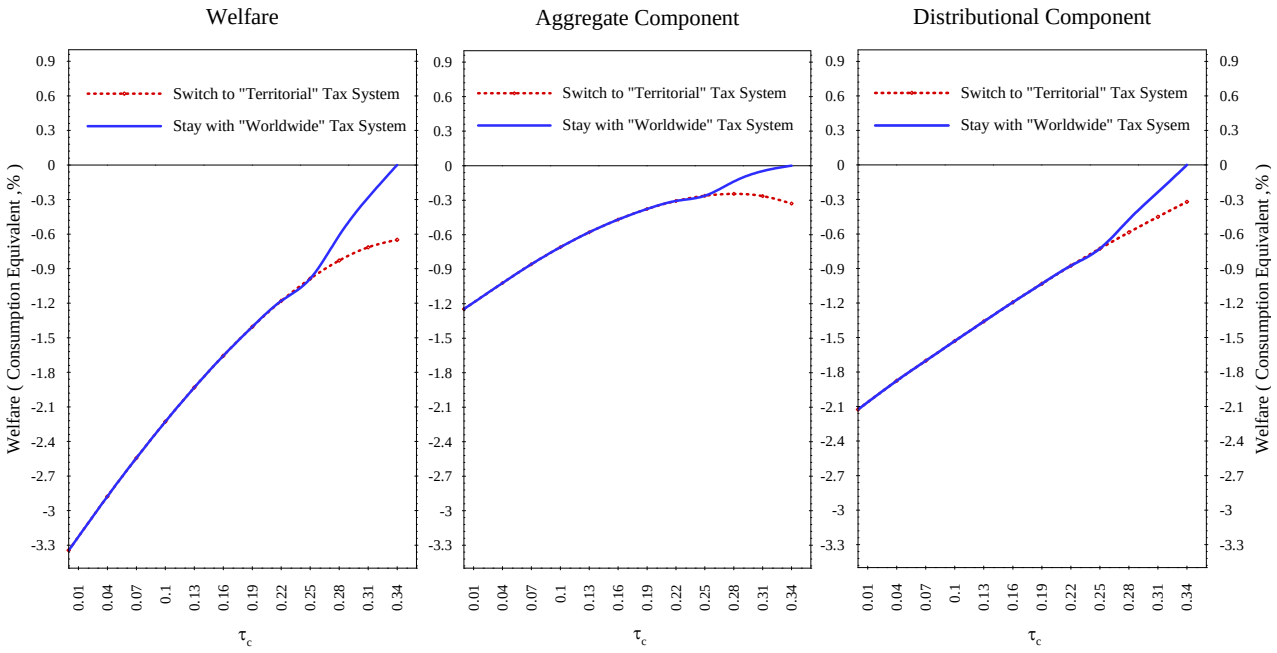
* values relative to the pre-reform levels

Figure 5A. Welfare Effects of Corporate Income Tax Cuts when U.S. Economy

(i) switches to "Territorial" System vs. (ii) stays with "Worldwide" System

(τ_c vs. τ_l)

U.S. Economy



ROW Economy

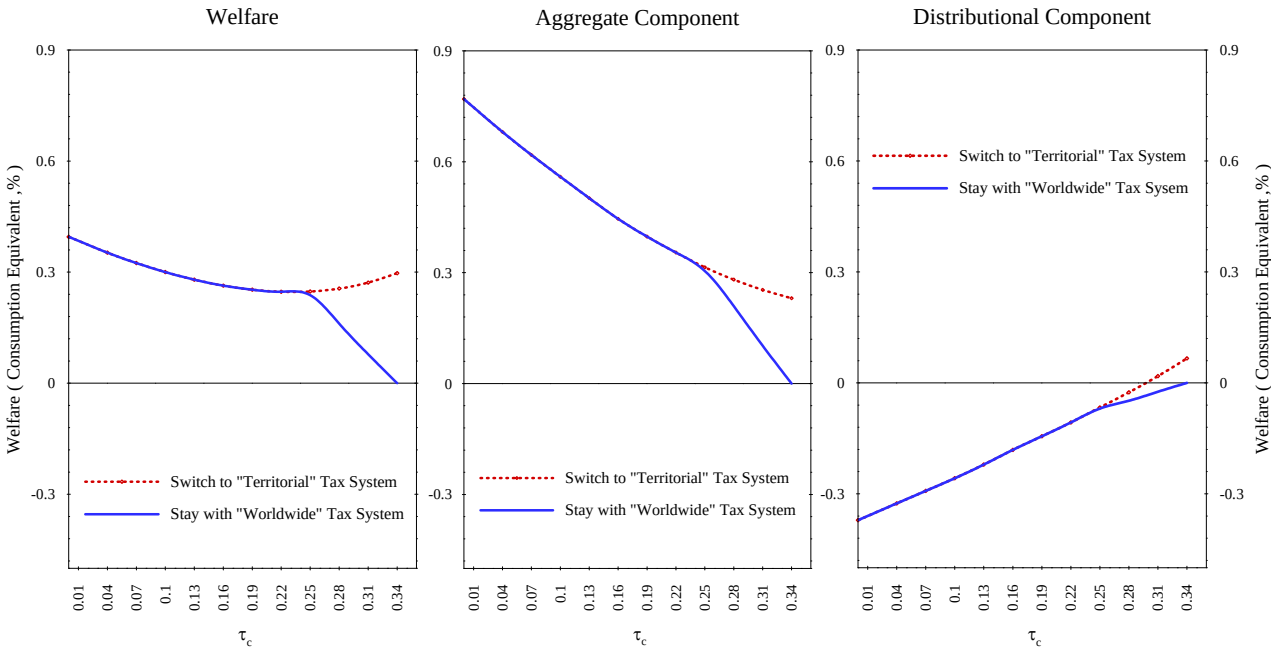


Figure 5B. Welfare Effects of Corporate Income Tax Cuts when U.S. Economy

(i) switches to "Territorial" System vs. (ii) stays with "Worldwide" System

(τ_c vs. τ_d)