Cross-Border Effects of U.S. Tax Policy*

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Abstract

This paper studies the transmission of U.S. fiscal policy changes to its major trading partners. In particular, I study the impact of removing the U.S. corporate repatriation tax on foreign tax policy. A two-country model with heterogeneous U.S. and foreign firms is developed and calibrated. The Foreign Government in the model solves a Ramsey taxation problem whereby it optimally chooses domestic corporate and personal tax rates. I run an experiment in the model whereby the repatriation tax is removed. The U.S. reform encourages more FDI by U.S. firms in the Foreign Country. I find that the Foreign Government chooses to decrease its domestic corporate tax rate so as to complement the U.S. policy change and further incentivise domestic investment.

Keywords: Optimal taxation, Multinational corporations, Firm dynamics, Corporate taxation, Repatriation taxes, Territorial tax system

JEL Codes: H21, F23, F41, L11

I Introduction

The Tax Cuts and Jobs Act (TCJA) of 2017 saw substantial reform to the tax treatment of U.S. multinationals. Prior to the reform, U.S. multinationals were subject to two layers of taxation on their overseas earnings. The first was by the foreign government presiding over the jurisdiction in question and the second was by the U.S. Government when the earnings were repatriated. The U.S. Government was one of the few OECD nations to tax its multinationals overseas earnings; this aspect of the U.S. code was colloquially referred

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to as the "repatriation tax". The repatriation tax was removed through the TCJA; going forward, U.S. multinationals only pay taxes to the foreign government on their foreign-made earnings.

An earlier work, Spencer (2018), evaluates the impact of this reform on U.S. multinationals and the domestic economy. The present paper instead studies the spill-over effect of this U.S. tax reform on foreign countries. Specifically, I study how foreign governments would best respond to the reform via adjustments to their own domestic corporate and personal tax rates.[1] I also examine the effect of the reform on firms incorporated abroad, which come about through their iterations with U.S. multinationals.

I calibrate a dynamic model with heterogeneous U.S. and foreign firms and a foreign government that solves a Ramsey optimal taxation program. Firms in each country are heterogeneous along the dimension of productivity. The foreign government maximises the welfare of a representative foreign household subject to needing to raise some minimum level of tax revenues. Firms incorporated in each country have the option to operate as domestic firms (D), exporters (X), multinationals (M) or to exit the industry (E) and pay an associated fixed cost as in Helpman, Melitz and Yeaple (2004). Firms that choose to export, gain access to a second market in which to sell their goods, incurring an iceberg proportional transport cost in the process of sending their goods abroad. Multinationals, in contrast, produce their goods for overseas sales in the foreign country, thereby circumventing the iceberg costs. Operating as a multinational comes with a higher flow fixed cost than being an exporter. An equilibrium emerges where, firms that are the least productive exit, followed by domestics, exporters and then finally the most productive firms in each country are multinationals. I solve for a stationary competitive equilibrium of the model, (as in Hopenhayn, 1992), where the foreign government chooses optimal corporate and personal tax rates given the behavioural responses of all other agents in the model.

I run a basic counterfactual using the model. I calibrate the model to the pre-TCJA policy scenario, whereby the repatriation tax is present, and treat the optimal personal and corporate tax rates of the foreign government as moments to be targeted. Then I set the repatriation tax rate to zero and re-solve for the new equilibrium where the foreign counterfactual tax rates are estimated. Through this quantitative exercise, I find that the Foreign Government responds by optimally reducing their own domestic corporate tax rate.

[1] In future versions of this paper, I'll also include a consumption tax rate that is chosen on the part of the Foreign Government. Inclusion of such a rate is crucial for a thorough analysis since many OECD countries in Europe levy such taxes.

In the qualitative sense, the counterfactual optimal foreign corporate tax rate may be higher or lower than that prior to the reform. The intuition is driven by extensive margin switching on the part U.S. firms. Removing the repatriation tax, holding all else equal, encourages some U.S. exporting firms to change their status and to operate as multinationals. Removing this tax increases the benefit associated with being a multinational over an exporter — in addition to saving on their iceberg transport costs — U.S. multinationals also save on their tax bill post-reform. If a large amount of such switching occurs, in the absence of a foreign response, it may be optimal for the foreign government to lower their corporate rate to complement the U.S. policy change and provide further incentive for FDI by U.S. firms. More U.S. multinationals operating in the foreign country bolsters the foreign labour market. In contrast, if the U.S. change leads to little switching of U.S. exporters to multinationals, then the foreign government may have incentive to increase their corporate tax rate, so as to seize some of the benefit U.S. multinationals reap from saving on their U.S. tax bills.

This paper is related to several different literatures. The first is the literature, which seeks to quantitatively estimate the impact of removing the U.S. corporate repatriation tax. Spencer (2018) studies the domestic effects in an equilibrium environment with heterogeneous U.S. firms to find that this policy change is welfare improving for the U.S. and is approximately tax revenue neutral. Gu (2016) studies the impact of the reform on the cash holdings of U.S. firms. Curtis, Garin & Mehkari (2018) study the impact of governmental deliberations regarding this policy change and how the length of such deliberations prior to implementation affect the short-run behaviour of U.S. multinationals. My paper contributes to this literature by analysing the impact of the policy change on foreign countries, rather than focusing solely on the domestic U.S. effect.

A second related area of research is the tax competition literature in the presence of heterogeneous firms. These studies typically solve for the Nash equilibrium of a game where two countries compete against one another for tax revenues. An early paper to use this approach was Burbidge, Cuff & Leach (2006). Davies & Eckel (2010) develop a model with tax competition in the context of a model with endogenous entry. Becker (2009) extends the Melitz (2003) model to study optimal taxation of multinationals who can either export or undertake foreign direct investment. Devereux, Lockwood and Redoano (2009) study a game theoretic model and then take the model to data to find some evidence in support of the Worlds governments engaging in international tax competition. My main point of departure from this literature is that I study the optimal response of the foreign government in a quantitative rather than qualitative context. The studies in this area typically utilise stylised static models of heterogeneous firms; I add to this literature by developing a dynamic modelling framework, which can be disciplined by data, to give numerical forecasts of the impact of this policy change.

A third related literature is the set of studies, which utilise quantitative models to answer questions relating to optimal taxation. Some recent examples are Heathcote, Storesletten & Violante (2014) and Heathcote & Tsujiyama (2016), who study the optimal degree of tax progressivity in the context of calibrated models. *Still need to read some more related papers here.*

The remainder of this paper is organised as follows. Section II outlines the model environment and section III details its equilibrium. Section IV describes the calibration, section V details the quantitative exercise and section VI concludes.

II Model Environment

The model has two countries — Home (H) and Foreign (F). There is a representative household in each country and heterogeneous firms. I make the assumption that firms incorporated in a given country are owned entirely by the corresponding representative household for the purpose of simplicity. There are six agents: households, firms and government for the two countries.

Households in each country have preferences over two types of goods — those produced by the Home firms and those produced by the Foreign firms — hereafter referred to as Home and Foreign goods respectively. Firms from the Home (Foreign) Country service the Foreign (Home) household through either exports or direct production in the Foreign (Home) country via multinationals. The model environment is summarised graphically in figure 1.

The two countries are assumed to be geographically segmented without mobility of goods or labour. As a result, differing prices of consumption and labour goods can prevail. Prices without $*$ superscripts again correspond to the Home Country and those with such superscripts are for the Foreign Country. The setup with regard to prices is summarised in figure 2.

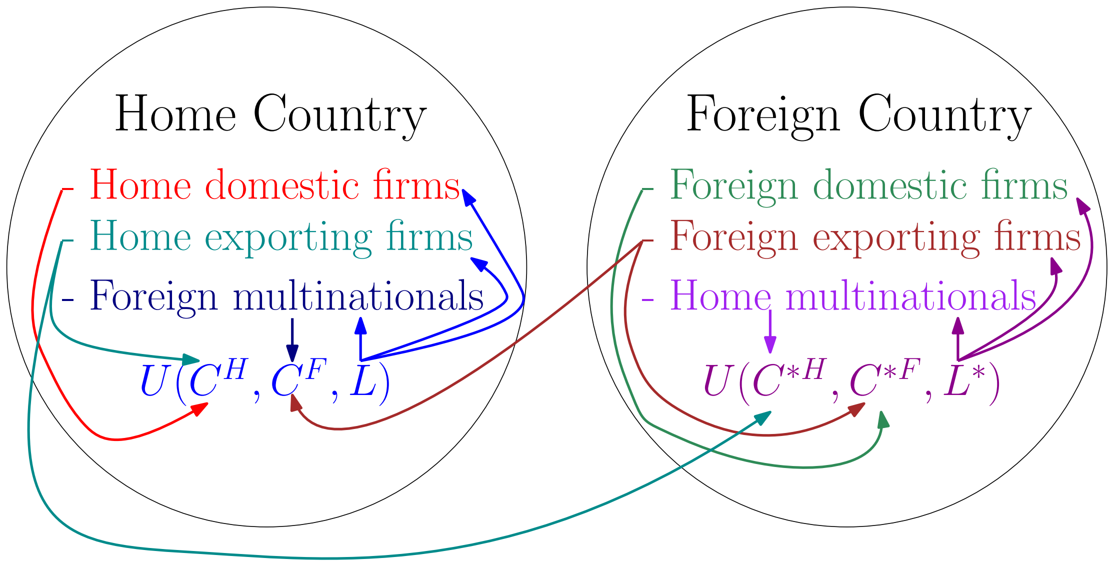

Figure 1: International market setup

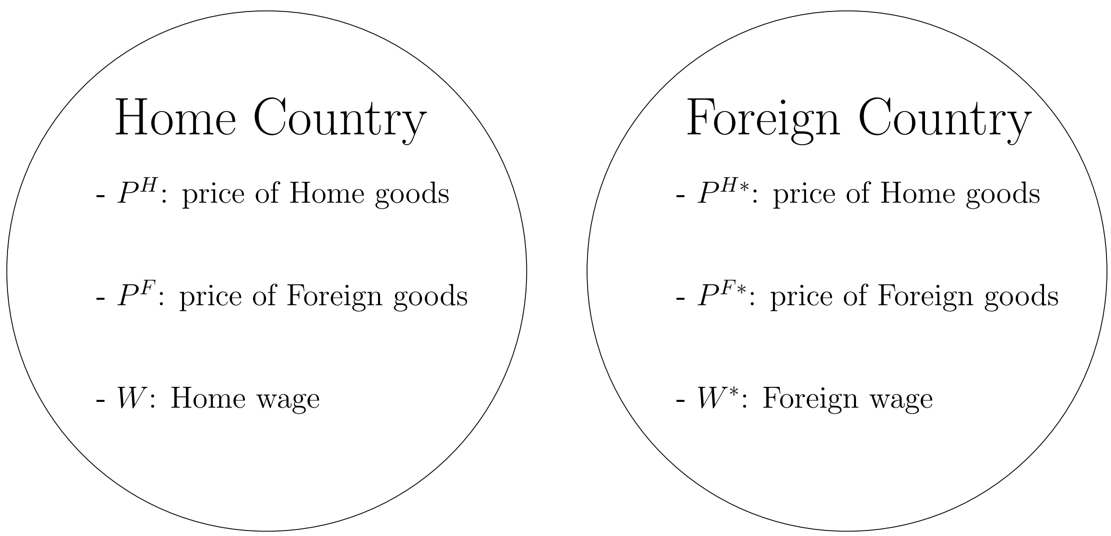

Figure 2: International prices setup

i Households

Households in the Home and Foreign Countries face symmetric setups. In what follows, I will describe the setup for Home households; that for Foreign households is symmetric except that their relevant variables are denoted with a superscript $*$. For example, L_t and L_t^* are the labour supply by households in the Home and Foreign countries respectively.

Households face period utility of the form $U(C^H, C^F, L)$ where U denotes their utility, $C(C^H, C^F)$ denotes an index of their consumption over Home goods (C^H) and Foreign goods (C^F), L denotes their supply of labour goods, which is normalised to be over the range $[0, 1]$. The two types of consumption goods are aggregated and enter into their preferences through the function

$$C(C^H, C^F) = \left[\lambda(C^H)^\eta + (1-\lambda)(C^F)^\eta\right]^{\frac{1}{\eta}}$$

where $\lambda \in [0, 1]$ is some share of spending on the Home consumption goods and η is related to the Armington elasticity of substitution between the two varieties of goods, where the elasticity is given by $1/(1-\eta)$. The aggregated price of consumption goods faced by the Home household is given by

$$P = [\lambda^{\frac{1}{1-\eta}}(P^H)^{\frac{\eta}{1-\eta}} + (1-\lambda)^{\frac{1}{1-\eta}}(P^F)^{\frac{\eta}{1-\eta}}]^{\frac{1-\eta}{\eta}}$$

where P^H represents the price of Home goods, (which is normalised to unity), P^F is the price of Foreign goods. The formal optimisation problem for the Home household is, as in Gomes (2001), given by

$$\max_{C_t^H, C_t^F, L_t, s_{jt}} \quad \mathbb{E}_0\left[\sum_{t=0}^{\infty} \beta^t U(C_t^H, C_t^F, L_t)\right]$$

subject to the constraint

$$P_t C_t + E_t^- = L_t W_t (1-\tau^L) + E_t^+$$

where P_t is the price of Home consumption goods and W_t is the rate, at which they are compensated for their labour. The variables E_t^- and E_t^+ represent equity injections from the household to the Home firms and dividend distributions from the Home firms to the household respectively. Note that these variables depend on the stationary distribution of

Home firms across their relevant state space, (to be described later).

ii Firms

Similarly to the household setup, in this section I will describe the Home firms' environment. That for the Foreign firms is symmetric except that their variables have additional superscripts $*$.

In each period at the extensive margin, firms from each country make a discrete choice from the following four options:

(1) Exit the industry (E),

(2) Operate as a domestic firm (D),

(3) Operate as an exporting firm (X),

(4) Operate as a Home multinational (M),

Discrete choices that involve production incur a flow fixed capital expenditure period by period. Firms that choose to export to the other country incur an iceberg transport cost, which is proportional to their export output. Operation as a multinational involves production directly in the other country, which circumvents any transport costs.

ii.1 Production Technology

Firms produce output using a decreasing returns to scale production function, which uses labour and capital as inputs. They produce using a separate technology along each dimension they choose to operate under at the extensive margin. Specifically

$$y_t^c = \theta_t (n_t^c)^\gamma (k_t^c)^\alpha, \ \ 0 < \alpha, \gamma < 1, \ \ \alpha + \gamma < 1 \tag{1}$$

for $c \in \{H, X, H*\}$ where y_t^c is firm output from plant c, k_t^c is the capital stock and θ_t is an idiosyncratic productivity shock. That is — a firm has a separate plant for production of goods for sale to its local consumers, for export and for production in the other country. Notice that the productivity shock has no superscript for the purpose of simplicity: it's assumed to be common across all plants of the firm.

I adopt the approach of assuming that a separate plant exits for production of goods to be shipped overseas in the case of an exporting firm. This is to avoid the scenario of corner solutions. Specifically, the alternative approach would be to have the firms produce a certain quantity domestically and then send a fraction of that overseas as exports. Given that the firms are price-takers in the model, configurations of the prices fetched domestically and abroad can result in all output being used for export or all sold to the domestic household. Clearly such an outcome is counterfactual and moreover, I seek to calibrate the iceberg cost parameter to match the average export intensity in the data. An outcome with corner solutions would make this impossible. Finally, I consider this assumption to be reasonable in light of empirical evidence provided by Bernard and Jensen (2007), namely that multi-plant firms are considerably more likely to be exporting than single-plant firms.[2]

The productivity shock is assumed to be distributed as follows

$$\log(\theta_t) = \rho_\theta \log(\theta_{t-1}) + \sigma_\theta \epsilon_t, \;\; \epsilon_t \sim N(0,1) \tag{2}$$

where $0 < \rho_\theta < 1$ captures persistence in the shock process while $\sigma_\theta > 0$ measures volatility. The probability distribution function for the technology shock is denoted by $G(\theta_t|\theta_{t-1})$. The law of motion for the capital stocks are given by

$$k_{t+1}^c = i_t^c - (1-\delta)k_t^c \tag{3}$$

where i_t^c denotes investment at time t in $c \in \{H, X, H*\}$ and $0 < \delta < 1$ represents the common depreciation rate. Firms pay an adjustment cost for changing each of their capital stocks

$$\Phi^c(i_t^c, k_t^c) = \frac{\phi}{2}\left(\frac{i_t^c}{k_t^c}\right)^2 k_t^c, \tag{4}$$

which is of a standard convex form designed to preserve concavity of the firm period payoff function.

[2] Their study finds that 29% of multi-plant firms export relative to 13% for single-plant firms.

ii.1.1 Firm Objective Function

The objective of the Home firms is to maximise the expected discounted value of dividends, net of personal dividend taxes, paid to the Home shareholders

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t d_t \tag{5}$$

where $0 < \beta < 1$ represents the discount factor of the firm and d_t is the period t dividend it pays to the shareholders.

ii.1.2 Fixed Costs of Production and Firm Entry

Incumbent firms are assumed to pay a fixed investment cost for each type of production, in which it engages as in the earlier two period model. Production in the Home country requires payment of an amount x^D. Should a firm chose to produce goods for export, it will incur an additional fixed cost of x^X. If a firm opts to be a multinational, it will pay a cost of x^M, which will involve a total fixed cost of $x^D + x^M$.

Notice that these fixed costs are paid in each period. An alternative specification could involve firms paying a one off fixed capital expenditure and then paying fixed operating costs in the periods subsequent. Identification of these two different costs, however, would be difficult. With the adopted approach, the entry and exit rates of firms between statuses will be equal in each period. In the alternative with separate fixed investment and operating costs, the entry and exit rates between each extensive margin will differ. While more of a realistic setup, this alternative is unlikely to change the qualitative result of the counterfactual.

A mass of new entrants come into the industry each period, where the rate of entry is denoted by R. New entrants are required to pay a fixed cost denoted by x^T. Their initial productivity draw comes from a probability distribution function given by $\bar{G}(\theta)$. I take the distribution to be a uniform over the productivity draws. The new entrants can issue debt to fund their initial investment; they can also use an initial public offering on equity.

ii.1.3 International Allocation of Funds and Period Dividends

In each period, a Home firm that chooses to operate as a multinational will make two decisions regarding international flows of funds. Firstly, they will choose how much to send from the parent company in the Home country to the Foreign subsidiary — denoted by $j_t \geq 0$. Secondly, they will choose the reverse — how much of their Foreign earnings they will repatriate from the Foreign subsidiary to the Home parent — denoted by $u_t \geq 0$. The firm's decision to repatriate funds from the Foreign subsidiary and the amount of Foreign capital to hold are directly related. Specifically, I write the amount of repatriated earnings as

$$u_t = (1 - \tau^{C*}) \left(P_t^{*H} \theta (k_t^{H*})^{\alpha} (n_t^{H*})^{\gamma} - W_t^* n_t^{H*} \right) - i_t^{H*} + j_t - \Phi^{H*}(i_t^{H*}, k_t^{H*}) \tag{6}$$

where P_t^{H*} is the output price fetched in the Foreign Country. Notice though that following the initial investment in the Foreign capital stock, the variable j_t will optimally be equal to zero. That is — it will always be dominant for the subsidiary to re-invest its overseas earnings than to repatriate funds to the parent, lose some in taxes and then send funds back to the subsidiary. Given the chosen level of foreign capital and repatriated earnings, the period dividend for a firm operating as a multinational is given by

$$\begin{aligned} e_t^M \quad = \quad & \left[(1 - \tau^C) \left(P_t^H \theta_t (k_t^H)^{\alpha} (n_t^H)^{\gamma} - W_t n_t^H \right) - i_t^H - x^D - \Phi^H(i_t^H, k_t^H) \right] + \\ & \left[\left(\frac{1 - \tau^{C,U} - \tau^{C*}}{1 - \tau^{C*}} \right) u_t - j_t - x^M \right] \end{aligned} \tag{7}$$

A firm who chooses to be an exporter is faced with the following expression for their period dividends

$$\begin{aligned} e_t^X \quad = \quad & \left[(1 - \tau^C) \left(P_t^H \theta_t (k_t^H)^{\alpha} (n_t^H)^{\gamma} - W_t n_t^H \right) - i_t^H - x^D - \Phi^H(i_t^H, k_t^H) \right] + \\ & \left[(1 - \tau^C) \left(\{1 - i\} P_t^{*H} \theta_t (k_t^X)^{\alpha} (n_t^X)^{\gamma} - n_t^X \right) - i_t^X - x^X - \Phi^X(i_t^X, k_t^X) \right] \end{aligned} \tag{8}$$

Notice that the firm who exports produces its export output using a separate production process from its goods whose destination are domestic. Consequently the price fetched from export income is equal to P_t^{H*} rather than P_t^H. Also notice that the tax rate on export income is given by the Home corporate tax rate — this follows from the fact that exporting firms do not have Foreign subsidiaries — meaning that they are unable to minimise their tax burden on such income through deferral. The revenue that the exporting firms receive is scaled by $(1 - i)$ to account for the iceberg cost associated with sending the goods to the

Foreign Country. The period dividends for a purely domestic firm are given by

$$e_t^D \quad = \quad \left[(1-\tau^C)\left(P_t^H\theta_t(k_t^H)^\alpha(n_t^H)^\gamma - W_t n_t^H\right) - i_t^H - x^D - \Phi^H(i_t^H, k_t^H)\right] \tag{9}$$

where these types of firms receive production income only on their domestic sales. Finally the period dividends for a Home firm that chooses to exit the industry is given by

$$e_t^E \quad = \quad \xi(k_t^H + k_t^X + k_t^{H*}) \tag{10}$$

which states that the firm pays to shareholders the firesale values of its current period capital stocks. Taken together, these equations, (6), (7), (8), (9) and (10) show that there are several sources and uses of funds for Home firms. These sources depend on the discrete choice, which has been made by the firm. They potentially include debt markets, equity markets, Home production income, Foreign production income and export production income.

iii Government

In this subsection, I describe the environment for the Home and Foreign Governments separately. While the household and firm problems are symmetric across the two countries, I elect to simplify the problem for the Home Government relative to that of the Foreign Government to keep the equilibrium computationally tractable.

iii.1 Home Government

The Home Government has five sources of tax revenue: collections from domestic sales of Home goods, export sales of Home goods, domestic sales of Foreign goods by Foreign multinationals, repatriated earnings from Home multinationals and personal taxes. The amount of revenue they raise for a given period is as follows

$$\begin{aligned} T_t = \tau^C(P_t^H Y_t^H - W_t N_t^H) + \tau^C(P_t^{H*} Y_t^X - W_t N_t^X) \\ + \tau^C(P_t^F Y_t^F - W_t N_t^F) + \tau^{C,U} U_t + \tau^L L_t W_t \end{aligned} \tag{11}$$

where T_t is their aggregated tax collections, Y_t^H is production by Home firms, N_t^H is labour hired by Home firms for production of domestic goods, Y_t^X is production by exporting Home firms, N_t^X is labour hired by Home firms for production of export goods, U_t is aggregate repatriations by Home firms, Y_t^F is production of Foreign goods by Foreign multinationals in Home and N_t^F is labour hired by Foreign multinationals in Home.

The Home Government has no required level of tax revenues to be raised. That is — I take the tax rates for the Home Country as being fixed in both the calibration exercise and counterfactual. Any changes to their tax policy in the counterfactual are taken to be exogenous — without any objective evaluation of the Home household utility function.

iii.2 Foreign Government

The Foreign Government has four sources of tax revenues — corporate collections from Foreign goods sales in Foreign and through export, corporate collections from Home multinationals producing in Foreign and personal tax collections. The amount in tax revenues raised by the Foreign Government is given as follows

$$\begin{aligned} P^{*F}T_t^* = \tau^{C*}(P_t^{F*}Y_t^{F*} - W_t^* N_t^{F*}) + \tau^{C*}(P_t^F Y_t^{X*} - W_t^* N_t^{X*}) + \\ + \tau^{C*}(P_t^{H*}Y_t^{H*} - W_t^* N_t^{H*}) + \tau^{L*} L_t^* W_t^* \end{aligned} \tag{12}$$

where T_t^* is tax collections by the Foreign Government, Y_t^{F*} and N_t^{F*} are output and labour hired for Foreign goods for sale in Foreign, Y_t^{X*} and N_t^{X*} are for export of Foreign goods, Y_t^{H*} and N_t^{H*} are output and labour from Home multinationals in Foreign, τ^{C*} is the Foreign Government's corporate tax rate and τ^{L*} is the Foreign personal tax rate.

I assume that the Foreign Government has some required level of revenues, which it must raise, in order to ensure the proper functioning of the economy. I denote this required level by $\bar{\Gamma}^*$. Consequently, the following constraint must be satisfied at all times

$$T_t^* \geq \bar{\Gamma}^*. \tag{13}$$

The Foreign Government chooses its two optimal tax rates to maximise the welfare of the Foreign household subject to the equilibrium of the economy in addition to equations (12) and (13).

iv Timing

Here the timing for firms in each period is described; note that the timing setup is the same for both Home and Foreign firms. The following list describes the timing for Home firms; the variables for Foreign firms simply have $*$ superscripts.

(1) Incumbent Home firms enter the period with state $(k_t^H, k_t^X, k_t^{H*}, \theta_{t-1})$.

(2) Receive the period t productivity draw — θ_t.

(3) Make the extensive margin decision: either exit the industry, operate as a domestic firm, an exporter or a multinational.

(4) Incumbent Home firms undertake all relevant production and make intensive margin investment decisions for the subsequent period.

(5) Home entrants pay a fixed cost to enter.

(6) Home entrants choose extensive margin.

(8) Home entrants choose intensive margin investment.

(9) Foreign firms hire labour and produce.

Notice that no productivity draw is received by the entrant in their period of entry. That is — they receive their first draw in the period subsequent to that of their entry. Consequently, no production takes place by new entrants in the initial period. As a result, they make their decisions regarding investment and the like based on the expected value they will receive from their first initial productivity draw.

III Model Equilibrium

The model uses the stationary competitive equilibrium solution concept pioneered in Hopenhayn (1992). In the following subsections, I describe the equilibrium decisions made by households, firms, government and go into greater detail regarding the equilibrium definition.

i Households

Here I detail the Home household equilibrium; note that the equilibrium for the Foreign household is symmetric. I assume a simple functional form for the period utility function of

$$U(C^H, C^F, L) = \log C(C^H, C^F) + \chi(1 - L).$$

Given that there are no aggregate shocks in this model, the problem of the Home household essentially simplifies down to a static problem, just as in Gomes (2001), of the form

$$\max_{C_t, L_t} \; \log(C_t) + \chi(1 - L_t) \tag{14}$$

subject to the constraint

$$P_t C_t = L_t W_t (1 - \tau^L) + E_t^+ - E_t^-. \tag{15}$$

where E_t^+ are dividend distributions from the firms to the household and E_t^- is aggregate new equity issuances. The optimality conditions for consumption and labour supply, assuming an interior solution, are then given by

$$\begin{aligned} C_t &= \frac{W_t}{\chi P_t}[1 - \tau^L] \\ L_t &= \frac{1}{W_t(1 - \tau^L)} \left[\frac{W_t}{\chi}[1 - \tau^L] + E_t^- - E_t^+ \right]. \end{aligned}$$

In the case of an solution that is not interior, the optimal consumption and labour supply are then given by

$$\begin{aligned} C_t &= \frac{W_t}{P_t} L_t (1 - \tau^L) + \frac{1}{P_t}\left[E_t^+ - E_t^-\right] \\ L_t &= 1. \end{aligned}$$

The division of consumption across the two types of goods is then given by

$$\begin{aligned} C_t^H &= \lambda \left[\frac{P_t^H}{P_t} \right]^{\frac{1}{\eta - 1}} C_t \\ C_t^F &= (1 - \lambda) \left[\frac{P_t^F}{P_t} \right]^{\frac{1}{\eta - 1}} C_t \end{aligned}$$

ii Firms

ii.1 Incumbent Firm Recursive Formulation

Choose (E), (D), (X) or (M) given the state vector, with which they enter the period. For notational ease, I define the state vector as $\vec{y}_t \equiv (k_t^H, k_t^X, k_t^{H*}, \theta_t)$. The value function for the firm at with the given state vector depends on the discrete choice it makes

$$V_t(\vec{y}_t) = \max\left[V_t^E(\vec{y}_t), V_t^D(\vec{y}_t), V_t^X(\vec{y}_t), V_t^M(\vec{y}_t)\right] \tag{16}$$

where the conditional value functions are given by

$$\begin{aligned}
V_t^E(\vec{y}_t) &= \xi(k_t^H + k_t^X + k_t^{H*}) \\
V_t^D(\vec{y}_t) &= \max_{k_{t+1}^H, i_t^H, n_t^H} e_t^D(\vec{y}_t) + \beta \mathbb{E}_t[V_{t+1}(\vec{y}_{t+1})] \\
V_t^X(\vec{y}_t) &= \max_{k_{t+1}^H, i_t^H, n_t^H, k_{t+1}^X, i_t^X, n_t^X} e_t^X(\vec{y}_t) + \beta \mathbb{E}_t[V_{t+1}(\vec{y}_{t+1})] \\
V_t^M(\vec{y}_t) &= \max_{k_{t+1}^H, i_t^H, n_t^H, k_{t+1}^{H*}, i_t^{H*}, n_t^{H*}} e_t^M(\vec{y}_t) + \beta \mathbb{E}_t[V_{t+1}(\vec{y}_{t+1})]
\end{aligned}$$

and the period payoff functions are

$$\begin{aligned}
e_t^D(\vec{y}_t) &= (1-\tau^C)\left(P_t^H \theta_t (k_t^H)^\alpha (n_t^H)^\gamma - W_t n_t^H\right) - i_t^H - \Phi^H(i_t^H, k_t^H) - x^D + \xi(k_t^X + k_t^{H*}) \\
e_t^X(\vec{y}_t) &= (1-\tau^C)\left(P_t^H \theta_t (k_t^H)^\alpha (n_t^H)^\gamma - W_t n_t^H\right) - i_t^H - \Phi^H(i_t^H, k_t^H) - x^D + \xi k_t^{H*} \\
&\quad + (1-\tau^C)\left[\{1-i\} P_t^{*H} \theta_t (k_t^X)^\alpha (n_t^X)^\gamma - W_t n_t^X\right] - i_t^X - \Phi^X(i_t^X, k_t^X) - x^X \\
e_t^M(\vec{y}_t) &= (1-\tau^C)\left(P_t^H \theta_t (k_t^H)^\alpha (n_t^H)^\gamma - W_t n_t^H\right) - i_t^H - \Phi^H(i_t^H, k_t^H) - x^D + \xi k_t^X \\
&\quad + \left(\frac{1-\tau^{C,U}-\tau^{C*}}{1-\tau^{C*}}\right)\left[(1-\tau^{C*}) P_t^{H*} \theta_t (k_t^{H*})^\alpha (n_t^{H*})^\gamma - W_t^* n_t^{H*} - i_t^{H*} - \Phi^{H*}(i_t^{H*}, k_t^{H*})\right] - x^M.
\end{aligned}$$

ii.2 New Entrant Firm Recursive Formulation

Recall that the firm pays the initial fixed cost of x^T to enter the industry. Then it makes the decision as to whether it will invest in the capital stocks required to be a multinational next period, an exporter next period or simply a domestic firm in the period following its startup. The recursive setup for the entrant's problem can be summarised by the following Bellman equation

$$V_t^T = \max\left[V_t^{T,D}, V_t^{T,X}, V_t^{T,M}\right] \tag{17}$$

where $V_t^{T,D}$ is the entrant's value from being a domestic firm and $V_t^{T,X}$ is the value from being an exporter and $V_t^{T,M}$ is that from choosing to operate as a multinational. The entrant's value from choosing to be a multinational is given by

$$V_t^{T,M} = \max_{k_{t+1}^H, k_{t+1}^{H*}} -k_{t+1}^H - x^T - j_t + (1 - \tau^{H,U} - \tau^{C*})u_t + \beta \left(\sum_{\theta_{t+1}} \bar{G}(\theta_{t+1}) V_t(k_{t+1}^H, 0, k_{t+1}^{H*}, \theta_{t+1}, b_{t+1}) \right)$$

where

$$u_t = j_t - k_{t+1}^{H*} \tag{18}$$

Notice that I allow for the new entrant to repatriate funds from the subsidiary to the parent, through (18), for completeness. The repatriation variable will obviously not be positive for the new entrant in equilibrium as this would involve sending funds to the subsidiary and then bringing them back right away, thereby losing funds through the repatriation tax in the process. If the new entrant elects to be an exporter, then its value its given by

$$V_t^{T,X} = \max_{k_{t+1}^H, k_{t+1}^X} -k_{t+1}^H - x^T - k_{t+1}^X + \beta \left(\sum_{\theta_{t+1}} \bar{G}(\theta_{t+1}) V_t(k_{t+1}^H, k_{t+1}^X, 0, \theta_{t+1}, b_{t+1}) \right)$$

Finally if the new entrant chooses to be a domestic firm, then its value is given by

$$V_t^{T,D} = \max_{k_{t+1}^H} -k_{t+1}^H - x^T + \beta \left(\sum_{\theta_{t+1}} \bar{G}(\theta_{t+1}) V_t(k_{t+1}^H, 0, 0, \theta_{t+1}, b_{t+1}) \right)$$

The optimal policy functions for the new entrant are denoted as $k_{t+1}^H = h_{k^H}^T$, $k_{t+1}^{H*} = h_{k^{H*}}^T$, $k_{t+1}^X = h_{k^X}^T$, $i_t^H = h_{i^H}^T$, $i_t^{H*} = h_{i^{H*}}^T$, $i_t^X = h_{i^X}^T$, $u_t = h_u^T$ and $e_t = h_e^T$. Notice that there are no state arguments for these policy functions given that the entrants come into the industry with no capital, debt or productivity draw in their period of entry.

iii Foreign Government

The Foreign Government optimally chooses the corporate and personal tax rates to maximise the welfare of the representative Foreign household subject to the required level of tax revenue. They make these tax rate choices with the prevailing equilibrium taken as given and with full commitment. That is — once the optimal tax rates are chosen, all agents in the model believe they will not be changed going forward.

iv Cross-Sectional Distribution

Given that there are two sets of independent heterogeneous agents in this model, there are two cross-sectional distributions — one for Home firms and one for Foreign firms. I denote the cross-sectional distribution of Home firms at time t by $\mu_t(k_t^H, k_t^X, k_t^{H*}, \theta_t)$; it evolves according to the following law of motion

$$\mu_{t+1}(k_{t+1}^H, k_{t+1}^X, k_{t+1}^{H*}, \theta_{t+1}) = R_t \int_{\theta, k^{H*}, k^X, k^H} \mathbb{1}_{h_{k^H}^E = k_{t+1}^H, h_{k^X}^E = k_{t+1}^X, h_{k^{H*}}^E = k_{t+1}^{H*}} \bar{G}(d\theta_{t+1})$$
$$+ \int_{\theta, k^{H*}, k^X, k^H} \Delta[(k_{t+1}^H, k_{t+1}^X, k_{t+1}^{H*}, \theta_{t+1}), (k_t^H, k_t^X, k_t^{H*}, \theta_t)] \mu_t(dk_t^H, dk_t^X, dk_t^{H*}, d\theta_t)$$

where $\Delta[(k_{t+1}^H, k_{t+1}^X, k_{t+1}^{H*}, \theta_{t+1}), (k_t^H, k_t^X, k_t^{H*}, \theta_t)]$ represents the probability of an incumbent transitioning between the two sets of states. Specifically this is given by

$$\Delta[(\vec{y}_{t+1}), (\vec{y}_t)] = \mathbb{1}_{\left[h_{k^H}(\vec{y}_t) = k_{t+1}^H, h_{k^X}(\vec{y}_t) = k_{t+1}^X, h_{k^F}(\vec{y}_t) = k_{t+1}^F\right]} (1 - z_t(\vec{y}_t)) G(\theta_{t+1} | \theta_t)$$

where the variable $z_t(\vec{y}_t)$ is assumes the value one when a firm with a given state exits the industry and zero otherwise, (recall $\vec{y}_t$ is shorthand for the state vector at time t: $(k_t^H, k_t^X, k_t^{H*}, \theta_t)$). In the case of the Foreign firms, an analogous cross-sectional distribution exits, which is denoted by $\mu_t^*(k_t^F, k_t^{X*}, k_t^{F*}, \theta_t^*)$.

v Balance of Trade

Combining the resource constraints for the households with the market clearing conditions gives the balance of trade condition

$$P^F X^*(1 - i^*) + NFI^* = P^{H*} X(1 - i) + NFI \tag{19}$$

where $NFI \equiv (1 - \tau^{C*})[P^{H*} Y^{H*} - W^* N^{H*}]$ and $NFI^* \equiv (1 - \tau^C)[P^F Y^F - W N^F]$ are net foreign income of Home and Foreign firms respectively. This expression states that the value of goods that are imported by the Home Country are equal to the value of the goods it exports plus the income its multinationals generate from producing and selling abroad.

vi Endogenous and Exogenous Prices

To minimise on the computational burden of this problem, I choose to fix some prices exogenously rather than solving for them all in equilibrium. I choose the wage in the Foreign Country to be the numeraire, ($W^* = 1$). I then solve endogenously for the relative prices of Home goods (P^{H*}) and Foreign goods (P^{F*}) sold in the Foreign Country such that the value to being a Home and Foreign entrant are both equal to zero respectively. Using the demand curves generated by the Foreign household's optimisation problem, I then pin-down the masses of Home and Foreign firms to clear the two markets.

For simplicity, I normalise the price of Home goods in the Home Country to zero, ($P^H = 0$). In doing so, I ensure that no Home firms will simply elect to operate as domestic firms. As a result, all Home firms will choose either to be exporters or multinationals, whereby the solely service the Foreign market. This normalisation spares on having to solve for this price endogenously, which I consider reasonable since the focus of this paper is on the Foreign Country.

The price of Foreign goods (P^F) is solved for endogenously to ensure that the balance of trade condition, equation (19), holds in equilibrium. Finally, I choose also to fix the wage in the Home Country to one ($W = 1$). The interpretation of the Home household's consumption-labour supply choices is then that their labour is supplied perfectly elastically and that their consumption of goods from abroad is ultimately pinned-down by the balance of trade condition.

vii Stationary Equilibrium Definition

The stationary competitive equilibrium for this model is given by a list

$$\{P^H, P^{H*}, P^F, P^{F*}, W, W^*, \mu, \mu^*, R, R^*, M, M^*, \tau^{C*}, \tau^{L*}\}$$

such that the following conditions hold

(1) Home and Foreign households optimise,

(2) The free entry condition for Home (Foreign) firms holds

$$V^T = 0 \quad (V^{T*} = 0)$$

(3) μ (μ^*) is an invariant stationary distribution of Home (Foreign) firms,

(4) R (R^*) is the rate of entry/exit of Home (Foreign) firms,

(5) $\mathcal{M}$ ($\mathcal{M}^*$) is the total mass of Home (Foreign) firms,

(6) P^H is the equilibrium price of Home goods in Home with market clearing condition

$$C^H = Y^H$$

(7) P^F is the equilibrium price of Foreign goods in Home with market clearing condition

$$C^F = (1 - i)X^* + Y^F$$

(8) P^{H*} is the equilibrium price Home goods in Foreign with market clearing condition

$$C^{H*} = (1 - i)X + Y^{H*}$$

(9) P^{F*} is the equilibrium price of Foreign goods in Foreign,

$$C^{F*} = Y^{F*}$$

(10) W is the equilibrium wage in the Home Country,

(11) W^* is the equilibrium wage in the Home Country,

(12) τ^{C*} is the optimal Foreign corporate tax rate chosen by the Foreign Government to maximise (14) subject to equilibrium conditions (1) – (11).

(13) τ^{L*} is the optimal Foreign personal tax rate chosen by the Foreign Government to maximise (14) subject to equilibrium conditions (1) – (11).

IV Calibration

The parameters that are selected outside of the model are presented in table 1. Of crucial importance going forward is calibrating many of these parameters inside the model. Specifically, the fixed costs need to be matched to data moments to ensure the extensive margin effects of the counterfactuals are accurately captured.

Parameter	**Description**	**Value**
τ^C	U.S. corporate tax rate	35%
$\tau^{C,U}$	Pre-reform U.S. repatriation tax	8%
τ^L	U.S. personal tax rate	25%
ξ	Firesale capital stock fraction	0.60
β	Discount factor	0.95
δ	Depreciation rate	0.15
η	Preference substitution	0.50
λ	Consumption bundle fraction	0.50
α	Capital share	0.30
γ	Labour share	0.65
i	Iceberg cost	0.10
x^X	Fixed cost exporting (H)	0.01
x^M	Fixed cost multinational (H)	0.10
x^E	Fixed cost entry (H)	2.00
x^{X*}	Fixed cost exporting (F)	0.05
x^{M*}	Fixed cost multinational (F)	0.08
x^{E*}	Fixed cost entry (F)	0.50
ϕ	Adjustment cost	0.10

Table 1: Parameters selected outside of the model

Table 2 gives the parameters calibrated inside the model. I choose two parameters to hit the observed tax rates for the Foreign Country in the data — the fixed cost of operating as a domestic Foreign firm and the required level of tax revenues for the Government.

Parameter	**Description**	**Value**	**Target**
$\bar{\Gamma}$	Required F Gov. spending	0.25	τ^{L*}
x^{D*}	Fixed cost domestic (F)	0.10	τ^{C*}

Table 2: Parameters calibrated inside the model

The fixed cost of being a Foreign domestic firm is chosen to hit the optimal corporate tax rate. As this parameter gets larger, the cutoff standard for being a non-exiting Foreign firm increases. Through the free-entry condition for Foreign firms, this higher cost then translates into a higher cost of Foreign goods in Foreign. The higher price fetched by Foreign firms then induces an increase in corporate tax collections.

The required level of tax collections is chosen to hit the optimal foreign personal tax rate. One can interpret the Foreign Government's problem as choosing the corporate tax rate to balance the firms' incentives and then setting the personal tax rate as the residual from the required level of revenues. A higher value of $\bar{\Gamma}$ directly results in a higher personal tax rate.

Tax rate	**Model moment**	**Data moment**
τ^{C*}	24%	25%
τ^{L*}	36%	36%

Table 3: Tax rate moments inside the model

Table 3 shows the optimal corporate and personal tax rates in the model and how they contrast with the data targets. I interpret the Foreign Country in the model to be a representative trading partner of the U.S. In particular, I take the average corporate and labour tax rates of the OECD as targets for the Foreign Government.

V Counterfactual Results

In this section, I report the results of a simple counterfactual. I start by solving for the stationary equilibrium prior to the repatriation tax reform on the part of the U.S. (with $\tau^{C,U} > 0$) and then re-solve for the new equilibrium with $\tau^{C,U} = 0$. The results of the optimal tax problem for the Foreign Government is presented in table 4. Table 5 shows the model moments regarding the composition of U.S. firms who service the Foreign Country.

Tax rate	**Pre-reform**	**Post-reform**
τ^{C*}	24%	21%
τ^{L*}	36%	29%

Table 4: Counterfactual results for optimal tax rates

Table 4 shows that, subsequent to removing the U.S. repatriation tax, the Foreign Government responds by lowering both their domestic corporate and personal tax rates. The corporate rate falls from 24% to 21% and the personal rate decreases from 36% to 29%. The basic intuition is the following — the U.S. removes the repatriation tax and this incentivises more FDI by U.S. firms in the Foreign Country. The Foreign Government does best then to complement this change by lowering its corporate tax rate — this will further stimulate FDI by U.S. firms. Given the higher corporate tax collections, the Foreign

Government can afford to lower their personal tax rate, thereby lowering the direct tax burden borne by the Foreign household and increasing welfare.

Moment	**Pre-reform**	**Post-reform (no F response)**	**Post-reform (with F response)**
Fraction of U.S. multinationals	25%	31%	39%
Fraction of U.S. exporters	75%	69%	61%

Table 5: Counterfactual results for U.S. firm moments (conditional on servicing F)

The optimal tax rate changes can be best understood through examination of table 5. The table illustrates the post-reform outcome for U.S. firms under two scenarios. The first is with no response from the Foreign Government and the second is with their optimal response, (the same as that presented in table 4). In the absence of Foreign tax rate responses, the composition of U.S. firms servicing Foreign differs such that the fraction of firms operating as multinationals increases by around 6%. This response is relatively strong: U.S. firms save on their transport costs and additionally on their tax bill from being a multinational.

This increase in the fraction of U.S. multinationals can be thought of as shifting the supply curve of Home goods in Foreign toward the right; fewer of these goods are lost to the proportional transport costs. This has the effect of decreasing the price of Home goods in the Foreign Country — an effect that one can think of as leading to an increase in the purchasing power of the Foreign household.

In response, the Foreign Government lowers the corporate tax rate, which induces an even further shift away from U.S. firms being exporters and towards FDI. This leads to further favourable price effects from the perspective of the Foreign household. In all, the fraction of multinationals reaches 39% in the post-reform scenario with tax rate responses.

VI Conclusion

Tax reform has been an active area of U.S. public policy in recent months. One major aspect of these reforms was removal of the repatriation tax levied on U.S. multinationals. These reforms have been implemented with an eye towards increasing the profitability and competitiveness of U.S. firms (Speaker's Office, 2017). Previous studies have shown that indeed this reform is likely to be beneficial from a domestic perspective. Given that multinational firms interact directly with consumers and governments of foreign countries, a natural question that arises is — how will this U.S. tax reform impact the rest of the world? I answer this question quantitatively.

To study the issue, I developed a model with firm heterogeneity and incorporated a strategic fiscal response to the U.S. reform on the part of the Foreign Government, (which I interpret as the OECD). I solve for the post-reform equilibrium of the model and study how the optimal corporate and personal tax rates in Foreign are impacted as a result. I find that the Foreign Government best responds by lowering its domestic corporate tax rate to further encourage investment upon its shores.

The results of this paper, as they stand, are very preliminary. I intend to shore-up the quantitative results in the future through a more rigorous calibration. Moreover I intend to also focus more on the impact of the reform to Foreign firms. Further avenues for research could involve incorporating financial frictions in the model. Doing so would allow one to answer interesting questions, such as how the U.S. reform would impact the capital structure of foreign firms. The current version of the paper lays-out a first attempt at understanding the transmission of U.S. fiscal policy initiatives on the rest of the world.

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VIII Appendix

i Computational Algorithm

(0) Fix the Foreign corporate tax rate to some value τ_0^{C*}.

(1) Conjecture price vector (P^{*H}, P^F, P^{*F}).

(2) Solve Home firm decision problem: given the price vector, solve for the optimal intensive and extensive margin investment policy functions.

(3) Solve the Foreign firm decision problem.

(4) Update prices P^{*H} and P^{*F} until the values to Home and Foreign entrants respectively are zero.

(5) Find the stationary distributions $\mu^H(\vec{x}^H)$ and $\mu^F(\vec{x}^F)$ for the Home and Foreign firm state spaces respectively.

(6) Solve the Foreign household problem to obtain labour supply and consumption demands.

(7) Pin-down the masses of Home and Foreign firms using the Foreign goods market clearing conditions.

(8) Evaluate the balanced-trade condition. Repeat steps (1) – (7), each time updating P^F until balanced trade holds.

(9) Repeat steps 0 – 8 for a grid of permissible values of the Foreign corporate rate. The solution to the Ramsey problem is the rate, which yields the highest Foreign utility level.