Policy Effects of International Taxation on Firm Dynamics and Capital Structure

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6 May 2017

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April 26, 2017

Abstract

I develop and calibrate an industry equilibrium model with heterogeneous multinational firms to study the impact of a potential policy change from the current U.S. worldwide taxation system to a territorial system on firm investment, capital structure, payout policy and tax revenues. Firms in the model make both intensive and extensive margin decisions in terms of overseas investment. They optimally choose dividend payments to shareholders, holdings of riskless debt securities and earnings repatriations from the subsidiary to the parent in each period. To estimate the impact of the policy change, I solve the model under both worldwide and territorial systems and compare the stationary equilibria. The results show that the policy change causes both domestic and overseas production by U.S. firms to rise. In addition, firms borrow more and pay larger dividends to shareholders. These effects on firm variables are coupled with a rise in U.S. Government tax collections.

*I thank Oliver Levine and my advisor, Dean Corbae, for some valuable discussions that helped me to develop this project and to get it off the ground. Comments received by Mark Ready, Michael Gofman and David Brown have also been particularly helpful. I'm grateful to participants at the 2017 Midwest Finance Association Annual Meeting and in particular, thankful to Joseph Farhat for giving a helpful discussion. I'm also appreciative for suggestions during the Spring 2016 Midwest Macro Meeting at Purdue University in addition to those provided during the macroeconomics brownbag, the macro-finance reading group and the finance brownbag all at UW – Madison. I am also thankful for funding provided by the Culbertson Prize, the Richard E. Stockwell Fellowship and a Summer Research Fellowship awarded by the economics department and generous support from the finance department at UW – Madison. I'm also fortunate to have received outstanding computational support from the Center for High Throughput Computing (CHTC). All remaining errors are my own.

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Keywords: Multinational corporations, Firm dynamics, Capital structure, Corporate taxation

JEL codes: F23, G32, H25, L11

I Introduction

The United States (U.S.) currently operates under a *worldwide system* of taxation of the foreign earnings of its multinational corporations. In general terms, the government of a country that uses a worldwide system of taxation is entitled to tax revenue from the overseas earnings of its multinationals. In contrast, the government of a country, which operates under what is called a *territorial system* stakes no claim on such earnings. The system under which a country operates has implications for the decisions made by its domestically-incorporated multinationals, their shareholders and domestic tax collections of its Federal Government.

The current distribution of OECD countries across these two broad types of systems is such that 26 operate under a territorial system, while 8 adopt a worldwide setup. The specific countries under each type of system is displayed in table 1. Two countries under the territorial banner, namely the United Kingdom (U.K.) and Japan, switched to their current system from a worldwide scheme in 2009. The British Government cites reasons for the policy change such as tax simplification and improved international competitiveness of its firms (HM Government, 2013). The Japanese reasons for change were more related to fear over funds being trapped overseas. The idea was that the policy change would result in more funds being brought back to Japan, resulting in higher domestic investment and employment (Altshuler, Shay and Toder, 2015).

There has been an ongoing debate in the U.S. in recent years surrounding the need for this potential tax policy change. It is an issue, which has been debated by academics, politicians and the media. One major point of controversy in the debate surrounds the deferrability of active foreign earnings in the current system, (see section II for more details). This particular aspect of the U.S. tax code has allowed many large firms to hold-off on repatriating their overseas earnings and to accumulate large amounts of funds abroad. U.S. politicians have expressed concern regarding this behaviour by firms along the dimension that it may be serving the firms at the expense of domestic economic activity. In response, the 2004 Homeland Investment Act was implemented where firms were able to undertake a one-time repatriation of overseas earnings from their subsidiaries at a reduced tax rate. Switching to a territorial system would eliminate the tax-based incentive for firms to hold-off on repatriating their foreign earnings.

Another contentious issue in the debate surrounds the concept of *foreign inversions*. A U.S. firm is said to undertake a foreign inversion when it re-incorporates in another

System	OECD Countries
Worldwide (8)	Chile, Greece, Ireland, Israel, Korea, Mexico, Poland, U.S.
Territorial (26)	Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia Finland, France, Germany, Hungary, Iceland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Slovak Republic Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom

Table 1: Distribution of OECD countries over tax systems.

country for tax purposes. By re-incorporating in a country with a territorial tax system, future foreign earnings of the firm will no longer be subject to taxes by the home country. Typically U.S. firms will invert to places like the U.K., Bermuda, the Netherlands or the Cayman Islands. These particular countries are attractive given that they operate under territorial tax systems with a low corporate tax rate. Since the first instance of an inversion by a U.S. firm in 1982, several policies have been passed in Congress aimed at reducing the incidence of such transactions. Moving to a territorial tax system would reduce the benefits associated with these activities.

The question that I aim to answer in this paper is — how would moving to a territorial tax system affect U.S. multinational firm capital structure, investment decisions, payout policy and Federal Government tax collections. Specifically, I examine the effect of the policy change on the incentives for overseas investment, repatriation decisions of firms, dividend payments to shareholders and the impact on their holdings of debt. To address the question, I develop and estimate a model of firm heterogeneity and examine the impact on the implied firm stationary equilibrium of the policy change.

The model is written in the spirit of Gomes (2001) while also taking elements from Melitz (2003) and Helpman, Melitz and Yeaple (2003). The model is from the viewpoint of firms incorporated in the U.S.. In each period, firms receive a productivity draw. Following the draw, the firms make an extensive margin decision — they can opt to exit the industry, compete only in the U.S. market or operate in both the U.S. and abroad with a parent-foreign subsidiary setup. Firms are subject to costly equity financing in the form introduced by Gomes (2001) and are allowed to undertake collateralised borrowing where they can borrow against their capital stocks in each country of operation.

The numerical results of the model suggest that the current U.S. worldwide system of taxation acts to distort both the financial policy and investment decisions of U.S. multinationals. They show that moving to the territorial tax system would result in a fall in

the U.S. capital stock of around 1.5%, while increasing domestic output by a little under 4%. In contrast, the capital stock held by U.S. firms abroad is estimated to more than double, on account of a strong effect on the incentive for U.S. firms to invest abroad. In terms of capital structure and payout policy, moving to the territorial regime is predicted to cause firm borrowings to increase by around 30%, while dividend payments to U.S. shareholders increase by 54%. The model also predicts that the benefits received by U.S. firms from this tax code change aren't predicted to come at the expense of Federal tax collections. The results suggest that tax collections are 5% higher under the territorial stationary equilibrium.

There exists a small group of studies, which aim to answer this question in an empirical context. Arena and Kutner (2015) examine firm data pertaining to British and Japanese firms to deduce the effect of these countries' switch to the territorial system. They find that as a result of the change, the firms accumulate less cash, pay more in dividends to shareholders, invest less abroad and repurchase more shares. They also find no significant effect on domestic investment. Foley, Hartzell, Titman and Twite (2007) use Compustat and Bureau of Economic Analysis (BEA) data on multinationals to find that firms with a higher repatriation tax cost hold more in cash. Pinkowitz, Stulz and Williamson (2012) use similar data to find a contradictory result — that repatriation tax treatment does not explain increasing firm cash holdings.

A related paper is Gu (2016), who examines the effect of the U.S.' current international tax setting on cash holdings of multinational firms with the context of a model. Their approach entails simulating a panel of multinational firms in a partial equilibrium context and examining how switching to a territorial system will affect the distribution over cash holdings. My paper differs considerably from that of Gu (2016) in terms of the scope of my research question, in addition to my methodology. My paper models industry equilibrium, which allows me to speak to the number of U.S. firms operating in the U.S. and how that would change from this tax reform. This feature gives me the ability to speak to aggregate variables, which is particularly important from the perspective of speaking in a quantitative sense about U.S. variables such as tax collections. Using this framework, I can also speak about firm dynamics — how variables such as the fraction of U.S. multinationals and exit rates would be affected — something that can not be done in a partial equilibrium context. In other words: my study adopts a more macro-approach to studying this problem, which goes beyond the scope of Gu (2016). In addition, my paper can speak to the effects of the policy change on equity and debt issuances of U.S. firms separately, as opposed to

distinguishing between only external and internal financing.

This paper looks at the effect of corporate taxation on capital structure beyond the typical narrative of the tradeoff theory of debt tax shields. In so doing, I also contribute to the literature that seeks to examine corporate financial and investment decisions in the context of dynamic structural models. Strebulaev and Whited (2012) provide an excellent summary on the state of the field. Riddick and Whited (2009) look at the optimal firm cash holdings problem in the presence of costly external finance. Hennessy and Whited (2005) study the optimal debt choice in the presence of corporate taxes and financial distress costs. Gamba and Triantis (2008) allow for a more flexible capital structure where firms can make investment, debt holdings and retained earnings decisions to find that the value of such flexibility depends on the cost of seasoned equity financing.

The remainder of this paper is organised as follows. Section II describes in more detail the specifics regarding the current U.S. worldwide tax system and sketches recent alternatives that have been floated by members of Congress. Section III provides some data facts relating to U.S. multinational firms. Section IV looks at a very simple two period model to cement the intuition regarding how this policy change would affect firm decisions. Section V outlines the environment of the dynamic model. Section VI describes the equilibrium of the dynamic model. The numerical solution and estimation methods are detailed in section VII. Section VIII reports the results from switching to a territorial system. Section IX explores additional counterfactuals regarding U.S. international tax policy. Section X conducts robustness checks on the territorial counterfactual and section IX concludes.

II Current U.S. System and Proposed Alternatives

The purpose of this section is to provide specific details regarding the current U.S. system and to outline alternatives that have been proposed, in addition to the stylised territorial alternative to be analysed later in the paper. Although the details below describe the basic spirit of the tax laws, it is worth bearing in mind that the U.S. tax code is incredibly intricate and complicated. More specifics on the current code can be found at the Internal Revenue Service (IRS) website.

i Current U.S. Worldwide System

The specifics surrounding the current U.S. system are as follows. The basic idea is that a firm incorporated in the U.S. will eventually pay 35% on any income it earns, regardless of where it is made. If a U.S. firm earns \$1 of income in a foreign country, it will owe taxes to two different governments — that which resides over the country in which the income was earned and the U.S. Government. If we denote the domestic corporate tax rate in the foreign country by τ^F, then the firm will owe $\$\tau^F$ to the foreign government. Then the amount $\$(0.35 - \tau^F)$ will be owed to the U.S. Government, thereby making the total tax burden \$0.35 out of the original \$1.

In terms of the timing of the tax revenue collection by the U.S. Government, all foreign income that falls under the category of *Subpart F* is taxable in the year in which it is earned. In various outlets, this type of income is referred to as *passive income* due to the nature of the activities, which it broadly comprises. IRS (2014) states that Subpart F income is generally income that is movable. For example — investment income such as dividends, rents, interest and royalties. Income that does not fall under the Subpart F category, which is commonly referred to as *active income*, is such that payment of taxes to the U.S. Government is deferrable until repatriation. That is — until active earnings are distributed as a dividend from the foreign subsidiary to the U.S. parent, taxes are not required to be paid to the U.S. Government. For this reason, this tax on overseas earnings is colloquially referred to in the media as a *repatriation tax*.

	2000	**2002**	**2004**	**2006**	**2008**	**2010**
Passive Income/ Total Income	0.121	0.125	0.108	0.102	0.094	0.088

Table 2: Passive income as a fraction of total foreign income

Table 2 gives an idea as to how much of reported foreign earnings by U.S. multinationals comes under the Subpart F category over the period 2000 – 2010 for foreign subsidiaries, which are majority-owned by U.S. shareholders. The fraction of these earnings has generally been small and in decline over this period — falling from around 12% in 2000 down to 8.8% in 2010. That is — the majority of earnings that U.S. multinationals make overseas are of the active type.

ii Recent Reform Proposals

The U.S. Committee on Ways and Means is the body responsible for tax change proposals put before congress. In recent years, the some of committee's recommendations have related directly to reform to the international tax code. In 2014, when the Committee was chaired by Congressman Dave Camp, it recommended maintaining the worldwide structure of the current system, but with rates that are considerably reduced. Some of the aspects of the proposal were:

- All active earnings currently held abroad as cash would be taxed once-off at a rate of 8.75%,
- Active earnings held abroad in outlets other than cash would be taxed a rate of 3.5%,
- Future active earnings will be taxed at a flat rate of 5%,
- Reduce the corporate tax rate from 35% to 25%,
- The setup would generally remain the same for the tax treatment of passive income as in the current system,
- The scope of passive income would be increased to include more types of intangible income.

A more recent proposal by the Committee in early 2016, headed by Congressman Kevin Brady, put forth another set of potential reforms that moved closer towards a territorial system. The specifics of the policy were

- Reduce corporate taxes to a flat rate of 20%,
- Provide a 100% exemption of all future foreign earnings from U.S. taxation,
- Foreign earnings currently held abroad by U.S. multinationals can be repatriated at a one-time tax of 8.75%.

The reasons underlying the 2014 and 2016 reform proposals were broadly similar — to increase the competitiveness of U.S. multinationals and to simplify an increasingly complex tax code. Although these proposals have not been passed by congress at this point, they illustrate that moving towards a territoriality appears to be the future direction of U.S. policymakers.

The stylised territorial system I will consider in the counterfactual policy experiment will closely resemble aforementioned 2016 reform proposal. In this iteration of the paper, I contrast the current worldwide system against an alternative where all future overseas earnings will be exampt of taxes by the U.S. Government. Moreover, to keep things simple at this stage, I will assume that the overseas earnings that these firms currently have saved overseas can be repatriated without triggering taxes. Future versions of the paper will consider the 8.75% rate levied on the earnings currently held abroad put forth by the proposal. I will also conduct a tax revenue-neutral experiment, aimed isolating the effect of exempting the overseas earnings from taxation.

III Data Facts on U.S. Multinationals

This section provides details from those data, which are pertinent to the firm dynamics and capital structure of U.S. multinational companies. I draw on two sources of data for this purpose — Compustat and the statistical tables from the BEA website on the activities of multinational corporations. The Compustat data I use are reported on an annual basis over the period 1980 – 2012. The data available from the BEA website span the period 1982 – 2015, which are reported annually.

Compustat contains a rich amount of firm-level information on North American firms, with information regarding their investment decisions and financial policy. To identify multinational corporations in the dataset, I appeal to the income statement item labelled "PIFO – Pretax Income Foreign". I define a multinational corporation to be a firm that has a reported value for this variable. I drop any firm whose country of incorporation is not the U.S., (if variable "FIC" is not equal to USA), so as to rule-out multinationals from other countries operating in the U.S. To complement these data, I make use of the statistical tables from the BEA website, as they provide an accurate picture of the interactions between subsidiary and parent firms. They provide information relating to the type of foreign income earned in addition to the amount repatriated in aggregate.

i Firm Dynamics

The focus of this section is the exit rates of firms in addition to the fraction of multinationals in the Compustat sample. Here I define the exit rate as the fraction of deletions relative to the number of all firms for a given year. I choose to define an exit in the data by looking

at the variable "DLRSN" in the Compustat sample. I include a deletion as an exit if the reason is given as bankruptcy (code 02) or liquidation (code 03). In what follows, details regarding the exit rates and how they evolve over the span of the dataset will be provided for multinational firms and the dataset as a whole separately.

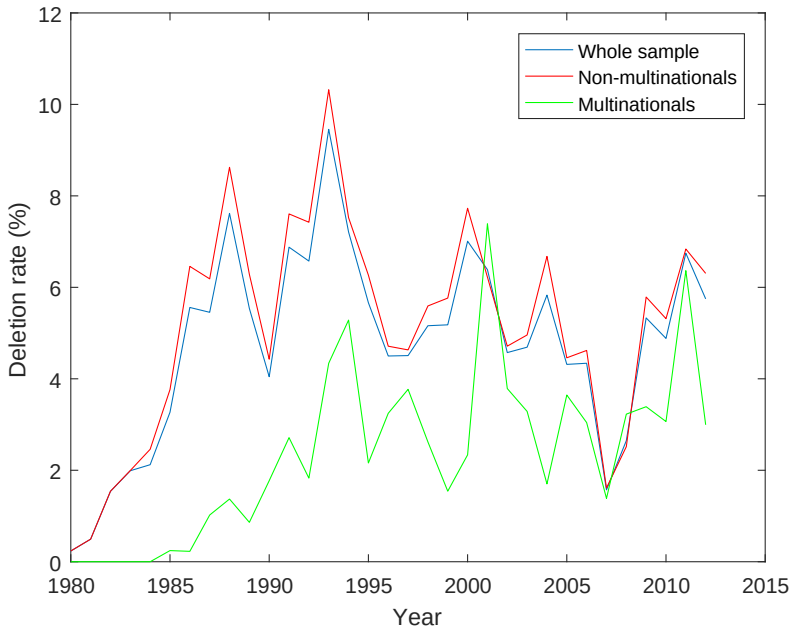

Figure 1: Deletion rates across Compustat firms.

Figure 1 displays the exit rates across time for the sample as a whole and for multinationals and non-multinationals separately. The average exit rate for multinational firms across all sample years is 2.39% in contrast with 5.14% for all firms in the sample. Looking at the figure, the exit rates exhibit considerable volatility and are cyclical in nature. For the years 1980 – 1984, the exit rate was zero for multinational firms; it rose to 0.02% in 1985. From there onwards, the rate for multinationals cycles up and down reaching maxima of 6.36% in 2011. The exit rate for non-multinationals tends to be higher than that of the sample as a whole for most years; with a maximum rate of 10.32% being reached in 1993. The exit rate as a whole is below 2% until the year 1984. From there it rises and cycles between values as low as 1.57% (2007) and as high as 9.45% (1993).

Figures 2 gives an idea of the number of firms in the sample in addition to the number of multinationals. The total number of firms is hump-shaped over the sample period — it

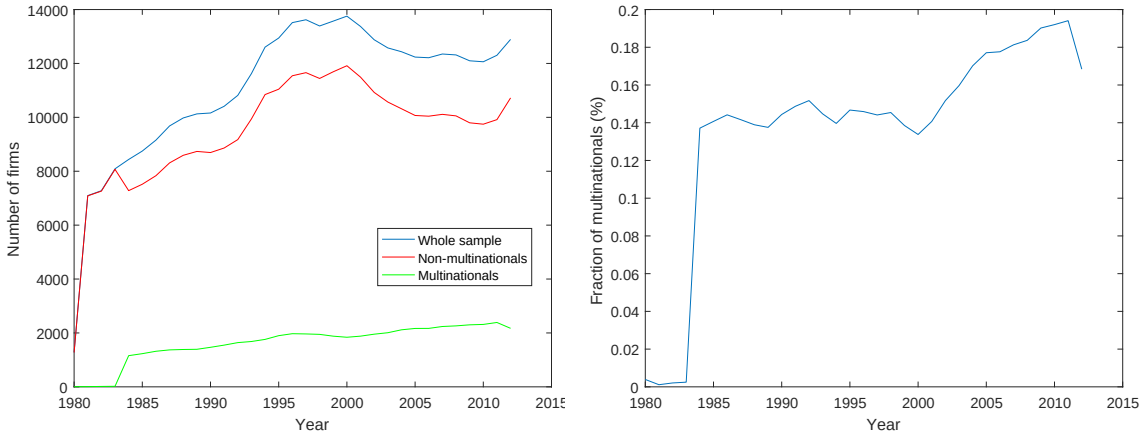

Figure 2: Number of firms and fraction of multinationals in Compustat sample.

starts at 1,280 in 1980; it gradually rises over time to reach a maximum of 13,775 in 2000; it decreases subsequently to finish at 12,895 in 2012. In contrast, the number of multinationals in the sample appears to increase somewhat monotonically from the start of the sample period. The dataset begins with 5 multinationals in 1980, rising to 1,467 in 1990, 1,840 in 2000 and 2,316 in 2010. When re-expressed as a percentage of the total number of firms in the dataset, the fraction of multinationals starts close to zero in 1980 and rises to reach a figure around 20% by 2012. A sudden spike in the number of multinationals appears in 1984, which could potentially be related to reporting issues with regard to foreign income in the years prior. Overall these figures seem to suggest that over time it has become more profitable for U.S. firms to expand their operations overseas. This should agree with intuition in the wake of lower communications and transport costs in recent decades.

ii Capital Structure and Earnings

In examining the capital structure of U.S. multinationals, this section again draws on the Compustat dataset; the summary statistics are provided in table 3. The table provides the mean, median and standard deviations of the variables under consideration. These summary statistics are reported separately for multinational firms only and for non-multinational firms only. In the table, the data are cleaned by dropping the top and bottom 1% of observations so as to remove outliers.

The net debt/assets variable refers to the ratio of debt less cash divided by the book

Multinationals			
Variable	**Mean**	**Median**	**Std. dev.**
Net debt/Assets	12.84%	12.17%	0.29
Pretax income/Assets	2.23%	5.18%	0.17
Foreign pretax income/ Assets	1.58%	0.89%	0.04
Net equity issuance/Assets	0.20%	-0.02%	0.09
Capex/Assets	5.09%	3.78%	0.05
Non-multinationals			
Variable	**Mean**	**Median**	**Std. dev.**
Net debt/Assets	20.62%	16.40%	0.45
Pretax income/Assets	-15.33%	1.69%	0.70
Foreign pretax income/ Assets	N/A	N/A	N/A
Net equity issuance/Assets	7.41%	0.00%	0.24
Capex/Assets	6.01%	3.56%	0.08

Table 3: Compustat data on U.S. firms.

value of assets, which is designed to capture leverage. The mean level of leverage is considerably higher for non-multinationals than multinationals, with values of 20.62% and 12.84% respectively. This difference likely captures the fact that multinationals are likely to have larger pools of internal funds available to finance investment and payout policies. Given that issuing equity is expensive relative to debt or internal funds, non-multinationals instead rely on high leverage. The spread in the data is also larger for non-multinationals with a standard deviation of 0.45, in contrast with 0.29 for multinationals.

A stark contrast is drawn between the pre-tax income/assets ratio of multinationals and non-multinationals — the mean ratio is 2.23% for the former, as opposed to -15.33% for the latter. In particular, it may be a reflection of the hypothesis put forth and modelled in Melitz, Helpman & Yeaple (2003) that the most productive firms are the ones that become multinationals. As a result, we see that using both the mean and median as measures, multinational firms are able to make better use of the assets they have available in terms of generating income. The difference in the median measure is considerably smaller. The distribution over pretax foreign income to assets is centred about 1.58% coupled with a tight spread of 0.04 standard deviation for multinationals.

In terms of payout policy, the table reports the ratio of net equity issuance to assets.

This measure of net equity issuance is defined as the value of new equity issued less dividends less the value of share repurchases. The mean multinational ratio is slightly positive at 0.20%, while the median measure of -0.02% indicates a net dividend payment at the 50^{th} percentile. The scenario for non-multinationals is quite different, with a large spread of standard deviation 0.24, coupled with a relatively large average issuance to assets ratio of 7.41%. The median non-multinational issuance is zero. This contrast in values likely picks-up on the fact that multinationals are more likely to pay dividends in a given period than a non-multinational.

Finally the mean level of capital expenditure to assets for multinationals is 5.09%, relative to 6.01% for non-multinationals. This difference is likely a result of multinationals being larger in size and more mature in their operations, thereby reducing the need to undertake large capital expansions as a fraction of their existent asset level.

iii Repatriations

Figure 3 presents information regarding repatriations of U.S. multinationals given by the BEA dataset. The figure presents repatriations by CFCs in both nominal and real terms, where the base year for the real series is 1982. These data are taken from table 4.2 line 3 of the BEA's dataset on International Transactions, International Services, and International Investment Position.

From 1982 – 2004, real repatriations were relatively stable at values ranging between \$15 – \$36b. A dramatic spike occurs in 2005, where repatriations rose by a factor of 3.5 in real terms over the previous year to \$148b. The spike in 2005 coincides perfectly with the Homeland Investment Act mentioned in section I. This Act is known colloquially as the "One Time Repatriation Tax Holiday" as it mandated that, throughout the year 2005, U.S. firms could repatriate their overseas earnings at a reduced tax rate of 5.25%. This observed spike in repatriations is likely a direct consequence of the Act given the sharp drop in repatriations in the year subsequent down to \$48b in real terms.

Interestingly, another upward trend in aggregate repatriations appears in the years following the HIA. Following the decline in the series in 2006, repatriations rise in the following two years to reach a peak of \$78 in 2008 in real terms. These years coincide with the height of the GFC. One hypothesis that could arise from this observation is that U.S. firms, faced with higher domestic financing costs, turned to their saved overseas earnings as a relatively cheaper source of financing. In spite of the taxes they would have paid upon

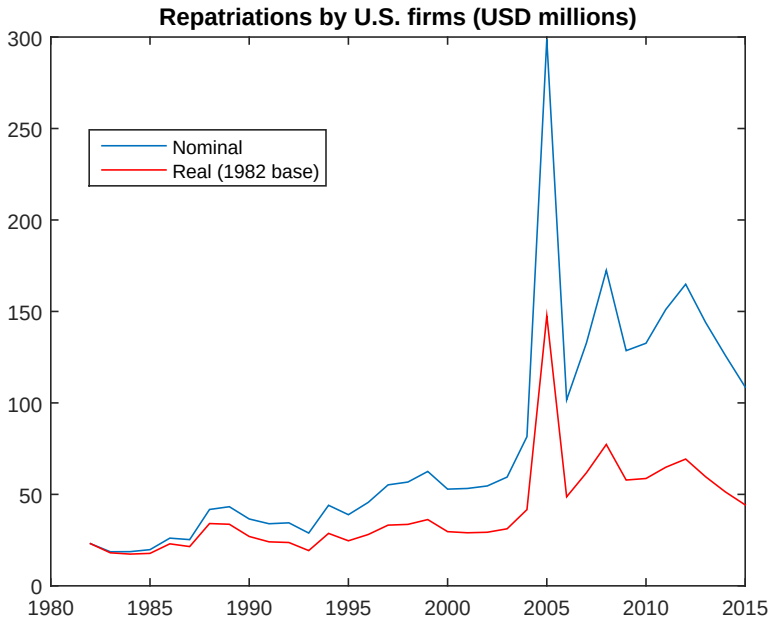

Figure 3: Earnings repatriations by U.S. firms.

repatriation, utilising these funds may have been dominant over issuing debt or equity financing. This idea may be supported by the fact that the series drops-off in 2009 through 2015. Testing this hypothesis would ultimately be an empirical question, which is beyond the scope of this paper and is as such left as an avenue for future research.

iv Location of Foreign Operations

Again utilising the BEA dataset, this section briefly examines the geographical areas where U.S. multinationals mostly operate. These data were taken from the Direct Investment and MNEs tables from the BEA. Looking at this aspect of the data will have implications for deciding upon the appropriate foreign tax rate to calibrate in the structural model in the coming sections.

The main variable used to gauge the firms' operations in this section is their net income. Figure 4 presents a breakdown of the aggregate overseas net income earned by U.S. multinationals over the period 2000 – 2013 into the regions of Canada, Europe, Latin America, Africa, Middle East and Asia/Pacific.

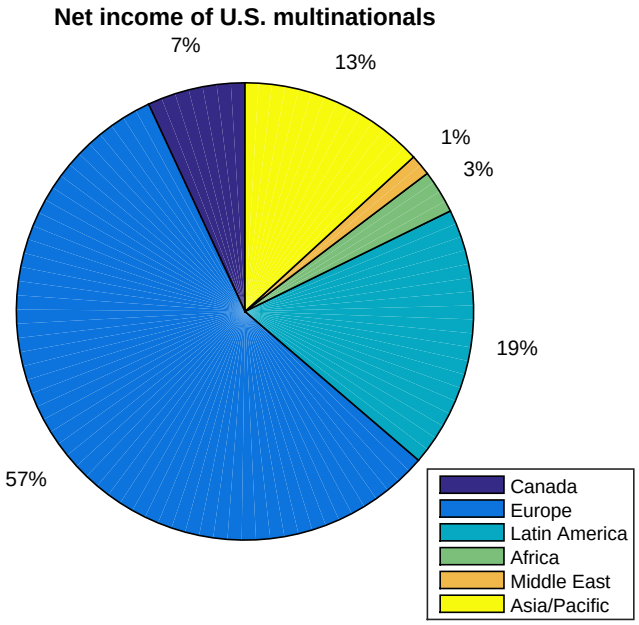

Figure 4: Location of U.S. multinational operations.

The chart shows that over the sample period, the majority of the overseas net income made by these multinationals was earned in Europe (57%). Following this, Latin America and Canada are placed at 19% and 7% respectively. Asia/Pacific, Africa and the Middle East then follow at 13%, 3% and 1% respectively.

IV Two Period Model for Intuition

The purpose of this section is to develop a simple, two period model to illustrate one of the main channels, through which the policy change affects the firm decision problem and in turn government tax collections.

i Firm Problem and Solution

In particular, this explores the effect on extensive-margin overseas investment by U.S. firms. This simple model has time periods $t \in \{0, 1\}$ and two countries — Home (H) and Foreign (F). The setting is of partial equilibrium and is from the perspective of firms

incorporated in the Home Country. Firms' objectives are standard — to maximise the present expected value of dividends to shareholders net of taxes, (which I assume are all in the Home Country).

The governments in each country tax earnings at a rate τ^c for $c \in \{H, F\}$ where I assume that $\tau^F < \tau^H$ to capture the idea that the U.S. has tax rates that are higher than all other OECD nations. In addition to taxing Home earnings, the Home Government also taxes dividends at rate τ^e and repatriated overseas earnings at $\tau^{H,R}$.

Firms in the model choose at time $t = 0$ whether to operate as a non-multinational, (with a branch in the Home Country only), a multinational, (a branch in both countries) or to not operate. Each country that the firm elects to operate in requires payment of a fixed cost, x^c for $c \in \{H, F\}$. There is firm-level heterogeneity along the dimension of productivities, θ, which enter into their production function, which is given as follows

$$f(\theta, k^c) = \theta(k^c)^\alpha$$

where k^c is capital the firm holds in country $c \in \{H, F\}$ and $0 < \alpha < 1$. I assume that these idiosyncratic productivity levels are known to the firms at time $t = 0$. There is assumed to be a unit mass of firms, which follow a distribution over θ, given by a continuous $F(\theta)$ over the interval $[\underline{\theta}, \bar{\theta}]$. I assume these productivities are deterministic as it allows me to abstract from thinking about differential productivity expectations across firms, which keeps notation simple. However this assumption is relatively innocuous and almost without loss of generality, as one could instead think of the deterministic draw as an expectation, which could vary across firms through this function F.

I assume that firms rent their capital stocks in each country of operation at some rate r, which I assume for simplicity is the same in each country. In effect, this reduces the firm's intensive-margin input decision boils-down to an entirely static problem. I make this assumption rather than having firms invest in capital at $t = 0$ to keep the decision problem tractable. When a firm with productivity θ makes its discrete choice at $t = 0$, its objective is as follows

$$V_0(\theta) = \max_{\{X,NM,M\}} [V_0^X(\theta), V_0^{NM}(\theta), V_0^M(\theta)],$$

where $V_0(\theta)$ is the optimal value to the firm's shareholders at $t = 0$. The abbreviation X stands for exit, (choose not to operate), NM stands for being a non-multinational and M

for being a multinational. If the firm chooses to exit the industry, their value is given by

$$V_0^X(\theta) = 0.$$

If instead, the firm chooses to operate as a non-multinational, their value is given by

$$V_0^{NM}(\theta) = (-x^H) + \beta(1-\tau^e)\left[(1-\tau^H)\{\theta(k^H)^\alpha - rk^H\}\right]$$

where at $t = 0$, the firm raises equity from its shareholders in the amount of (x^H). It then returns a dividend net of taxes at $t = 1$ from the earnings generated by its Home branch. At $t = 0$, the shareholders discount this future dividend payment at rate $\beta \in [0, 1]$. Finally, if the firm chooses to be a multinational, it's value is given by

$$\begin{aligned} V_0^M(\theta) = (-x^H) + \beta(1-\tau^e)\left[(1-\tau^H)\{\theta(k^H)^\alpha - rk^H\}\right] + \\ (-x^F) + \beta(1-\tau^e)\left[(1-\tau^{H,R}-\tau^F)\{\theta(k^F)^\alpha - rk^F\}\right] \end{aligned}$$

where the reader should notice that the earnings from the branch in the Foreign Country are taxed at two rates — τ^F and $\tau^{H,R}$. The interpretation is that the firm pays taxes to the Foreign Government at the time the earnings are generated, then upon repatriation, the Home Government taxes at the rate $\tau^{H,R}$. Notice also that the firm will always optimally repatriate all of its overseas earnings at the end of $t = 1$ to pay as a dividend.

Conditional upon opening a branch in country i, notice that the firm's optimal choice of capital is given by

$$k^c = \left(\frac{\theta\alpha}{r}\right)^{\frac{1}{1-\alpha}}. \tag{1}$$

Notice that the solution given in equation (1) is independent of all the tax rates in the problem. The intuition follows from two aspects of the problem: firstly the capital rental decision is a static problem and secondly that the rental cost is an expense, which serves to reduce the firm's taxable earnings. Bearing equation (1) in mind, the value to operating as a non-multinational and multinational conditional on θ can be written respectively as

$$\begin{aligned} V_0^{NM}(\theta) &= (-x^H) + \beta(1-\tau^e)(1-\tau^H)\Omega(\theta)^{\frac{1}{1-\alpha}} \\ V_0^{M}(\theta) &= (-x^H) + (-x^F) + \beta(1-\tau^e)\left[(1-\tau^H) + (1-\tau^{H,R}-\tau^F)\right]\Omega(\theta)^{\frac{1}{1-\alpha}} \end{aligned} \tag{2}$$

where $\Omega \equiv (\frac{\alpha}{r})^{\frac{\alpha}{1-\alpha}} - r\left(\frac{\alpha}{r}\right)^{\frac{1}{1-\alpha}}$ is defined for notational ease. Notice that $\Omega > 0$ always for $\alpha < 1$ as assumed above. At this point, some intuition can be gained with regard to how the U.S. switching to a territorial system will affect the firm decision problem from studying equation (2). Notice that under the current U.S. worldwide system of taxation, $\tau^{H,R} = \tau^H - \tau^F$. In this scenario, the value for being a multinational, denoted $V_0^{M,WW}(\theta)$, boils-down to

$$V_0^{M,WW}(\theta) = (-x^H) + (-x^F) + 2\beta(1-\tau^e)(1-\tau^H)\Omega(\theta)^{\frac{1}{1-\alpha}}, \tag{3}$$

which shows that the firm's earnings will be taxed a rate of τ^H in both branches should it operate as a multinational. This contrasts against a territorial system where $\tau^{H,R} = 0$. In this scenario, the value to being a multinational $V_0^{M,T}(\theta)$, is given by

$$V_0^{M,T}(\theta) = (-x^H) + (-x^F) + \beta(1-\tau^e)\left[(1-\tau^H) + (1-\tau^F)\right]\Omega(\theta)^{\frac{1}{1-\alpha}} \tag{4}$$

where now the earnings the firm generates in the Foreign Country are taxed at a lower rate than those made in the Home Country. Notice then that by comparing equations (3) and (4), that $V_0^{M,T}(\theta) > V_0^{M,WW}(\theta)$ given $\tau^F < \tau^H$, meaning that for a fixed θ, the value to being a multinational firm is higher under the territorial system. The implication is that, regardless of the firm's discrete choice under the worldwide and territorial systems, the value associated with being a multinational increases. It is ambiguous however whether or not the policy change will affect the firm's discrete choice — it depends on θ in addition to the parameters of the problem.

In making its discrete choice, a firm with productivity θ will compare all three options — $V_0^X(\theta), V_0^{NM}(\theta), V_0^M(\theta)$ — and choose the option, which delivers the highest value to shareholders. Table 4 characterises the three possible choices and the conditions, which need to hold relating θ and the other parameters for the corresponding choices to be optimal. The table gives conditions on the productivity parameter θ, under which each of the three choices are optimal.

Table 4 gives conditions for the optimal discrete choice at a firm-level contingent on θ. The solution with regard to the whole distribution of firms over $\theta \in [\underline{\theta}, \bar{\theta}]$ is easiest understood graphically. Figures 5 and 6 depict the interval of possible productivity values and show regions, over which firms make a given discrete choice. Notice that the cut-off productivity levels over the intervals depend on the parameters of the model, in addition

$V_0(\theta)$	**Condition 1**	**Condition 2**
$V^X(\theta)$	$\theta < \left\{ \frac{x^H}{\beta(1-\tau^e)(1-\tau^H)\Omega} \right\}^{1-\alpha}$ $(V^{NM}(\theta) < V^X(\theta))$	$\theta < \left\{ \frac{x^H+x^F}{\beta(1-\tau^e)[(1-\tau^H)+(1-\tau^{H,R}-\tau^F)]\Omega} \right\}^{1-\alpha}$ $(V^M(\theta) < V^X(\theta))$
$V^{NM}(\theta)$	$\theta > \left\{ \frac{x^H}{\beta(1-\tau^e)(1-\tau^H)\Omega} \right\}^{1-\alpha}$ $(V^{NM}(\theta) > V^X(\theta))$	$\theta < \left\{ \frac{x^F}{\beta(1-\tau^e)(1-\tau^{H,R}-\tau^F)\Omega} \right\}^{1-\alpha}$ $(V^M(\theta) < V^{NM}(\theta))$
$V^M(\theta)$	$\theta > \left\{ \frac{x^H+x^F}{\beta(1-\tau^e)[(1-\tau^H)+(1-\tau^{H,R}-\tau^F)]\Omega} \right\}^{1-\alpha}$ $(V^M(\theta) > V^X(\theta))$	$\theta > \left\{ \frac{x^F}{\beta(1-\tau^e)(1-\tau^{H,R}-\tau^F)\Omega} \right\}^{1-\alpha}$ $(V^M(\theta) > V^{NM}(\theta))$

Table 4: Conditions on θ summarising when each discrete choice is optimal.

to the tax rates, $\vec{\tau} = (\tau^H, \tau^F, \tau^{H,R}, \tau^e)$.

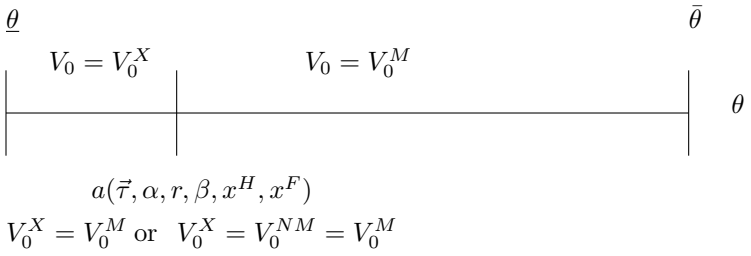

Figure 5: General solution over productivity with single cut-off.

In the case of figure 5, there is a single cut-off productivity level, to the left of which firms opt to not produce and to the right of which firms choose to be multinationals. At the cut-off in figure 5, the firm may be indifferent between being a multinational and not producing, or they may be indifferent between all three options. In contrast, figure 6 shows a situation where there are two cut-offs. The first divides the regions of choosing not to produce and being a non-multinational and the second divides those of being a non-multinational and a multinational.

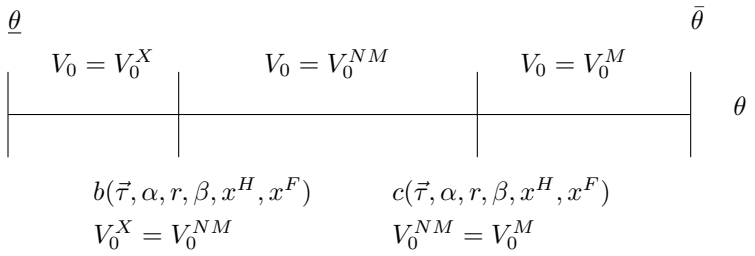

Figure 6: General solution over productivity with two cut-offs.

Intuitively, the factor, which determines whether the solution for a given set of parameters looks like that in figure 5 or figure 6 is the fixed cost of producing in the Foreign branch relative to that at Home. That is — if x^F/x^H is very small, it is relatively inexpensive for the firm to establish a subsidiary in Foreign in contrast with Home. If this ratio of fixed costs is sufficiently small, the solution will look as in figure 5: firms with very low productivities will find it optimal not to produce and those with higher productivities will find it optimal to be multinationals. Under this scenario, the measure of firms operating as non-multinationals will be zero given the high return to be had from investing in the Foreign subsidiary.

When the ratio of x^F/x^H is relatively high, the solution in figure 6 can resemble the solution. The idea is that firms with intermediate productivity levels will be able to justify the fixed outlay of x^H, but the earnings generated in the Foreign branch would be insufficient in present value terms to cover the outlay of x^F.

ii Effect of Policy Change on Extensive Margin Investment

In this subsection, I depict the solution for a particular case with regard to the ratio of x^F/x^H — namely that $x^F/x^H > (1-\tau^F)/(1-\tau^H)$ under the worldwide and territorial alternatives.[1] There are five cases in total that need to be considered to fully characterise the solution to this problem; the remaining four are deferred to the appendix.

[1] I consider this case for the fixed costs as it proves to be the scenario in the calibrated dynamic model discussed in section VII.

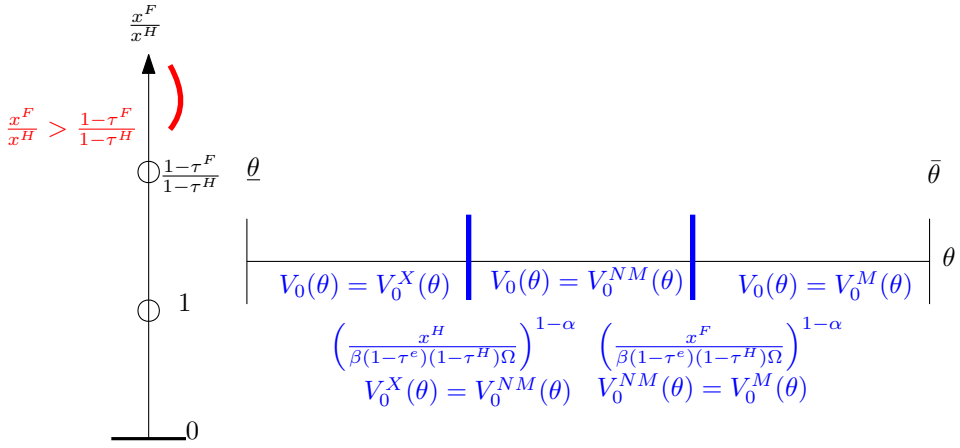

Figure 7: Solution under worldwide system for $x^F/x^H > (1-\tau^F)/(1-\tau^H)$.

Figure 7 shows the solution under the worldwide system with x^F/x^H over the range $x^F/x^H > (1-\tau^F)/(1-\tau^H)$ and figure 8 contrasts this against the solution under the territorial alternative. Notice that, under both alternatives, the ratio of fixed costs is sufficiently high such that there exist two cut-off productivity levels along the interval. The implication is that, assuming there is a positive density of productivities along the whole interval, there will exist a non-zero fraction of firms operating as non-multinationals both before and after the policy change.

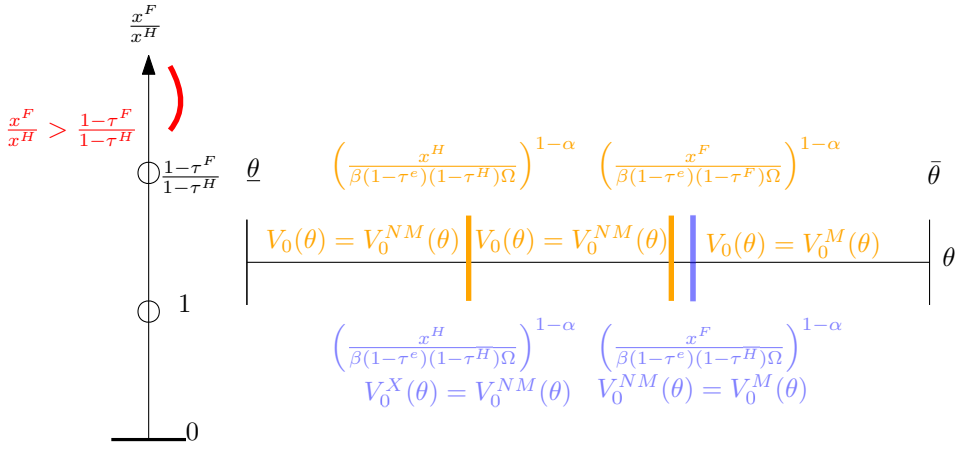

Figure 8: Solution under territorial system for $x^F/x^H > (1-\tau^F)/(1-\tau^H)$.

In moving from the worldwide system to the territorial alternative, the upper cut-off

productivity level shifts strictly to the left on the interval, while the lower cut-off remains the same. Recall that the firms who lie to the left of the lower cut-off point choose to not produce, $V_0^X(\theta)$, given their low productivity. Moving to the territorial system leaves these firms unaffected as their decision was between not producing and being a non-multinational. A higher net tax level of earnings from a potential Foreign branch doesn't affect their decision as x^F is still to high to justify overseas operations.

In contrast, firms with intermediate levels of productivity, which were slightly below the upper cut-off under the worldwide system may now find it optimal to operate as multinationals under the territorial system. The reduction in losses to taxes on Foreign earnings results in a rise the value to operating with a Foreign branch, which can outweigh the extra initial outlay of x^F for firms over the range $\left[\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^H)\Omega}\right)^{\frac{1}{1-\alpha}}, \left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^F)\Omega}\right)^{\frac{1}{1-\alpha}}\right]$. Consequently, under this scenario for the fixed costs, a fraction $F\left(\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^F)\Omega}\right)^{\frac{1}{1-\alpha}}\right) - F\left(\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^H)\Omega}\right)^{\frac{1}{1-\alpha}}\right)$ of firms will switch from being non-multinationals under the worldwide system to multinationals under the territorial system. The extent to this rise in investment at the extensive margin naturally depends on how far x^F is from x^H, in addition to the tax rates and the density of firms across productivities, as captured by F.

iii Effect of Policy Change on Home Tax Collections

Again in this subsection, I will consider the effect of the tax policy change in the case where $x^F/x^H > (1-\tau^F)/(1-\tau^H)$. This policy change has the potential to increase or decrease tax collections by the Home Government depending on the parameters of the problem. The basic trade-off is that tax collections are lost on repatriations, while taxes are gained on higher dividends attributable to more firms operating as multinationals. Formally, the expression for lost repatriation taxes to the Home Government is given by

$$(\tau^H - \tau^F) \int_{\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^F)\Omega}\right)^{\frac{1}{1-\alpha}}}^{\bar{\theta}} \Omega\theta^{\frac{1}{1-\alpha}} dF(\theta).. \tag{5}$$

The difference of tax terms in equation (5), $(\tau^H - \tau^F)$, is equal to the repatriation tax under the worldwide system. The integral represents the total amount of earnings generated by the firms, who were multinationals under the worldwide system, in their Foreign branches. Notice also that the lower-limit of the integral is the upper cut-off point under the worldwide

solution. The expression for the tax revenues that are gained by the Home Government is given by

$$\tau^e \int_{\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^H)\Omega}\right)^{\frac{1}{1-\alpha}}}^{\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^F)\Omega}\right)^{\frac{1}{1-\alpha}}} (1-\tau^F)\Omega\theta^{\frac{1}{1-\alpha}}\,dF(\theta) + \tau^e(\tau^H-\tau^F)\int_{\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^F)\Omega}\right)^{\frac{1}{1-\alpha}}}^{\bar{\theta}} \Omega\theta^{\frac{1}{1-\alpha}}\,dF(\theta). \tag{6}$$

Notice the second expression in equation (6): this represents the increased dividend taxes collected on firms that were already multinationals prior to the policy change. The idea is that, what these firms are no longer paying to the Home Government as repatriation taxes, they are now paying-out as dividends to shareholders, which the Government taxes at the rate τ^e. The first term in the equation, represents dividend tax collections on firms that switch to being multinationals under the territorial system. They each generate new earnings in their Foreign branch, which are taxed by the Foreign Government at the rate τ^F. Then when the earnings are paid-put to the shareholders, the Home Government collects dividend taxes.

The question as to whether this policy change increases or decreases tax collections by the Home Government, in the context of this simple model, is determined by comparing the losses in equation (5) to the gains in (6). The ultimate determining factor will be what fraction of firms switch to becoming multinationals, which motivates the need for a carefully calibrated model to answer this empirical question.

iv Effect of Policy Change on Capital Structure

Finally, I turn to see what insights can be gained from this simple 2 period model with regard to financing of firms in the Home Country at $t = 0$. Again, I focus on the case with $x^F/x^H > (1-\tau^F)/(1-\tau^H)$. As noted in the previous subsections, moving to the territorial regime will lead to a fraction of firms with intermediate productivities switching to become multinationals. See that the model predicts that equity issuance, on account of

these switching firms, will increase at $t = 0$ by

$$x^F \int_{\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^H)\Omega}\right)^{\frac{1}{1-\alpha}}}^{\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^F)\Omega}\right)^{\frac{1}{1-\alpha}}} dF(\theta) =$$
$$x^F \left[F\left(\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^F)\Omega} \right)^{\frac{1}{1-\alpha}} \right) - F\left(\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^H)\Omega} \right)^{\frac{1}{1-\alpha}} \right) \right],$$

which will be positive assuming that the mass of firms upgrading to become multinationals is greater than zero. This result captures the idea that, under the territorial regime, more firms operating as multinationals ultimately means that more external financing will need to be raised in the aggregate. However to properly characterise the effect on capital structure, a model is needed with dynamics, which disentangles issuance of debt and equity financing.

V Structural Model Environment

The model closely follows the setup of Gomes (2001), while also borrowing several aspects from Helpman, Melitz and Yeaple (2003). Heterogeneity in the model originates from firms receiving differential productivity draws in each period. There is only uncertainty at the idiosyncratic level; not at the aggregate. In each period, firms make investment decisions at the intensive and extensive margins. I consider firm entry and exit into the industry under consideration. The behaviour of households and government are taken as exogenous in this model — they are not explicitly modelled for the purpose of simplicity.[2] The model is solved in a way similar to Hopenhayn (1992) such that industry equilibrium holds.

The model setup is such that there are two countries — Home and Foreign. For the purpose of simplicity, I abstract from thinking about exchange rate movements and assume that the conversion rate from Home to Foreign currency is 1:1. I study the behaviour of firms, which are incorporated in the Home country. At the extensive margin, firms decide in each period whether to exit from the industry, operate as a non-multinational firm or to whether to function as a multinational. A non-multinational in this context is defined as a firm, which has a branch in the Home country and no operations in the Foreign country. A

[2]Including households in the model is left as a potentially interesting avenue of future research. Making these additions to the model will enable us to explore the effects of the tax policy change on household welfare and domestic employment.

multinational is defined as a firm with both a Home parent and a subsidiary in the Foreign country.

At the intensive margin, firms will choose investment in capital stocks, which are held in each country in which they operate. In addition they will choose how much of their Foreign earnings to repatriate back to the parent company, what amount of funds to send from the parent to the subsidiary, how much to pay to investors as dividends and how much to take-out in debt.

i Technology

Firms in this model are assumed to behave competitively; the good they produce is homogeneous.[3] In what follows, time is indexed by subscript t, while variables corresponding to country $c \in \{H, F\}$ are given a superscript c where H denotes the Home country and F denotes Foreign. I omit notation at the firm level for notational ease. The production function they for output in a given country has one input — the capital stock — which is specific to each country with decreasing returns to scale as follows[4]

$$y_t^c = \theta_t (k_t^c)^\alpha, \;\; 0 < \alpha < 1 \tag{7}$$

where y_t^c is firm output in country c, k_t^c is the capital stock in country c and θ_t is an idiosyncratic productivity shock. Notice that the productivity shock has no country superscript — I assume it is the same in each country for simplicity in keeping the size of the state space small. The productivity shock is assumed to be lognormally distributed

$$\log(\theta_t) = \rho \log(\theta_{t-1}) + \sigma \epsilon_t, \;\; \epsilon_t \sim N(0, 1) \tag{8}$$

where $0 < \rho < 1$ captures persistence in the shock process while $\sigma > 0$ 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 stock is given by

$$k_{t+1}^c = i_t^c - (1 - \delta) k_t^c \tag{9}$$

[3] Extending this model to the case of differentiated products with monopolistic competition is again another direction for future research. Moreover this seems like a more realistic modelling assumption in this context than perfect competition — as many multinational firms produce inherently unique products.

[4] It is obviously important to think about complementarities between the Home and Foreign capital stocks when analysing multinational firms. Getting the specification correct is difficult and can become arbitrary though. As a result, I don't consider such an interaction in this version of the paper.

where i_t^c denotes investment at time t in country c and $0 < \delta < 1$ represents the common depreciation rate. Firms pay an adjustment cost for changing the capital stock in each country

$$\Phi^i(i_t^c, k_t^c) = \frac{\phi}{2}\left(\frac{i_t^c}{k_t^c}\right)^2 k_t^c, \tag{10}$$

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

ii Firm Objective Function

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

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t (1 - \mathbb{1}_{d_t \geq 0} \tau^e) d_t \tag{11}$$

where $0 < \beta < 1$ represents the discount factor of the firm, d_t is the period t dividend it pays and τ^e is the personal tax on dividends paid to the Home Government. The equity issuance premium is modelled as in Gomes (2001) such that the dividend cash flow from the firm to shareholders is given by

$$d_t = e_t - \mathbb{1}_{e_t < 0}[\eta(e_t)] \tag{12}$$

where e_t is the dividend to households prior to the payment of equity issuance costs and $\eta(e_t)$ is a convex function of the pre-cost dividend. If e_t is negative — denoting a seasoned equity issuance — then the firm will pay some issuance cost. The issuance cost is of the form

$$\eta(e_t) = \eta |e_t|, \tag{13}$$

which says that the equity issuance premium is comprised of a cost proportional to the size of the issuance. One can think of the cost as capturing factors such as floatation fees paid to underwriters in addition to information asymmetries.

iii Borrowing

Firms are able to borrow riskless collateralised debt in each period in the Home country. I abstract from borrowings in the Foreign country for the purposes of simplicity. I consider the assumption regarding the debt being riskless to be relatively innocuous from the perspective that I explicitly model the behaviour of multinational firms in the model. It seems reasonable to think that the debt of multinationals is relatively close to riskless. To support this idea, the credit ratings of the 20 largest U.S. multinationals are presented in table 5: notice that most of these firms have relatively high-quality credit ratings from all three of the major ratings agencies.

The collateral constraint for borrowings follows Hennessy and Whited (2005). Specifically, I allow for firms to borrow up to some fire-sale value of their capital stocks for next period

$$b_{t+1} \leq \xi^H k_{t+1}^H + \xi^F k_{t+1}^F \tag{14}$$

where b_{t+1} represents net debt chosen in period t to be repaid at $t+1$. $0 < \xi^c < 1$ for $c \in \{H, F\}$ is the fire-sale value of the capital stock given in country c. The right-side of inequality (14) says that in the case that in the case that the cash flows of the firm are sufficiently low, the firm can liquidate its assets to repay its debt obligations.

The firm is able to borrow at the risk-free rate in the Home economy, denoted by r, which is assumed exogenous. Borrowings enter directly into the sources of funds for the Home parent company and are assumed to be bought at a discount. That is — firms choose the amount to pay-back in $t+1$, b_{t+1}, and will receive $b_{t+1}/(1+r)$ at period t. In addition, they will receive tax benefits associated with the interest payments in the subsequent period, totaling $b_{t+1}\left(1 - 1/(1+r)\right)\tau^H$.

iv Fixed Costs of Production and Firm Entry

Incumbent firms are assumed to pay a fixed cost of production in each country, in which it operates, as in Helpman, Melitz and Yeaple (2003). These costs are paid in each period. Production in the Home country requires payment of an amount x^H; the analogous cost from Foreign country operates is denoted by x^F. That is — a firm that operates as a non-multinational will incur a fixed cost of x^H only. In contrast, a multinational will pay x^H in addition to x^F.

Multinational	Moody's	S&P	Fitch
Berkshire Hathaway	Aa2	AA	AA-
JP Morgan Chase	A3	AAA	AAA
Wells Fargo	Aa1	A	AA-
Apple	Aa1	AA+	AAA
ExxonMobil	Aaa	AA+	–
Bank of America	Baa1	A	A
AT&T	Baa1	BBB+	A-
Citigroup	Baa1	BBB+	A
Verizon Communications	Baa1	BBB+	A-
Wal-Mart Stores	Aa2	AA	AA
Microsoft	Aaa	AAA	AA+
Alphabet	Aa2	AA	–
Chevron	Aa2	AA-	–
Johnson & Johnson	Aaa	AAA	AAA
Comcast	A3	A-	A-
Procter & Gamble	Aa3	AA-	–
Ford Motors	Baa2	BBB	BBB
IBM	Aa3	AA-	A+
UnitedHealth Group	A3	A+	A
General Motors	Ba1	BBB-	BBB-

Table 5: Credit ratings (long term debt) of 20 largest U.S. multinationals

The values of these parameters have a significant influence on the extensive margin decisions of firms. In particular — the amount of multinational firms relative to non-multinationals is a function of both the absolute level of each of these costs as well as their values relative to each other.

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^E. 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.

v International Allocation of Funds and Period Dividends

In each period, a 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

$$u_t = (1-\tau^F)P_t\theta_t(k_t^F)^\alpha - i_t^F + j_t - \Phi^F(i_t^F, k_t^F) \tag{15}$$

where P_t is the output price on output. 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, before the equity premium is paid, for the firm is given by

$$\begin{aligned} e_t \;=\; & \left[(1-\tau^H)P_t\theta_t^H(k_t^H)^\alpha - i_t^H - x^H - \Phi^H(i_t^H, k_t^H)\right] + \\ & \left[\left(\frac{1-\tau^{H,U}-\tau^F}{1-\tau^F}\right)u_t - j_t - x^F\right] + \left[\frac{b_{t+1}}{1+r} - b_t + b_t\left(1-\frac{1}{1+r}\right)\tau^H\right]. \end{aligned} \tag{16}$$

Again, notice that in equation (16), the price on Home earnings is assumed to be the same as on Foreign earnings in (15). The alternative specification would be to set one of the two Countries' earnings to be denoted in terms of the numerairé and to place a price on the other. Doing so, however, would create an additional distortion with regard to the marginal productivity of investing in Home relative to Foreign in excess of that already in place under the worldwide tax system. However, when it comes to pinning-down the mass of firms in the industry, I use only the Home output demand function, (see next section).

Taken together, equations (15) and (16) show that there are several sources and uses of funds for the firm. The sources are debt markets, equity markets, Home output income and repatriated Foreign output income. The firm can then use these funds for Home investment, Foreign investment and paying dividends to shareholders.

vi Home Output Demand

As stated in section V.v, there is assumed to be a price associated with earnings in the Home and Foreign Countries, P_t. For the purposes of attaining industry equilibrium, I specify a demand function to pin-down the mass of firms operating in the representative industry. Proceeding in this manner, I specify the behaviour of the households in the Home Country exogenously through the use of an output demand function of the following form

$$Q_t^{H,D} = \frac{1}{a^H P_t^H} \tag{17}$$

for some parameter $a^F > 0$.

vii Timing

Here the timing assumptions for both an incumbent firm and a potential entrant are listed. For an incumbent firm in period t the timing is as follows

(1) Enter the period with state $(k_t^H, k_t^F, b_t, \theta_{t-1})$.

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

(3) Make the extensive margin decision: either exit the industry, operate as a non-multinational or operate as a multinational.

(4) Produce in Home country **only** if non-multinational and produce in Home **and** Foreign countries if a multinational.

(5) Make the intensive margin decisions — choose the following variables:

$$(k_{t+1}^H, k_{t+1}^F, i_t^H, i_t^F, b_{t+1}, j_t, u_t, e_t, d_t). \tag{18}$$

Then for potential entrants, the timing is

(1) Pay a fixed cost to enter.

(2) Enter the period with no Home capital, Foreign capital, debt or productivity draw.

(3) Choose whether to operate as a non-multinational **or** a multinational.

(4) Choose the variables given in (18).

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.

VI Structural Model Equilibrium

Here I consider the stationary competitive equilibrium of the model.

i Incumbent Firm Problem Recursive Formulation

Denote the incumbent firm value function at period t by $V_t(k_t^H, k_t^F, \theta_t, b_t)$. We can then write it in the following form

$$V_t(k_t^H, k_t^F, \theta_t, b_t) = \max_{\{M,NM,X\}} \left[V_t^M(k_t^H, k_t^F, \theta_t, b_t), V_t^{NM}(k_t^H, k_t^F, \theta_t, b_t), V_t^X(k_t^H, k_t^F, \theta_t, b_t)\right] \tag{19}$$

where $V_t^M(k_t^H, k_t^F, \theta_t, b_t)$ denotes the value from operating as a multinational firm, $V_t^{NM}(k_t^H, k_t^F, \theta_t, b_t)$ is that from being a non-multinational and $V_t^X(k_t^H, k_t^F, \theta_t, b_t)$ is that from exiting the industry. The firm's solution to this extensive margin decision will be a cut-off productivity level, which will be a function of its other state variables. Specifically, there will be cut-off values $\widehat{\theta}^M(k_t^H, k_t^F, b_t)$ and $\widehat{\theta}^{NM}(k_t^H, k_t^F, b_t)$ such that if $\theta_t \geq \widehat{\theta}^M(k_t^H, k_t^F, b_t)$ then the firm will operate as a multinational and if $\widehat{\theta}^M(k_t^H, k_t^F, b_t) > \theta_t \geq \widehat{\theta}^{NM}(k_t^H, k_t^F, b_t)$ then it will be a non-multinational. Consequently, if $\theta_t < \widehat{\theta}^{NM}(k_t^H, k_t^F, b_t)$ then it will choose to exit the industry. The intuition is the same as in section IV: the most productive firms will be multinationals, those that have intermediate productivities will be non-multinationals and those who are very unproductive will exit. The only difference from the 2 period model is that these cutoffs will now depend on the current state variables of the firm.

If the firm chooses to exit the industry, it receives the fire-sale values of its capital stocks less the amount, which is owed to the lenders from the previous period's borrowings,

formally given as follows

$$V_t^X(k_t^H, k_t^F, \theta_t, b_t) = (1 - \mathbb{1}_{d_t^X \geq 0}\tau^e) d_t^X(k_t^H, k_t^F, \theta_t, b_t)$$
$$d_t^X(k_t^H, k_t^F, \theta_t, b_t) = \xi^H k_t^H + \xi^F k_t^F - b_t,$$

which notice is a weakly positive number due to the collateral constraint given in equation (14). The continuation value of the firm choosing to be a multinational this period is given by

$$\begin{aligned} V_t^M(k_t^H, k_t^F, \theta_t, b_t) &= \max_{\{k_{t+1}^H, k_{t+1}^F, i_t^H, i_t^F, b_{t+1}, d_t^M, u_t\}} (1 - \mathbb{1}_{d_t^M \geq 0}\tau^e) d_t^M(k_t^H, k_t^F, \theta_t, b_t) \\ &\quad + \beta \mathbb{E}_t[V_{t+1}(k_{t+1}^H, k_{t+1}^F, \theta_{t+1}, b_{t+1})] \end{aligned} \tag{20}$$

where

$$\begin{aligned} d_t^M(k_t^H, k_t^F, \theta_t, b_t) &= (1 + \mathbb{1}_{e_t^M < 0}\eta) e_t^M(k_t^H, k_t^F, \theta_t, b_t) \\ e^M(k_t^H, k_t^F, \theta_t, b_t) &= \left[(1 - \tau^H) P_t \theta_t^H (k_t^H)^\alpha - i_t^H - x^H - \Phi^H(i_t^H, k_t^H)\right] + \\ &\quad \left[\left(\frac{1 - \tau^{H,U} - \tau^F}{1 - \tau^F}\right) u_t - j_t - x^F\right] + \left[\frac{b_{t+1}}{1+r} - b_t + b_t\left(1 - \frac{1}{1+r}\right)\tau^H\right] \\ u_t &= (1 - \tau^F) P_t \theta_t (k_t^F)^\alpha + j_t - i_t^F - \Phi^F(i_t^F, k_t^F) \\ j_t, u_t &\geq 0 \\ b_{t+1} &\leq \xi^H k_{t+1}^H + \xi^F k_{t+1}^F. \end{aligned}$$

In words — if the firm decides to operate as a multinational for the period — then it chooses Home and Foreign investment, debt holdings, repatriations from the subsidiary, injections from the parent and dividends to shareholders. It chooses these variables subject to the collateral constraint for borrowing and such that repatriations and injections to the subsidiary are weakly positive. I impose that the variables u_t and j_t be weakly positive as the rules governing the transfer of funds between parent and subsidiary differ depending upon the direction. For instance, to allow for $j_t < 0$ would allow the firm to repatriate funds to the parent while bypassing the repatriation tax. Next if the firm chooses to operate

only as a domestic firm then the continuation value is given by

$$V_t^{NM}(k_t^H, 0, \theta_t, b_t) = \max_{\{k_{t+1}^H, i_t^H, b_{t+1}, e_t^{NM}\}} (1 - \mathbb{1}_{d_t^{NM} \geq 0}\tau^e) d_t^{NM}(k_t^H, k_t^F, \theta_t, b_t) + \beta \mathbb{E}_t[V_{t+1}(k_{t+1}^H, 0, \theta_{t+1}, b_{t+1})] \quad (21)$$

such that

$$\begin{aligned} d_t^{NM}(k_t^H, k_t^F, \theta_t, b_t) &= (1 + \mathbb{1}_{e_t^{NM} < 0}\eta) e_t^{NM}(k_t^H, k_t^F, \theta_t, b_t) \\ e^{NM}(k_t^H, k_t^F, \theta_t, b_t) &= (1 - \tau^H) P_t \theta_t^H (k_t^H)^\alpha - x^H - i_t^H - \Phi^H(i_t^H, k_t^H) + \xi^F k_t^F \\ &\quad + \frac{b_{t+1}}{1+r} - b_t + b_t \left(1 - \frac{1}{1+r}\right) \tau^H \\ b_{t+1} &\leq \xi^H k_{t+1}^H. \end{aligned}$$

The problem is such that the firm will choose optimal investment at Home, debt holdings and dividends. Again it is able to borrow up to the value of its fire-sale capital stock as per the collateral constraint, which now only includes the Home capital stock given that the firm is a non-multinational. Notice also that the non-multinational firm receives the liquidation value of the Foreign capital stock it enters the period with, $\xi^F k_t^F$, should it be positive, from downsizing its operations.

Overall the incumbent firm's solution will be comprised of policy functions for the intensive-margin state variables in addition to an extensive margin policy function. Notice that the extensive margin choice will be a function of the entire state space, $(k_t^H, k_t^F, \theta_t, b_t)$ due to the relatively complicated nature of the problem. The optimal policy functions are denoted by $k_{t+1}^H = h_{k^H}(k_t^H, k_t^F, \theta_t, b_t)$, $i_t^H = h_{i^H}(k_t^H, k_t^F, \theta_t, b_t)$, $k_{t+1}^F = h_{k^F}(k_t^H, k_t^F, \theta_t, b_t)$, $i_t^F = h_{i^F}(k_t^H, k_t^F, \theta_t, b_t)$, $u_t = h_u(k_t^H, k_t^F, \theta_t, b_t)$, $e_t = h_e(k_t^H, k_t^F, \theta_t, b_t)$ and $b_{t+1} = h_b(k_t^H, k_t^F, \theta_t, b_t)$. I define another choice variable $z_t(k_t^H, k_t^F, \theta_t, b_t)$, which is an indicator variable that equals one when the firm decides to exit the industry and zero when it continues to operate, (either as a multinational or non-multinational). Finally the output policy functions are denoted by $y_t^H = h_{y^H}(k_t^H, k_t^F, \theta_t, b_t)$ and $y_t^F = h_{y^F}(k_t^H, k_t^F, \theta_t, b_t)$.

To gain some intuition for the way, in which the U.S.' current worldwide tax system distorts the decision problem of incumbent firms, it is instructive to think about first order conditions with regard to the firms' choice variables. Consider a firm who makes the decision to operate as a multinational. Conditional upon this decision, the Euler equation

governing the firm's optimal Home capital stock decision is given by

$$
\begin{aligned}
&(1+\mathbb{1}_{e_t^M<0}\eta)(1-\mathbb{1}_{d_t^M\geq 0}\tau^e)(1+\Phi_i^H) = \xi^H\mu_t + \beta\mathbb{E}_t\left[\xi^H\mathbb{1}_{X,t+1}(1-\mathbb{1}_{d_{t+1}^X\geq 0}\tau^e)\right] \qquad (22)\\
&+\beta\mathbb{E}_t\left[\mathbb{1}_{NM,t+1}\{\alpha(1-\tau^H)P_{t+1}\theta_{t+1}(k_{t+1}^H)^\alpha+(1-\delta)-\Phi_k\}(1+\mathbb{1}_{e_{t+1}^{NM}<0}\eta)(1-\mathbb{1}_{d_{t+1}^{NM}\geq 0}\tau^e)\right]\\
&+\beta\mathbb{E}_t\left[\mathbb{1}_{M,t+1}\{\alpha(1-\tau^H)P_{t+1}\theta_{t+1}(k_{t+1}^H)^\alpha+(1-\delta)-\Phi_k^H\}(1+\mathbb{1}_{e_{t+1}^{M}<0}\eta)(1-\mathbb{1}_{d_{t+1}^{M}\geq 0}\tau^e)\right],
\end{aligned}
$$

where $\mathbb{1}_{X,t+1}$, $\mathbb{1}_{NM,t+1}$ and $\mathbb{1}_{M,t+1}$ are indicators that light-up when the firm chooses to exit, be a non-multinational or a multinational at $t+1$ and μ_t is the Lagrange multiplier on the collateral constraint. Notice also that this Euler equation holds at all points where the value function is differentiable; this won't be everywhere due to fixed costs and discontinuities caused when the firm issues new equity.

Equation (22) looks complicated, but in it are contained many different variables that are affected by the Home Government's tax rate on Foreign earnings. If the Home Government switches to a territorial system, notice that the firm will become less reliant on new equity issuance in the current period, given that it retains a greater proportion of its repatriated overseas earnings. As a result, the $\mathbb{1}_{e_t^M<0}$ indicator will light-up with reduced frequency, meaning the equity issuance premium will be paid less often.

On the right-side of equation (22), see that the shadow value of borrowing, μ_t is likely affected by the policy change as the values of capital, against which the firm can borrow, will change. Notice then that the discrete choice of the firm will potentially be affected inside the expectation, with the number of states over which it chooses to be multinational next period weakly increasing. Moreover, as the optimal choice of k_{t+1}^H changes, the marginal productivity of the investment will also be affected. In addition, there will be industry equilibrium effects, (to be described in detail later), which will be reflected by an adjustment to the output price, P_{t+1}.

Looking at the equation shows that the effect on the Home capital stock is ambiguous: the marginal cost of investment today falls and the value to being a multinational next period rises. However, it is unclear how μ_t will be affected. Moreover, the incidence of equity issuance at $t+1$ when operating as a multinational will decline, thereby reducing the marginal benefit of investment captured by the right-side of the equation. We can derive

a similar equation to describe the Foreign capital choice as follows

$$(1+\mathbb{1}_{e_t^M<0}\eta)(1-\mathbb{1}_{d_t^M\geq 0}\tau^e)(1+\Phi_i^F)=\xi^F\mu_t+\beta\mathbb{E}_t\left[\xi^F\mathbb{1}_{X,t+1}(1-\mathbb{1}_{d_{t+1}^X\geq 0}\tau^e)\right] \tag{23}$$
$$+\beta\mathbb{E}_t\left[\mathbb{1}_{NM,t+1}\{\xi^F\}(1+\mathbb{1}_{e_{t+1}^{NM}<0}\eta)(1-\mathbb{1}_{d_{t+1}^{NM}\geq 0}\tau^e)\right]$$
$$+\beta\mathbb{E}_t\left[\mathbb{1}_{M,t+1}\{\alpha(1-\tau^F)P_{t+1}\theta_{t+1}(k_{t+1}^F)^\alpha+(1-\delta)-\Phi_k^F\}(1+\mathbb{1}_{e_{t+1}^M<0}\eta)(1-\mathbb{1}_{d_{t+1}^M\geq 0}\tau^e)\right],$$

The intuition associated with the effect of going territorial on equation (23) is the same as that of (22). The main channels of effect are: reduction in equity issuance costs through cheaper multinational financing, higher value to having a Foreign subsidiary, collateral constraint effects and industry equilibrium effects. Finally the Euler equation for the multinational firm's borrowing decision is given by

$$\beta\mathbb{E}_t\left[[\mathbb{1}_{NM,t+1}(1+\mathbb{1}_{e_{t+1}^M<0}\eta)(1-\mathbb{1}_{d_{t+1}^M\geq 0}\tau^e)+\mathbb{1}_{M,t+1}(1+\mathbb{1}_{e_{t+1}^{NM}<0}\eta)(1-\mathbb{1}_{d_{t+1}^{NM}\geq 0}\tau^e)]\left\{1+\left(1-\frac{1}{1+r}\right)\tau^H\right\}\right]+ \tag{24}$$
$$\mu_t+\beta\mathbb{E}_t\left[\mathbb{1}_{X,t+1}(1-\mathbb{1}_{d_{t+1}^X\geq 0}\tau^e)\right]=(1+\mathbb{1}_{e_t^M<0}\eta)(1-\mathbb{1}_{d_t^M\geq 0}\tau^e)\frac{1}{1+r}$$

where the left-side of (24) is the cost of borrowing and the right-side is the benefit. The costs are the shadow cost plus the amount to be repaid next period in addition to the additional burden that places on financial structure next period, (i.e. the potential to push the firm to issue additional equity next period). The debt tax shields net-out of the costs on the left side. The benefit is the market value of the debt raised at time t, in addition to the equity issuance premium this new debt saves on.

Similarly to the investment decisions of the multinational, the borrowing policy seems to be affected in an ambiguous way by the Home Country switching to a territorial tax system. Specifically, cheaper financing for the firm reduces the need to issue new equity at time t, but it also reduces the number of states associated with equity issuance at $t+1$. Both of these effects serve to shift-around the left and right-sides of equation (24).

In thinking about the effect of the territorial policy change, notice that the decisions regarding these three control variables are solved simultaneously. Although thinking about these Euler equations will not provide a definitive qualitative estimate as to how the incumbent multinational's problem will be affected, they still illuminate the main channels of the policy change's effect. Notice also that the non-multinational incumbent firms' Euler

equations will also be affected by the policy change through the extensive margin effect. That is — there will be more states of the world next period whereby they will elect to switch the being a multinational firm; I omit these corresponding Euler equations out of the interest of brevity.

ii New Entrant's Problem

Recall that the firm pays the initial fixed cost of x^E to enter the industry. Then it makes the decision as to whether to operate as a multinational firm or as a non-multinational. The recursive setup for the entrant's problem can be summarised by the following Bellman equation

$$V_t^E = \max\left[V_t^{E,M}, V_t^{E,NM}\right] \tag{25}$$

where $V_t^{E,NM}$ is the entrant's value from being a non-multinational and $V_t^{E,M}$ is that from choosing to operate as a multinational. The entrant's value from choosing to be a multinational is given by

$$\begin{aligned} V_t^{E,M} = \max_{k_{t+1}^H, k_{t+1}^F, b_{t+1}} & -k_{t+1}^H - x^E + \frac{b_{t+1}}{1+r} - j_t + \\ & (1-\tau^{H,U}-\tau^F)u_t + \beta\left(\sum_{\theta_{t+1}} \bar{G}(\theta_{t+1}) V_t(k_{t+1}^H, k_{t+1}^F, \theta_{t+1}, b_{t+1})\right) \end{aligned} \tag{26}$$

where

$$u_t = j_t - k_{t+1}^F \tag{27}$$

subject to the following constraints

$$\begin{aligned} b_{t+1} &\leq \xi^H k_{t+1}^H + \xi^F k_{t+1}^F \\ u_t &\geq 0 \\ j_t &\geq 0. \end{aligned} \tag{28}$$

Notice that I allow for the new entrant to repatriate funds from the subsidiary to the parent, through (27), 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. Next if the new entrant chooses to be a non-multinational, then its continuation value is given by

$$V_t^{E,NM} = \max_{k_{t+1}^H, b_{t+1}} -k_{t+1}^H - x^E + \frac{b_{t+1}}{1+r} + \beta \left(\sum_{\theta_{t+1}} \bar{G}(\theta_{t+1}) V_t(k_{t+1}^H, 0, \theta_{t+1}, b_{t+1}) \right) \quad (29)$$

which is solved subject to

$$b_{t+1} \leq \xi^H k_{t+1}^H. \quad (30)$$

The optimal policy functions for the new entrant are denoted as $k_{t+1}^H = h_{k^H}^E$, $k_{t+1}^F = h_{k^F}^E$, $i_t^H = h_{i^H}^E$, $i_t^F = h_{i^F}^E$, $u_t = h_u^E$, $e_t = h_e^E$ and $b_{t+1} = h_b^E$. 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 Cross-Sectional Distribution

Denote the cross-sectional distribution of firms at time t by $\mu_t(k_t^H, k_t^F, b_t, \theta_t)$; it evolves according to the following law of motion

$$\mu_{t+1}(k_{t+1}^H, k_{t+1}^F, b_{t+1}, \theta_{t+1}) = R \int_{\theta, b, k^F, k^H} \mathbb{1}_{h_{k^H}^E = k_{t+1}^H, h_{k^F}^E = k_{t+1}^F, h_b^E = b_{t+1}} \bar{G}(\theta_{t+1}) \quad (31)$$
$$+ \int_{\theta, b, k^F, k^H} \Gamma[(k_{t+1}^H, k_{t+1}^F, b_{t+1}, \theta_{t+1}), (k_t^H, k_t^F, b_t, \theta_t)] \mu_t(k_t^H, k_t^F, b_t, \theta_t)$$

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

$$\Gamma[(k_{t+1}^H, k_{t+1}^F, b_{t+1}, \theta_{t+1}), (k_t^H, k_t^F, b_t, \theta_t)] = \quad (32)$$
$$\mathbb{1}_{\left[h_{k^H}(k_t^H, k_t^F, \theta_t, b_t) = k_{t+1}^H, h_{k^F}(k_t^H, k_t^F, \theta_t, b_t) = k_{t+1}^F, h_b(k_t^H, k_t^F, \theta_t, b_t) = b_{t+1}\right]} (1 - z_t(k_t^H, k_t^F, \theta_t, b_t)) G(\theta_{t+1} | \theta_t)$$

which is the conditional transition probability between the productivity shocks multiplied by two indicators — one which denotes staying in the industry and another for the corresponding state variables. Recall also that R is the rate of entry into the industry, which is

defined such that

$$\int_{\theta,b,k^F,k^H} \mu_t(k_t^H, k_t^F, b_t, \theta_t) = 1,$$

which guarantees that $\mu_t(k_t^H, k_t^F, b_t, \theta_t)$ gives a probability distribution over the state space.

iv Stationary Equilibrium Definition

The stationary competitive equilibrium for this model is given by a list $\{P^*, \mu^*, R^*, M^*\}$ such that the following conditions hold

(1) The free entry condition holds

$$V_t^E = 0, \tag{33}$$

through an adjustment of P^* — the price of output,

(2) μ^* is an invariant stationary distribution,

(3) R^* is the rate of entry/exit and

(4) M^* is the total mass of firms that ensures the Home goods market clears.

It is worth elaborating a little more on condition (4), which looks at the total mass of firms operating in the industry. Recall from section V that the price P^* attained from the free-entry condition, equation (33), is applied to output in both the Home and Foreign Countries. Given this, there are two alternative specifications, which could be used in order to pin-down the mass of firms. The first is to instead find the mass that ensures the Foreign goods market clears. The second is to consider market clearing in a combined market of Home and Foreign goods, such that demand equals supply in both markets. I choose not to consider the second alternative given that these two markets are supposed to be segregated, as to combine the two in a single market clearing condition would imply that they are integrated. This would result in all firms in the model operating only with a single branch in the Home Country and then exporting goods to the Foreign Country, thereby making being a multinational redundant.

I choose to use market clearing in the Home output market rather than the Foreign output market as the firms are assumed to be incorporated in the Home Country. From

this perspective, using a Foreign demand function to pin-down the mass of operating Home firms seems unnatural. Moreover any policy that makes operating as a multinational more (less) profitable, such that the fraction of firms operating as multinationals dramatically increases (decreases), may result in a considerable decrease (increase) in the mass of firms in the industry, which seems counter-intuitive. Given that all firms, who operate as multinationals, have branches in the Home Country, such dramatic and counter-intuitive changes in the mass of firms won't eventuate by clearing the Home market.

VII Structural Model Calibration Method

In this section, details regarding the calibrated parameter values and the computational methods used are discussed in detail. One period in the model is calibrated to be a year and the sample period used is 1980 – 2012. To estimate the parameters, I calibrate the stationary distribution of the model solved under the worldwide taxation scheme to match moments in the data.

The section is divided into three subsections — the first describes the calibration of parameters outside the model, the second details those calibrated within and the third examines the the model moments to those in the data. Details regarding the definition of the moments in the model in addition to the model's solution algorithm are deferred to technical appendices B and C respectively.

i Parameters Calibrated Outside the Model

To reduce the computational burden associated with the model estimation, I match 11 parameters outside the model by drawing directly on data and other sources. Table 6 gives the specific parameter values that were calibrated outside of the model.

The exogenous interest rate at which the firms' riskless debt is borrowed is the average 3 month T-bill rate over the sample period, which gives a rate of around 4.98%. The firm discount rate is then found using this estimate for the interest rate in addition to the expression $1/(1+r)$ to get a value a little above 0.95.

The production function curvature parameter, α, is taken to be 0.45 from the classic structural corporate finance paper by Moyen (2004). The depreciation rate is taken from Compustat; it is found as the average of depreciation relative to assets over firms; it's estimated to be around 0.15. The parameters for the technology process are estimated

Name	Symbol	Value	Source
Interest rate	r	0.05	T-bill rate
Discount factor	β	0.95	$1/(1+r)$
Capital share	α	0.45	Moyen (2004)
Depreciation rate	δ	0.14	Ratio of depreciation to assets in Compustat
Technology persistence	ρ_θ	0.87	Standard
Technology standard deviation	σ_θ	0.32	Standard
Home firesale fraction	ξ^H	0.59	Hennessey and Whited (2007)
Foreign firesale fraction	ξ^F	0.59	ξ^H
Foreign production tax	τ^F	0.25	OECD average
Home production tax	τ^H	0.35	U.S. rate
Home dividend tax	τ^e	0.15	U.S. rate
Home repatriation tax	$\tau^{H,U}$	0.1000	$\tau_H - \tau_F$
Home output demand	a^H	4.65×10^{-6}	Inverse domestic pretax income of U.S. firms in Compustat

Table 6: Parameters matched/selected outside the model

using Compustat in the following way. I first obtain an estimate of total factor productivity (TFP) at the firm-level by generating the following variable

$$\widehat{TFP}_{it} = \log\left(\frac{Q}{L}\right) - \frac{1}{3}\log\left(\frac{K}{L}\right) \tag{34}$$

where Q is the sales variable in Compustat, L is the number of employees hired by the firm and K is the value of PP&E. I use this approach to estimating the $\widehat{TFP}_{it}$ variable to follow the analysis undertaken in Tomiura (2007), who studies the productivity of Japanese multinational firms relative to non-multinationals in the data. Following obtaining an estimate for this variable, I run the following regression

$$\widehat{TFP}_{it} = \rho_{TFP}\widehat{TFP}_{it-1} + \epsilon_{it}.$$

I then use the estimated coefficient and error residual standard deviation to estimate the parameters of ρ_θ and σ_θ as being equal to 0.87 and 0.32. These two parameter values are relatively standard and consistent with the literature. I then discretise the produc-

tivity process using these parameters using the Tauchen method such that there are 15 productivity values in the model.

The U.S. domestic corporate tax rate is set equal to the rate of 35%, while the dividend rate is set as 15%. The corporate tax rate in the Foreign country is set bearing in mind the figures reported in section III.iv. Specifically, given the large fraction of total income of U.S. multinationals earned in Europe and Canada, (combined at 64%), I set τ^F equal to the OECD average corporate tax rate of 25%. The repatriation tax rate, under the worldwide solution of the model, is set as the difference between the Home and Foreign corporate tax rates as is done currently for active earnings by the U.S. Government. Consequently, $\tau^{H,U}$ is set equal to 10% under the worldwide regime. In contrast, the rate is set equal to 0% for the territorial regime to capture the exemption of overseas earnings to U.S. taxation.

For the liquidation fraction in the Home Country, ξ^H, I take the same value estimated in Hennessey and Whited (2005), of 0.529. I choose to fix this parameter outside of the model rather than calibrating inside given that it's likely that the model will have some difficulty identifying x^H and ξ^H both separately. This concern arises from the fact that ξ^H and x^H both have an important bearing on the choice for firms to exit the industry in a given period. Given that ξ^H is a fraction, it is more reasonable to take this value as fixed and determine x^H within the model. The liquidation parameter in the Foreign Country, ξ^F, is assumed to be the same as ξ^H for simplicity.

Finally the Home output demand function parameter, a^H, is set to match the average aggregate pretax home earnings of U.S. multinationals in the Compustat dataset over the sample period. Specifically, the equation (17) can be re-arranged to yield the expression $a^H = (Q_t^{H,D} P_t)^{-1}$. The right-side can be interpreted as the reciprocal of aggregate Foreign earnings, which is found to be 214932 million USD in the data.

ii Parameters Calibrated Inside the model

The remaining 5 parameters in the model are calibrated within the model to match 7 moments from the Compustat data described in section III. Table 7 gives the parameters calibrated from within the model and their estimates in addition to the moments chosen for their identification.

The moments to be matched are chosen with a view to shed light on the corresponding parameter of interest. The mean ratio of borrowings to assets (book value) is chosen to estimate the Home fixed cost x^H, as this ratio is tied directly to a firm's exit decision. A

firm who receives a very low productivity shock, who is very highly levered, is more likely to exit the industry than a firm with the same shock value but less levered. The idea is that a higher value of x^H fed-into the model will increase the cost burden associated with operating. Consequently, firms are likely to borrow less as a fraction of their asset value so as to ensure to minimise the chance of exiting or alternatively to ensure greater value in the event of exit.

To estimate the fixed cost of operating in the Foreign Country, x^F, I target the fraction of firms in the model, who choose to operate as multinationals. As this fixed cost increases, the cut-off $\widehat{\theta}^M(k_t^H, k_t^F, b_t)$ will increase for given values of (k_t^H, k_t^F, b_t). This translates into a rise in the fraction of firms, who draw θ_t values that are insufficiently high to justify paying x^F to operate with a branch in the Foreign Country, which leads to a rise in the fraction of non-multinationals.

The exit/entry rate of firms is used to pin-down the fixed cost of entry x^E, as is standard in the literature. A higher value of this parameter serves to reduce the value to entering into the representative industry via equation (25), thereby reducing the rate of entry. Notice also that this parameter has direct implications for the equilibrium price found in the stationary equilibrium of the model given. Specifically, a higher x^E, will cause the price to rise with all other things held equal. This has implications for incumbent firms in excess of the effect on potential entrants; a higher equilibrium price reduces the incentive for incumbents to exit the industry.

I appeal to the mean ratio of net investment relative to assets to calibrate the adjustment cost parameter ϕ. This parameter contains information about the curvature of the period payoff function of the firms with respect to investment. All else equal, a higher value of ϕ causes deviations from firms' current capital stocks to be more costly. In turn, this should be reflected by a lower value of this moment. Finally, I use data relating to the mean equity issuance size relative to firm book value to estimate the equity issuance cost parameter, η. Given that this cost is proportional to the size of firms' equity issuances, a higher value of η would be expected to reduce this moment.

The calibration procedure is executed with the following objective function in mind

$$J(\Theta) = [\mu^d - \mu^s(\Theta)]' W [\mu^d - \mu^s(\Theta)],$$

where $\Theta = (x^H, x^F, x^E, \phi, \eta)$ are the parameters to be estimated, μ^d are the moments in the data and $\mu^s(\Theta)$ are the simulated moments from the model's stationary equilibrium

and W is a positive definite weighting matrix. I choose to set the weighting matrix equal to the identity, such that this objective function simplifies-down to the sum of squared deviations of the model moments from those in the data.

Before turning to discuss the estimated values of the parameters, it is worth taking some time to discuss how changes in the parameters in Θ change the objective function $J(\Theta)$. Given that the model solves for industry equilibrium, changes in parameters will typically lead to very moderate changes in the objective. For example, an increase in x^F would result in a decrease in the value associated with being a multinational for an incumbent firm. Given that new entrants receive the expected value associated with an incumbent value function in the period following their entry, this will result in a decline in the value to entering. In order to achieve the free-entry condition, the equilibrium price in the stationary equilibrium will increase. Consequently, the marginal benefit associated with the Foreign capital stock will rise at the intensive margin. This will partially mitigate the downward pressure on the fraction of multinational firms induced by the rise in x^F. A similar logic extends to variations in the other parameters. Ultimately, this industry equilibrium effect on the price serves to ensure that the objective function is well-behaved, preventing small changes in the parameters from inducing extreme changes in $J(\theta)$.

Name	**Symbol**	**Value**	**Moment Targeted**
x^H	Home fixed production cost	0.74	Mean leverage ratio
x^F	Foreign fixed production cost	1.20	Fraction of multinationals
x^E	Fixed cost of entry	2.96	Entry/exit rate
ϕ	Adjustment cost scaling	0.04	Mean investment to book ratio
η_1	Equity issuance cost	0.03	Mean issuance to book ratio

Table 7: Parameters matched inside the model

The estimated value of the fixed cost in the Home Country is found to be 0.74, while that associated with Foreign operations is 1.20. Reflecting back on the 2 period model of section IV, this implies that the stationary equilibrium associated with the worldwide system has non-trivial fractions of firms operating as multinationals and as non-multinationals. These estimates imply that the fixed cost of Foreign operations is around 62% higher than the cost of having a branch in the U.S. This result seems intuitive from the perspective that a U.S. firm is likely to have to hire many lawyers, consulting companies and the like to manage the establishment of a Foreign subsidiary, which it wouldn't require to set-up operations domestically.

New entrants pay a fixed cost of entry of 2.96, which is around 1.5 times higher than the fixed costs of Home and Foreign production combined. These estimates may seem somewhat counter-intuitive at first thought — that a firm must pay more in fixed costs terms to establish itself in the industry than to be an incumbent multinational. The estimate is likely picking-up the idea that, since multinational firms are likely to be large and sophisticated in terms of cost management, thereby having relatively low fixed costs. The other point to bear in mind is that the firms in this model are calibrated to Compustat public firm data, meaning that x^E is effectively the cost of setting-up a new public firm. Given the high costs associated with government compliance and hiring underwriters and such, this result should seem reasonable.

The adjustment cost of investment in the U.S. and Foreign countries is estimated to be relatively small in magnitude — with a value of 0.04 — which implies a moderate degree of convexity in the adjustment cost function. This represents an estimate, which is lower than the range of values found and discussed in Cooper and Haltiwanger (2005), who aim to estimate the parameter structurally in a variety of contexts. It may be the case that the adjustment cost of the Foreign capital stock is lower than that domestically, driving my estimate to be somewhat lower relative to the literature.

The equity issuance cost parameter estimate comes-out to be consistent with the literature, with the premium associated with issuing seasoned equity being around 3.19% of the size of the sale. This figure is somewhat lower than the estimate given by Gu (2016), who finds it to be 12%, also in the context of multinational firms. However, the difference is likely driven by the fact that equity and debt issuance are all lumped-together in their model. It also contrasts against the result of Hennessey and Whited (2005), who find it to be around 16%; this difference is likely driven by the presence of multinationals in my model.

iii Fit of the Model to the Data

Before turning to the counterfactual experiment, I briefly examine the fit of the model to the data by comparing the data and model moments; table 8 provides the comparison of the model to the data. In addition to the five moments targeted to pin-down the parameters described in the previous subsection, I also examine the proximity of the model to five untargeted data moments.

In terms of the targets; the model gives a good match of moments that are related to

Targeted Moments		
Moment	**Data**	**Model**
Mean debt to book ratio	18.77%	19.47%
Mean investment to book ratio	5.80%	7.07%
Mean equity issuance to book ratio	5.60%	4.29%
Fraction of multinational firms	11.57%	10.81%
Exit rate	4.58%	4.29%
Untargeted Moments		
Moment	**Data**	**Model**
Fraction of firms issuing equity	33.14%	32.10%
Std. dev. of debt to book ratio	41.01%	40.57%
Std. dev. of equity issuance to book ratio	21.41%	18.12%
Aggregate repatriations to aggregate pretax foreign income ratio	52.60%	67.00%
Mean productivity of multinationals relative to mean productivity of non-multinationals	32.01%	35.00%

Table 8: Model moments versus data moments.

leverage, investment, equity issuance and firm heterogeneity. There mean leverage ratio is slightly higher in the model than the data, which is tied to a slightly lower mean equity issuance to book ratio. Firms in the model are slightly more inclined to borrow in the model than the data, which allows them to push the average equity issuance size below that in the data. The model also slightly over-estimates the mean investment to book ratio, which may also be tied to high firm leverage to take advantage of debt tax shields.

The model also does a good job of matching the untargeted moments in the table. In particular, the untargeted moments relating to capital structure are very close in the model to the data. The fraction of firms issuing equity in the model sits at 32% while the data number is 33%. The standard deviation for the debt to book ratio in the data and the model both take the value of around 41%. The standard deviation for the equity issuance to book ratio is 21% in the data, which is slightly above the 18% figure in the model. Given that the model is able to accurately match these three moments, the reader can be confident that the model is accurately capturing the financial behaviour of U.S. multinationals.

An moment in the table, which is important for testing the overseas savings behaviour of the multinationals in the dataset is the ratio of aggregate repatriations to aggregate

pretax foreign earnings. I use the ratio of the two aggregates due to data limitations — I do not observe repatriations in Compustat, so I draw on data from the BEA website on multinational behaviour. The model slightly over-predicts this figure with a value of 67% relative to the data number of 52%. The difference between these two numbers is likely attributable to the fact that the model doesn't have overseas cash as a choice variable; firms save only through the Foreign capital stock. In spite of the absence of overseas cash holdings, the model does a reasonably good job of capturing the savings-repatriation tradeoff of U.S. multinationals.

A final untargeted moment I study is the mean productivity of multinationals relative to non-multinationals in the model against the data, (as a percentage of the mean productivity of non-multinationals). The figure in the data is 32% while that in the model is 35%. The proximity of this moment to the data is crucially important with regard to accurately studying the effect of the tax policy change on firm dynamics. This moment captures how much more productive, on average, U.S. multinationals are relative to non-multinationals. I estimate this moment in the data using Compustat by using the estimated TFP values given in equation (34) of the previous subsection. I then generate the moment in table 8 by differencing the averages of $\widehat{TFP}_{it}$ across multinationals and non-multinationals in the data.

Tomiura (2007) is a comprehensive study on these productivity differences between multinationals and non-multinationals; it studies the differences in many different measures of productivity. It is worth noting that the moment in my model actually comes very close to matching the data moments for several of these different measures presented by Tomiura (2007) in the data. For example, the data give value-added output per unit of labour productivity difference of 40% in Tomiura (2007), which is also very close to my model's figure of 35%. It also lies within the range of moments predicted using other measures of productivity in the data. In summary, the model does a decent job of matching the productivity distribution of multinational firms relative to non-multinationals.

VIII Territorial System Counterfactual Results

In this section, I report the results from solving for the stationary equilibrium of the model under two tax regimes — firstly under the current worldwide regime the U.S. uses, (with $\tau^{H,R} = 0.35 - \tau^F$) and then again under the territorial system, (with $\tau^{H,R} = 0$). The two subsections that follow describe the effects of the tax policy change on the cross-section of

Moment	Worldwide	Territorial
Mean debt to book ratio	19.47%	20.91%
Mean investment to book ratio	7.07%	0.50%
Mean equity issuance to book ratio	4.29%	2.50%
Fraction of multinational firms	10.81%	31.60%
Exit rate	4.29%	7.71%
Fraction of firms issuing equity	32.10%	22.13%
Std. dev. of debt to book ratio	40.57%	34.45%
Std. dev. of equity issuance to book ratio	18.12%	9.76%
Aggregate repatriations to aggregate pretax foreign income ratio	67.00%	92.67%
Mean productivity of multinationals relative to mean productivity of non-multinationals	35.00%	17.10%
Mean productivity of non-multinationals relative to mean productivity of exiting firms	68.43%	64.01%

Table 9: Cross-sectional effect of moving to territorial tax system.

U.S. firms and aggregate variables respectively.

i Cross-Section Variables

The effect of moving to the territorial tax system is summarised in table 9; in particular, the table shows the impact on the moments that were targeted and untargeted in the calibration. Focusing firstly on capital structure, the mean leverage ratio increases from 19% to 21% in moving to the territorial system. U.S. multinationals are able to justify borrowing more, without as much fear of having to pay the equity issuance premium next period, under the territorial system. On this note, the average equity issuance size relative to book value decreases to 2.5%, as internally-generated funds and debt act to displace new equity issuances. In addition to the mean of the leverage distribution shifting upwards, the distribution decreases in variance, with the standard deviation decreasing from 34% to 41%.

The fraction of firms issuing equity decreases from 32% to 22%, meaning that, not only do firms issue less equity conditional upon having to do so, but they also do so less frequently. As a result, the standard deviation of the equity issuance to book ratio also decreases to 10%; the equity issuance size distribution shifts downwards and becomes narrower.

The fraction of multinational firms rises from 11% to 32% under the territorial system. The intuition is as in the simple 2 period model: when the repatriation tax is removed, firms keep more over their overseas earnings. As a result, firms that were insufficiently productive under the worldwide system to establish a Foreign subsidiary, may switch to fulfilling this criterion under the territorial system.

As the value to operating in this industry rises, the entry rate rises from 4.3% to 7.8% under the territorial system. A complementary figure is that the mean productivity of non-multinationals relative to exiting firms decreases from 68% down to 64%. The idea is that, under this new tax policy, the more productive firms are those that survive. That is — the average productivity of entering firms increases on account of the fact that new entrants are now more eager to commence production and squeeze-out the older, less productive incumbents.

The mean productivity of multinationals relative to non-multinationals decreases considerably, from 35% under the worldwide system to 17% under the territorial system. Given that the cut-off productivity level sufficient to justify overseas operations decreases for a given state, the average multinational productivity falls. Moreover, since the fraction of exiting firms increases, the mean productivity of a non-multinational, given that it has not exited the industry, increases.

Multinational firms save less of their overseas earnings through the capital stock, under the territorial system. The level of aggregate repatriations to aggregate pretax foreign earnings increases from 67% to 93% after the policy change. This effect ties-in significantly with many popular stories about U.S. firms deliberately holding-off on repatriating their overseas earnings to avoid taxes. When the repatriation tax is removed, the amount that U.S. multinationals save from a dollar of generated overseas earnings decreases by around 78%. This result implies that indeed there is a considerable amount of "trapped cash" being held overseas by U.S. subsidiaries induced by this aspect of the tax code.

Finally the mean investment to book ratio declines from 7% to 0.5% under the territorial system. One cause of this result is the many firms switching from being non-multinationals to multinationals. The idea is that these firms who are expanding to set-up foreign subsidiaries after the policy change are reducing their investment in the U.S., such that they can facilitate the outlay to operate as multinationals. Another facilitating factor is the effect of the industry equilibrium channel of the policy change. Given that the value to entering rises ceteris paribus, the equilibrium output price falls, thereby reducing the marginal productivity of the two capital stocks.

Aggregate variable	Change
U.S. capital stock	-1.57%
Foreign capital stock	247.42%
U.S. output	3.78%
Foreign output	183.41%
Dividends paid by parents	53.69%
Debt issuance by parents	30.32%
Equity issuance by parents	-32.05%
Repatriations by subsidiaries	276.56%
U.S. Government Taxes	5.09%

Table 10: Aggregate variables percentage change in moving to territorial systems.

ii Aggregate Variables

The results of the counterfactual with regard to aggregates in the model are presented in table 10. The table presents the percentage increase in the aggregate variable in question in moving from the worldwide stationary equilibrium to that of the territorial system. For example, a result of 10% means the variable in question is 10% higher under the territorial regime.

Looking firstly at the result for aggregate U.S. capital, notice that there is a slight contraction by around 1.6%. This result is related to the decline in the mean investment to book ratio discussed in the previous subsection. The main driver of the result is a decline in U.S. capital holdings of firms, which were non-multinationals under the worldwide system. The idea is that the firms, who are least productive, decrease their U.S. capital investment. In contrast, the firms who were already multinationals under the worldwide system expand their holdings of U.S. capital, given that they have cheaper internally-generated funds from their overseas subsidiaries. The cumulative effect of this cross-sectional change is that, in spite of the decrease in the U.S. capital stock, U.S. output actually increases by the order of around 3.8%. The contraction in capital holdings by the least productive firms is offset by the increase by more productive firms, who are able to generate a modest increase through their production function when combined with their productivity level.

The aggregate changes in the variables relating to overseas variables are large in magnitude on account of the large increase in the fraction of multinational firms in the counterfactual, which rose by around 192% under the territorial system. Given that U.S. multinationals are greater in number after the policy change, the aggregate Foreign capital stock

rises by around 247.42%. This greater than proportional change is driven by an increase in Foreign capital holdings by firms, which were already operating as multinationals. Given the fall in the cost of repatriating funds under the territorial system, the aggregate level of repatriations also exhibits a large increase by around 276%.

Appealing to the intuition of the simple two period model of section IV, recall that the policy change results in a rise, in the value of being a multinational firm. Given that firms' objective is to maximise dividend payments to shareholders, it then follows that there is a rise in aggregate dividends by 54%. This result provides some evidence that this particular policy change is likely desirable from the perspective of domestic U.S. shareholders.

In terms of external financing issuance, firms substitute away from issuing equity so as to minimise the associated premium, with a reduction in aggregate issuance by 32%. As a reflection of the rise in the mean leverage ratio described in the previous subsection, aggregate borrowings by U.S. firms increase by around 30%. Ultimately the current U.S. worldwide system distorts the financing decisions of U.S. firms — it causes firms to be overly-reliant upon equity financing given the tax repatriation cost associated with overseas funds.

Finally, tax collections by the U.S. Government rise by around 5% under the territorial stationary equilibrium. The lost taxes on repatriations by firms, which were already multinationals before the policy change, are outweighed by increased tax collections on U.S. earnings, dividends and personal taxes on interest earnings. This is a remarkable result; these aggregate figures show that this policy change is desirable for U.S. firms and investors and comes at no harm to the Government's budget balance.

IX Additional Tax Policy Counterfactual Results

In this section, I explore counterfactuals, which involve alternative adjustments to the U.S.' tax code for its multinational firms. In particular, I firstly study the effect of changing the rate levied on repatriated earnings. Then secondly, I explore the effects on U.S. firm variables of removing the deferrability option on Foreign earnings.

i Adjusting the U.S. International Tax Rate

Recall that, under the current worldwide system of taxation, the cost of repatriation is equal to the difference of the U.S. domestic corporate tax rate from the Foreign corporate

tax rate. That is — $\tau^{H,R} = \tau^H - \tau^F$. In the territorial regime counterfactuals, this cost was set equal to 10% — the 35% domestic rate less the 25% OECD average. In this subsection, I consider alternative counterfactuals, whereby the repatriation tax rate is set equal to $\widehat{\tau}^{H,R} = \widehat{\tau}^H - \tau^F$ where $\widehat{\tau}^H$ is an alternative tax rate, not equal to the domestic U.S. corporate rate.

In this section, I adjust $\widehat{\tau}^H$ over the range $[0.25, 0.35]$, each time comparing the variable of interest under the equilibrium corresponding to $\widehat{\tau}^{H,R} = \widehat{\tau}^H - \tau^F$ with that under the current worldwide system with $\tau^{H,R} = \tau^H - \tau^F$. Figure 9 presents the results: I show the effect on the fraction of multinational firms, (represented as a percentage change), in addition to the percentage change in aggregate variables. The variable on the horizontal axis is $\widehat{\tau}^H$.

The idea behind these counterfactuals is that, by reducing the repatriation tax rate, U.S. firms will be incentivised to undertake further overseas expansion, while still collecting taxes on the firms' foreign earnings. Focusing firstly on the fraction of multinationals, notice that the percentage change in the statistic is positive for all values of $\widehat{\tau}^H$. The decline in the effect on this statistic is smooth and monotonic as the tax rate increases. For a value of the tax rate of 30%, the increase in the fraction is around 100%.

The U.S. capital stock falls for low values of $\widehat{\tau}^H$ — starting at the 1.57% decline at 25%, (effectively a territorial system). For a rate of 26%, the contraction is even sharper, with a decline by around 1.82%. For tax rates of 27% and higher, the effect on the U.S. capital stock is close to zero. The interpretation is that, for these relatively higher rates, the contraction in U.S. capital by the firms switching to become multinationals is being offset by the increased investment by incumbent multinationals. The effect on the U.S. capital stock contrasts against that on the Foreign capital stock — the decline in which with the rise in the tax rate is smooth and gradual. These effects on the capital stocks are also coupled by monotonic reductions in the magnitude of the effect on U.S. and Foreign output.

The effect on equity issuances as $\widehat{\tau}^H$ rises appears to be non-monotonic. In moving from the rate of 25% through 31%, the magnitude of the reduction in this aggregate variable oscillates. Similarly, the effect on aggregate borrowings is non-monotonic. When moving from 26% to 27%, the effect on borrowings falls from 25% to around 5%. The cumulative effect of all these changes is that the effect on U.S. tax collections is still positive for all tax rates under the range of consideration. However, this effect declines monotonically as the tax rate increases. The interpretation is that keeping this worldwide system of taxation

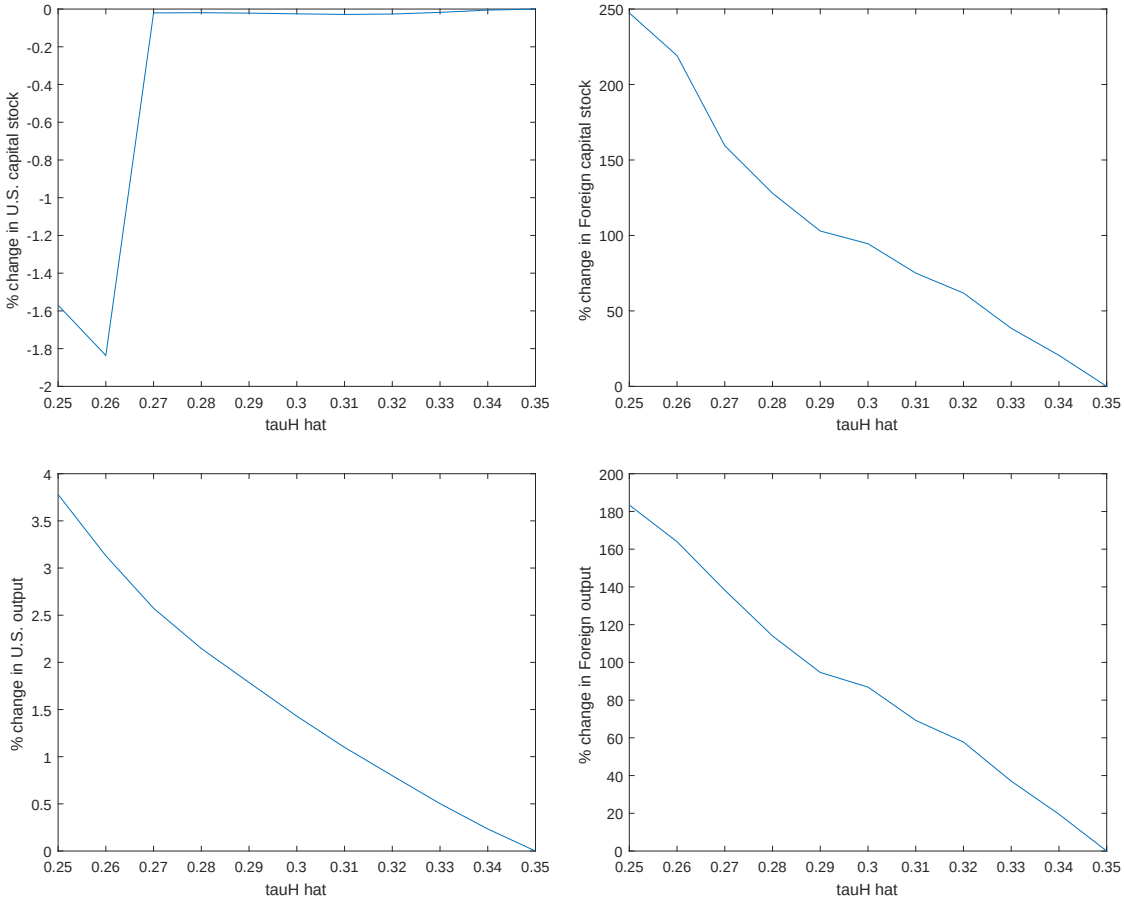

Figure 9: Counterfactual by adjusting U.S. international tax rate.

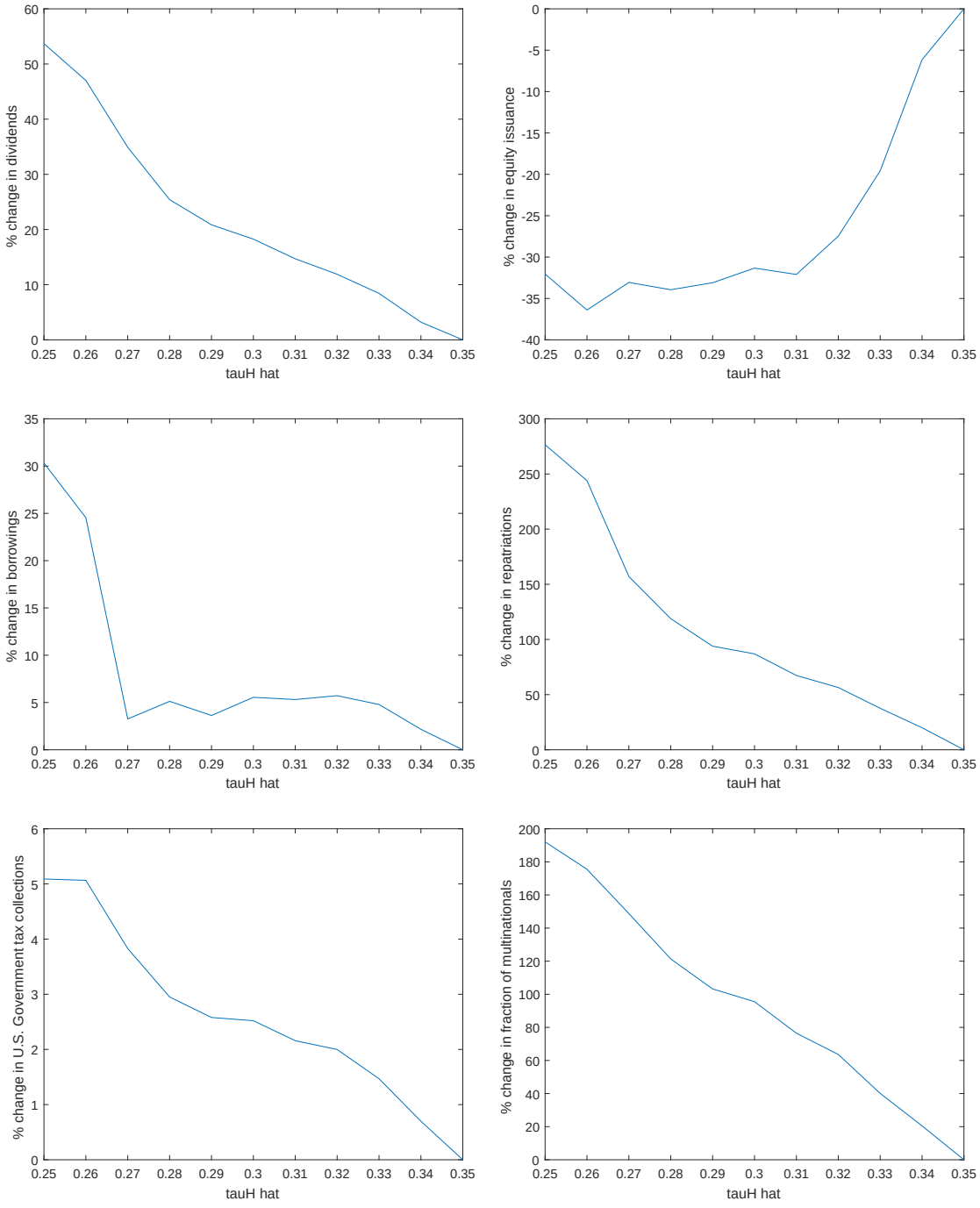

Figure 9: Counterfactual by adjusting U.S. international tax rate (continued).

Moment	Deferrability	No Deferrability
Mean debt to book ratio	19.47%	19.61%
Mean investment to book ratio	7.07%	7.37%
Mean equity issuance to book ratio	4.29%	4.37%
Fraction of multinational firms	10.81%	9.21%
Exit rate	4.29%	4.31%
Fraction of firms issuing equity	32.10%	31.78%
Std. dev. of debt to book ratio	40.57%	40.64%
Std. dev. of equity issuance to book ratio	18.12%	18.92%
Aggregate repatriations to aggregate pretax foreign income ratio	67.00%	66.04%
Mean productivity of multinationals relative to mean productivity of non-multinationals	35.00%	35.49%
Mean productivity of non-multinationals relative to mean productivity of exiting firms	68.43%	67.28%

Table 11: Cross-sectional effect of moving to worldwide system without deferrability.

with a reduced tax rate is dominated in some sense by moving to the territorial system. That is — the positive effect on firm-level variables is maximised with $\widehat{\tau}^{H,R} = 0.0$ — where the same can also be said for tax collections. From this perspective, it would make little sense to undertake the policy change discussed in this subsection.

ii Removing the Deferrability Option

In this subsection, I consider removal of the option to defer tax payment on overseas earnings until repatriation. That is — I think about keeping the basic worldwide setup, but instead, all earnings are taxable immediately at the time they are made. In terms of the structural dynamic model, notice that the continuation value from operating as a multinational firm will change to the following

$$\begin{aligned} V_t^M(k_t^H, k_t^F, \theta_t, b_t) \quad = \quad & \max_{\{k_{t+1}^H, k_{t+1}^F, i_t^H, i_t^F, b_{t+1}, e_t^M, u_t\}} e_t^M - \eta(e_t^M(k_t^H, k_t^F, \theta_t, b_t)) \\ & + \beta \mathbb{E}_t[V_{t+1}(k_{t+1}^H, k_{t+1}^F, \theta_{t+1}, b_{t+1})] \end{aligned}$$

where

$$\begin{aligned} e^M(k_t^H, k_t^F, \theta_t, b_t) &= \left[(1-\tau^H)P_t\theta_t^H(k_t^H)^\alpha - i_t^H - x^H - \Phi^H(i_t^H, k_t^H)\right] + \\ &\quad \left[u_t - j_t - x^F\right] + \left[\frac{b_{t+1}}{1+r} - b_t + b_t\left(1 - \frac{1}{1+r}\right)\tau^H\right] \\ u_t &= (1-\tau^F-\tau^{H,R})P_t\theta_t(k_t^F)^\alpha + j_t - i_t^F - \Phi^F(i_t^F, k_t^F) \\ j_t, u_t &\geq 0 \\ b_{t+1} &\leq \xi^H k_{t+1}^H + \xi^F k_{t+1}^F, \end{aligned}$$

where all other aspects of the incumbents' problem are the same. Notice that the main changes are that the repatriated earnings, u_t, are no longer taxed upon repatriation under this alternative formulation of the problem. Rather, the Foreign earnings, $P_t\theta_t(k_t^F)^\alpha$, are now instead taxed at the rate $\tau^F + \tau^{H,R}$ rather than simply τ^F at the time of earnings. In other words, when the Foreign earnings are made, taxes will be paid to both the Foreign and Home Governments immediately.

Intuitively, switching from the worldwide system with deferrability to that without will imply that the incentive for multinationals to save through the Foreign capital stock will be mitigated. Consequently, it would be expected that firms are likely to repatriate more under this alternative system, which potentially can have impacts on the investment, payout and financing policies of firms.

In exploring the effect of this potential policy change, I first present the effect on cross-sectional summary statistics in table 11, then follow-up by presenting the aggregate variables in table 12. The most crucial effect of this policy change comes through the change in the fraction of multinational firms — this statistic falls from 10.81% to 9.21%. This result should make sense intuitively; the idea is that removal of the option to defer will reduce the value to operating with a Foreign subsidiary. Consequently, the cut-off productivity level, conditional on state, will increase. Another interesting point to notice is the effect of the policy change on average productivity differences. The average difference between multinationals and non-multinationals increases by 0.5%, while the difference between non-multinationals and exiting firms decreases by a little over 1%.

This policy change adjusts the emphasis of U.S. firms, with more focusing on domestic operations rather than those of their overseas subsidiaries. As a consequence, firms turn to invest more in the U.S. capital stock and less in the Foreign capital stock at the intensive margin. In addition, given the fall in the value of operating as a multinational, when some

Aggregate variable	Change
U.S. capital stock	1.04%
Foreign capital stock	-15.19%
U.S. output	-0.41%
Foreign output	-14.49%
Dividends paid by parents	-2.66%
Debt issuance by parents	2.07%
Equity issuance by parents	4.37%
Repatriations by subsidiaries	-22.86%
U.S. Government Taxes	0.38%

Table 12: Aggregate variables under worldwide systems with and without deferrability.

firms receive very low productivity shocks, it becomes optimal to exit the industry, thereby increasing the exit rate.

The change in the fraction of multinational firms has implications for aggregate variables. The U.S. capital stock rises by around 1.03%; the Foreign capital stock decreases by 14.49%. These changes then have implications for the output variables: U.S. output falls by 0.41% while that overseas falls by 14.48%. Notice the severe asymmetry between the fall in U.S. and Foreign output. Recall that the most productive of firms, under the worldwide system with deferrability, were those who were operating as multinationals. Given the decline in the value of operating as such, the fall in Foreign output is large in magnitude. In contrast, these firms who were quite productive that were originally operating as multinationals now turn to be non-multinationals under the system without deferrability. Those firms, who remain multinationals after the policy change invest less domestically, while those that switch to being non-multinationals invest more. The latter effect somewhat mitigates the former to lead to a more modest decline in U.S. output.

Given the fall in the value to U.S. shareholders of owning a firm with a Foreign subsidiary, the aggregate level of dividends declines following the policy change by 2.65%. In terms of capital structure, firms borrow more by 2.07% after the policy change as large multinationals become less concerned with new equity issuance in the future, given that they no longer have incentive to defer repatriation. As firms who were previously multinationals under the system with deferrability switch to becoming non-multinationals, they no longer have any overseas earnings as a source of financing. Consequently, in addition to increasing their borrowing, they also turn to issuing more equity, causing a rise in aggregate

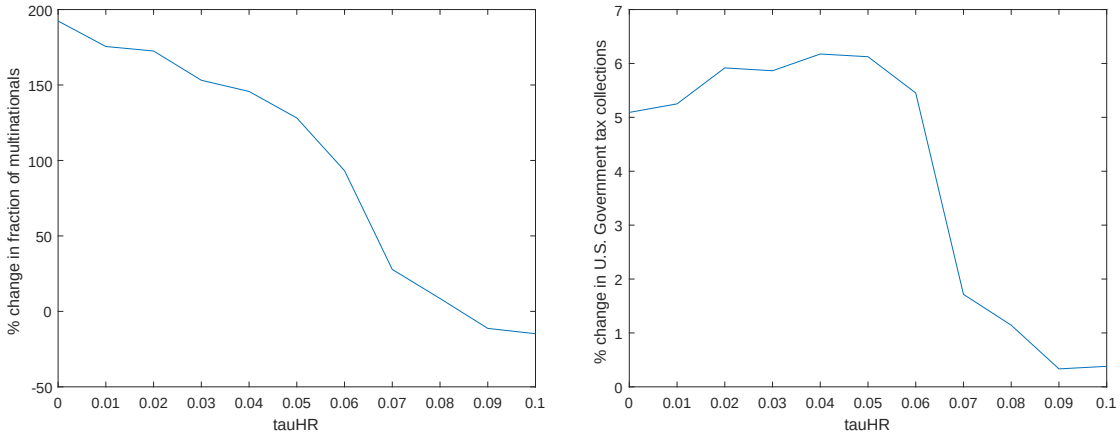

Figure 10: Effect of removing deferrability and reducing U.S. tax overseas earnings tax rate.

equity issuance by 4.37%.

Finally, U.S. Government tax collections rise slightly from this policy change by around 0.38%. All firms who continue to operate as multinationals after the policy change have to pay taxes immediately on their overseas earnings, causing U.S. tax collections to rise. The decrease in dividend payments, however, places downward pressure on collections, causing the net effect to be much more modest in size than in the territorial system counterfactual results. In all, these results indicate that removing the deferrability option will indeed increase tax collections. It appears, however, that this policy change will come to the detriment of U.S. firms and investors. This comes through the adverse impact on overseas investment and production, in addition to the rise of costly equity issuance and the decrease in dividend payments to shareholders.

As an additional policy experiment, I also consider removing the deferrability option and decreasing the tax rate levied by the U.S. Government on the Foreign earnings of its multinationals. In particular, figure 10 shows the effect of differing values of this U.S. rate on U.S. Government tax collections in addition to effect on the fraction of U.S. multinationals.

Looking firstly at the effect on the fraction of multinationals, notice that for U.S. tax costs of 9% and 10%, this fraction decreases after the policy change. However, the effect is positive for all counterfactual costs of 8% and below. For counterfactuals with

relatively U.S. tax rates on Foreign earnings, (5% and below), the percentage increase in the percentage of multinationals is still very high, (e.g. 129% for 5%).

This positive effect on the fraction of multinationals for low U.S. tax rates translates into an interesting effect on U.S. Government tax collections. These collections increase under the counterfactual for all of the different U.S. tax rates under consideration. However, the percentage change in U.S. tax collections does not decline monotonically as the U.S. rate in the counterfactual rises. It exhibits a hump-shape as the rate rises, with a peak being realised with removal of the deferrability, coupled with a counterfactual tax rate of 4%. The idea is that, there is some optimal tax rate, which is lower than present that balances the continued collection of U.S. taxes on overseas earnings, that provides a sufficient increase in the value to operating as a multinational.

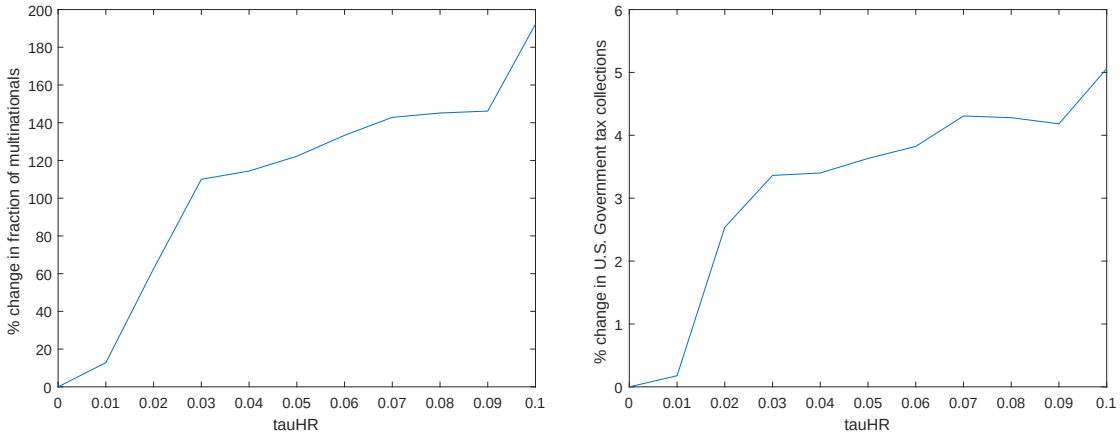

Figure 11: Territorial counterfactual results under varying worldwide $\tau^{H,R}$ values.

X Robustness Checks

In this section, I study how changing tax rate parameters affects the results of the territorial system counterfactual. In particular, I firstly study the effect of adjusting tax parameters to reduce the cost of repatriation for firms under the worldwide system. Secondly, I study how the results of the counterfactual would be affected by changing the U.S. tax rate levied on dividends.

Each time I re-run the counterfactuals with different tax rates, I re-calibrate the fixed cost of Foreign production, x^F, such that the fraction of multinationals under the worldwide system of the model coincides with the data. I also adjust the fixed cost of entry, x^E, to target the industry equilibrium price level to ensure that this price is the same as under the baseline specification. Re-calibrating in this way ensures the quantitative results associated with the counterfactual are accurate given the importance of the extensive margin investment channel in driving the results.

i Adjusting the Cost of Repatriation

In this subsection, the question I ask is — am I over-stating the cost of repatriating funds under the baseline calibration? The tax rate on repatriated overseas earnings ($\tau^{H,R}$) is set to 10% in the baseline calibration. In the subsection that follows, I study the counterfactual results with smaller repatriation costs over the range from 0% to 10%. A smaller cost of

repatriation under the worldwide system will intuitively mean a smaller effect associated with moving to the territorial system. In the extreme case, with a zero repatriation cost under the worldwide system, there will be no effect associated with the policy change.

Figure 11 shows the effect of switching to the territorial system on the fraction of multinational firms and tax collections of the U.S. Government for varying $\tau^{H,R}$ under the worldwide system. The figures correspond with adjusting this rate over the range of $[0, 0.1]$. Both figures are presented as percentage changes in the variable in question.

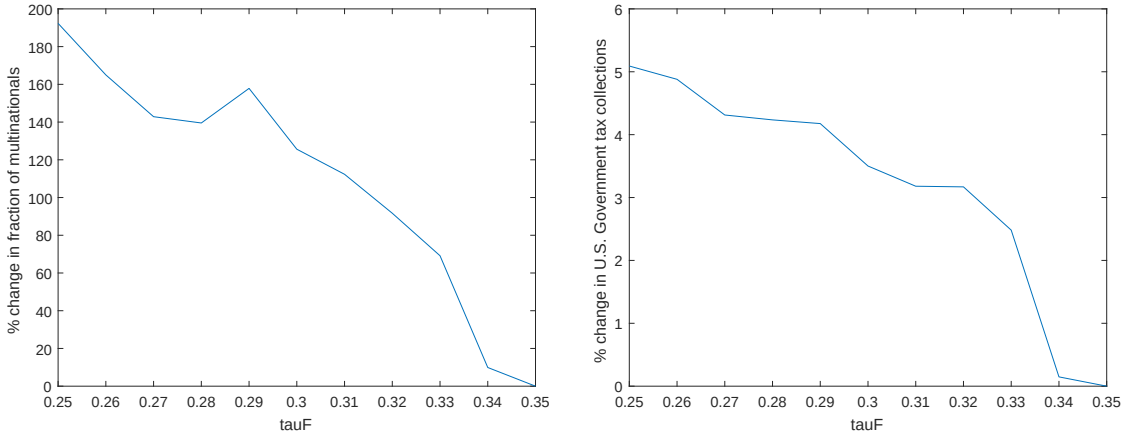

Figure 12: Territorial counterfactual results under varying τ^F values.

When the rate is set to the 10% of the baseline, the percentage change in the fraction of multinationals is 192.32%, (fraction increases from 10.81% to 31.60%). This change declines as the rate falls, but notice that even for relatively low rates, the increase in the fraction of multinationals is quite substantial. For example, a worldwide U.S. tax rate of 2% still sees the fraction increase by around 63% after the territorial change. The implication is that this relatively strong extensive margin effect, which generated the positive effects domestic variables.

U.S. Government tax collections increase in moving to the territorial regime for all the different values of $\tau^{H,R}$ above zero. The increase gradually declines in magnitude as the rate falls, from the 5% at the 10% rate down to 2.53% at the 2% rate. The increase is modest for the 1% repatriation rate at 0.2% on account of the relatively small effect on dividends and U.S. output, (not shown). These results provide some evidence in favour of this tax response result, which seem to hold-up, even if the baseline calibration over-estimates the

cost of repatriation.

I also run robustness on the Foreign domestic corporate tax rate, τ^F. Recall that this rate was set to 25% in the baseline calibration. In this robustness analysis, I re-run the counterfactual with varying rates over the rate from 25% to 35%. In doing so, I keep the U.S.' rule that $\tau^{H,R} = 0.35 - \tau^F$, meaning that a rise in τ^F can be interpreted as a reduction in the repatriation tax cost under the worldwide system. Figure 12 shows the effect on the fraction of multinationals and U.S. taxes from the policy change under these varying Foreign tax rates. Qualitatively, the results are the same as varying $\tau^{H,R}$ above: the direction of changes in variables appear to be robust.

ii Adjusting the U.S. Dividend Tax Rate

This section looks at adjusting the tax rate levied on dividends paid to shareholders by U.S. firms. This is a particularly important check to run from the perspective that this parameter has a big impact on the effect on U.S. tax collections through the extensive margin effect of the policy change. Relating this to the real world, it is likely that the dividend tax rate paid by most investors are likely to be considerably below the 15% statutory rate as many hold shares in mutual funds and other such vehicles.

Notice also that changing this parameter also has an impact on the decision problem of firms in the model. In particular, consider again the Euler equations of a multinational firm for Home capital, Foreign capital and borrowings, given by equations (22), (23) and (24). Under circumstances where the sign on the net dividend, $d_t^M(k_t^H, k_t^F, b_t, \theta_t)$, differs from that under a given state at $t+1$, (i.e. $d_{t+1}^i(k_{t+1}^H, k_{t+1}^F, b_{t+1}, \theta_{t+1})$ for $i \in \{M, NM, X\}$), the dividend tax creates a distortion.

To think about this distortion, take an example where $e_t^M(k_t^H, k_t^F, b_t, \theta_t) < 0$ and $e_{t+1}^i(k_{t+1}^H, k_{t+1}^F, b_{t+1}, \theta_{t+1}) \geq 0$ for all $i \in \{M, NM, X\}$ and possible states of the world at $t+1$. In this case, the firm pays the equity issuance premium at time t and pays a dividend to shareholders, which is taxed, at time $t+1$. Given this, the presence of the dividend tax can be thought of as having an amplifying effect on the issuance premium today. More formally, think of (22) and divide either side of the equation by $(1 - \tau^e)$ to

obtain

$$\frac{1+\eta}{1-\tau^e}(1+\Phi_i^H) = \xi^H \mu_t + \beta \mathbb{E}_t \left[\xi^H \mathbb{1}_{X,t+1}\right] + \beta \mathbb{E}_t \left[\mathbb{1}_{NM,t+1}\{\alpha(1-\tau^H)P_{t+1}\theta_{t+1}(k_{t+1}^H)^\alpha + (1-\delta) - \Phi_k^H\}\right] + \beta \mathbb{E}_t \left[\mathbb{1}_{M,t+1}\{\alpha(1-\tau^H)P_{t+1}\theta_{t+1}(k_{t+1}^H)^\alpha + (1-\delta) - \Phi_k^H\}\right],$$

where again notice that all the indicators on the right-side that depend solely on $e_{t+1}^i(k_{t+1}^H, k_{t+1}^F, b_{t+1}, \theta_{t+1})$ drop-out given that I've assumed that, for this specific example, all states of the world at $t+1$ deliver this firm a positive dividend. See that the left-side of the equation, which can be thought of as the marginal cost of Home investment, is impacted by this dividend tax. A smaller value of τ^e can be thought of as reducing the effective marginal cost of investing in this scenario at time t. This will have implications for the effect of going territorial — the incentives of firms after the policy change will change as τ^e is adjusted.

Figure 13 shows the results of the territorial counterfactual for selected variables when varying the dividend tax rate. Starting firstly with the fraction of multinationals, notice that for very low dividend tax rates, the increase in this variable is quite profound. In fact for values of τ^e, which are less than 5%, close to 100% of firms choose to operate with Foreign subsidiaries under the territorial regime. The driver behind the strong extensive margin effect comes through this low effective equity issuance premium discussed in the previous paragraph. When the dividend tax rate is very low, it is very inexpensive for firms to expand their operations under the territorial system. This intuition is supported by the strong response in aggregate equity issuances for low tax rates. Notice that, when $\tau^e = 0$, the rise in this aggregate is close to 80%. As the rate increases, the magnitude of this increase diminishes, until reaching a tax rate of 5%, at which point issuances decline in moving to the territorial system.

Notice also that, for all of the values of τ^e on the scale, the U.S. Government tax collections continue to rise under the counterfactual. Even for a dividend tax of 0%, there is around a 1% increase in taxes. This is driven by the large response of U.S. domestic output under the territorial regime. For values of τ^e, which are less than 5%, the increase is domestic output is around 6%. Still the reasoning for this effect comes through the cheaper financing story for multinational firms. More firms need to issue new equity to undertake their overseas expansion, but at the same time, there are more firms with a cheaper source of financing through their overseas earnings, culminating in a strong output

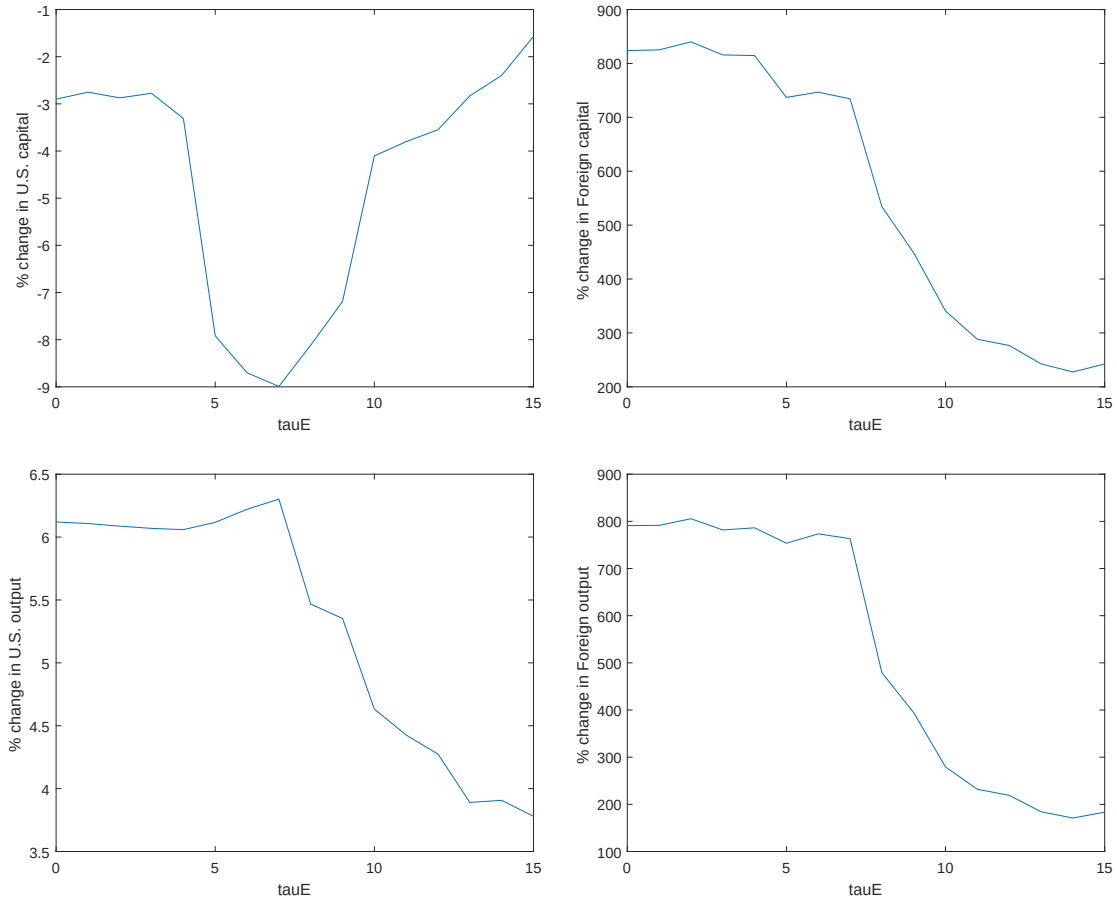

Figure 13: Territorial counterfactual results under varying τ^e values.

response. Notice that the tax collections peak for a rate of around 7% — this is driven by the peak in dividend payments at the same corresponding rate. The main takeaway from this robustness check is — most of the qualitative results of the territorial counterfactual are the same with different values of τ^e. In the quantitative sense, it seems as though the effect is often larger for these lower tax rates.

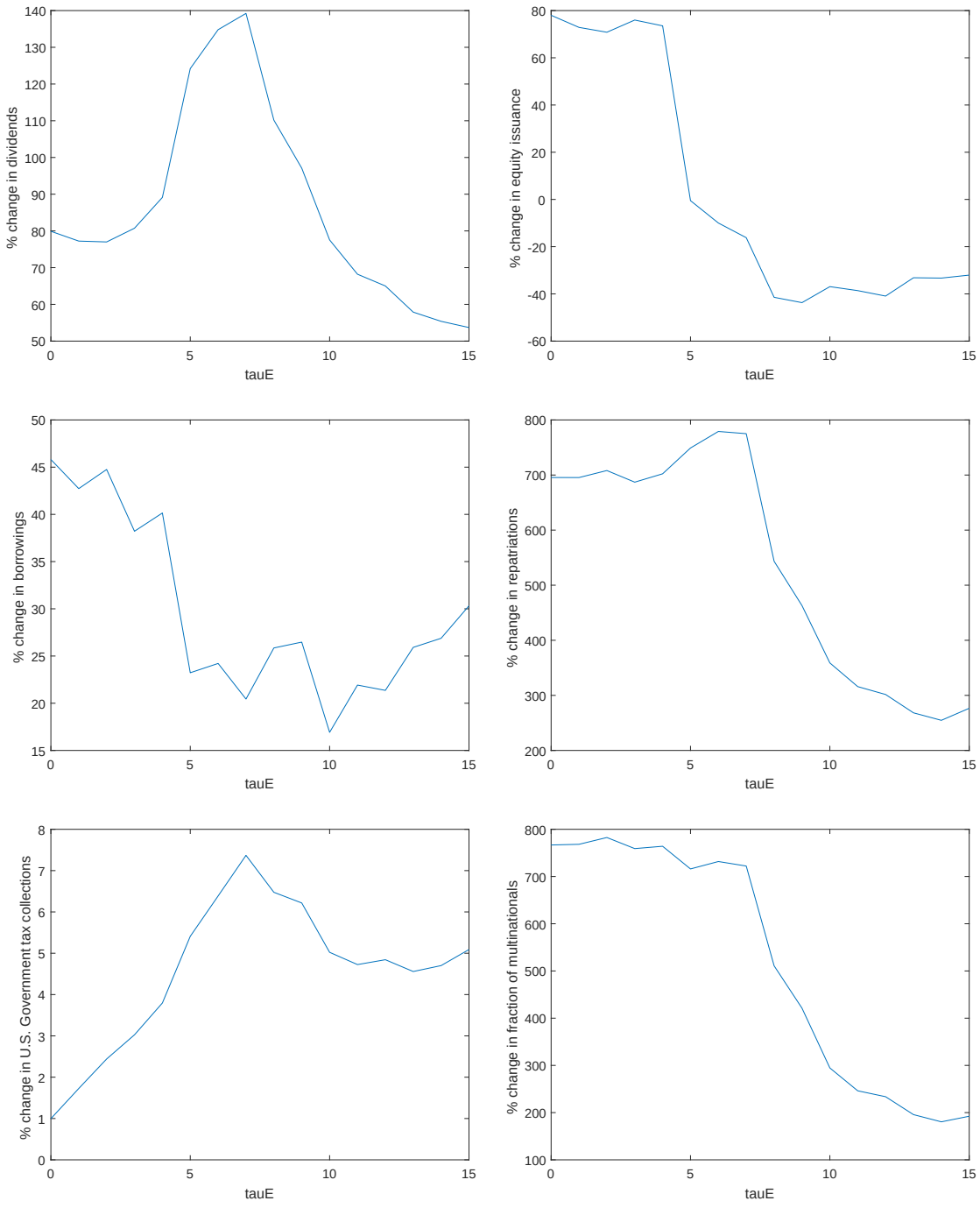

Figure 13: Territorial counterfactual results under varying τ^e values (continued).

XI Concluding Remarks

The U.S. is in the minority of developed nations to operate under a worldwide system of taxation. A move towards a territorial system is a policy change, which has been discussed in U.S. policy circles in recent years as a solution to increasingly complex tax code and potentially distorted incentives for firms provided by the current setup. Moreover this is an issue, which has received a great deal of attention in the media due to the controversial tax-planning strategies of large U.S. multinationals. This paper examined the effect that would result from such a policy change on U.S. firm investment, capital structure, payout policy and tax payments.

A structural model of firm dynamics was estimated and the stationary equilibria under the current worldwide tax system was compared to that corresponding to a stylised territorial alternative. Results suggest that this policy change would result in a rise in dividend payouts to shareholders and an expansion of production both domestically and abroad by U.S. multinationals. Moreover the benefits reaped by firms and investors from this policy change would be complemented by a rise in U.S. Government tax collections. The results also appear to be robust, in the qualitative sense, to different costs of repatriation and dividend tax rates levied by the U.S. Government.

In addition to exploring the effect of removing this U.S. international tax completely, I also explored counterfactuals that involved changing the repatriation tax rate and removing the deferrability option. The results suggest that maintaining the deferrability option while choosing a lower repatriation tax rate is a policy change, which is dominated by going territorial. However, removing the deferrability option and reducing the U.S. international tax rate has the potential to increase U.S. Government tax collections in excess of going territorial, while still providing some benefits to U.S. firms and investors.

The results of this paper should be of keen interest to two different groups of people. Firstly, they teach researchers in the areas of macroeconomics and corporate finance that indeed this international aspect of the U.S. tax code has an impact on both the real operations of U.S. firms in addition to their financial decisions. Secondly, U.S. policymakers can hopefully draw some insights from the results of the counterfactuals when thinking about the effect of such reforms on the Government's budget balance, in addition to their effect on the U.S. economy.

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Technical Appendices

A: Two Period Model Appendix

This appendix details the solution to the two period model for the remaining four cases not explained in the body of the text. Firstly consider the case where the Foreign fixed cost is relatively low — that is $0 < x^F/x^H < 1$. The solution under the worldwide system is given in figure 14.

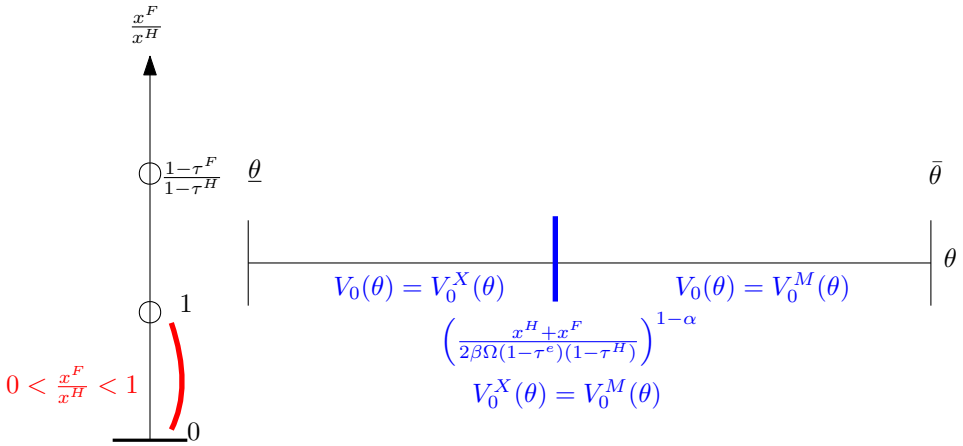

Figure 14: Solution under worldwide system for $0 < x^F/x^H < 1$.

Under the worldwide system, there exists a single cut-off under this scenario for pro-

ductivity. The cut-off is given by the productivity level, at which the marginal firm is indifferent between choosing to not produce and operating as a multinational. Given that the fixed cost for setting-up a Foreign subsidiary is very low, there is no region over which the firms find it optimal to operate as non-multinationals. Figure 15 gives the solution under the territorial system over the same parameter range.

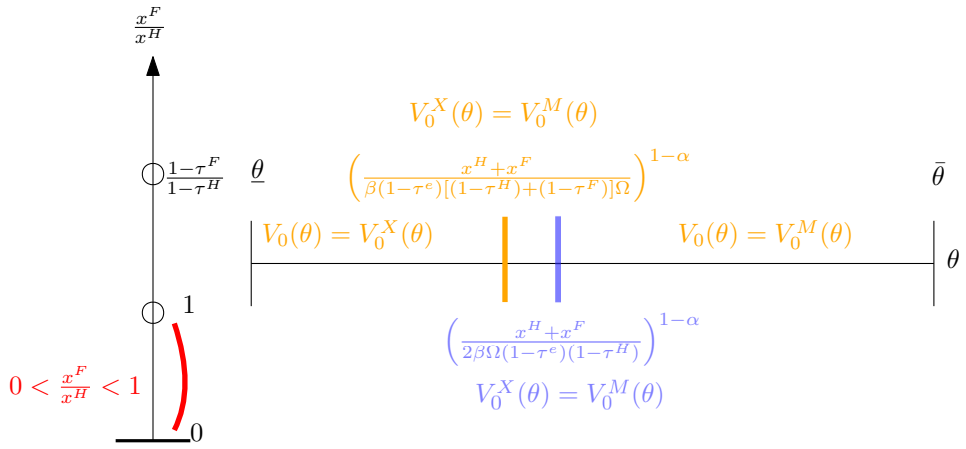

Figure 15: Solution under territorial system for $0 < x^F/x^H < 1$.

When the Home Government switches to the territorial system with $0 < x^F/x^H < 1$, notice that there is still a single cut-off productivity and again the marginal firm is indifferent between producing and being a multinational. Notice however that this cut-off level now sits strictly to the left of that under the worldwide system. Given that less of firms' overseas earnings are lost to taxes, the present value of dividends they are able to generate from being a multinational, thereby making it optimal for firms that were less productive under the worldwide system to now operate. In this scenario, the fraction $F\left[\left(\frac{x^H+x^F}{2\beta\Omega(1-\tau^e)(1-\tau^H)}\right)^{1-\alpha}\right] - F\left[\left(\frac{x^H+x^F}{\beta(1-\tau^e)[(1-\tau^H)+(1-\tau^F)]\Omega}\right)^{1-\alpha}\right]$ of firms will switch from not operating to being multinationals from the policy change.

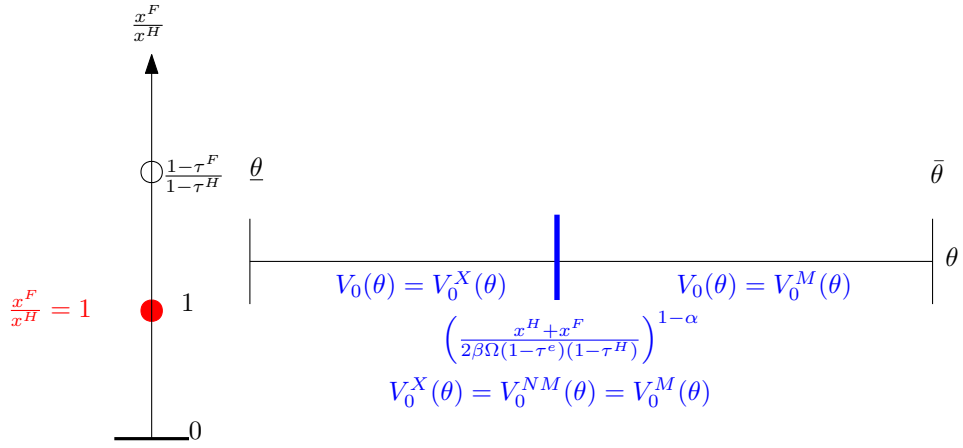

Figure 16: Solution under worldwide system for $x^F/x^H = 1$.

Next I turn to study the scenario where $x^F/x^H = 1$. Figures 16 and 17 show the solutions under this configuration under the worldwide and territorial systems respectively. Under this parameter configuration, the idea is that the cut-offs under each policy will be unaffected from the previous configuration, with the exception that the marginal firm under the worldwide system will be indifferent between all three options. When the fixed costs are equal in each country, production in either the Home or Foreign branches will produce zero value to shareholders net of the initial outlays under the worldwide system. This comes as a result of the fact that earnings stemming from both sources are taxed at the same rate — $(1 - \tau^H)$ — in total. Notice that the fraction of firms, which switch to being multinationals, is the same as in the scenario where $0 < x^F/x^H < 1$.

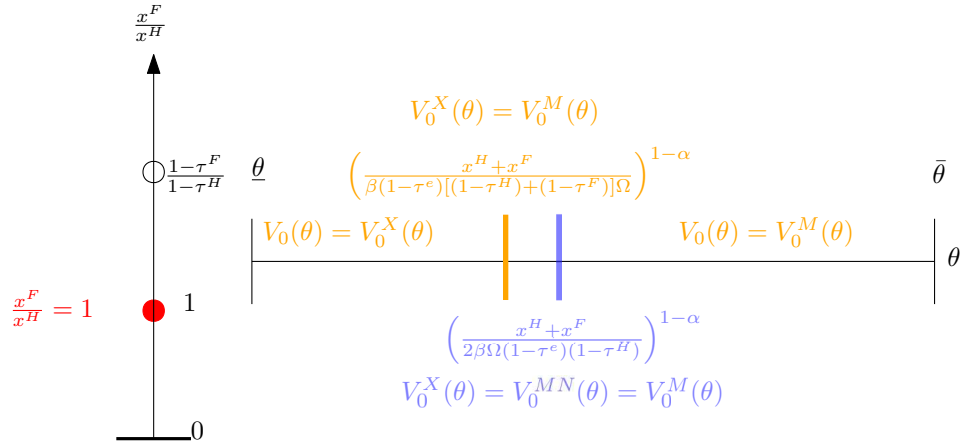

Figure 17: Solution under territorial system for $x^F/x^H = 1$.

The scenario where $1 < x^F/x^H < (1-\tau^F)/(1-\tau^H)$ is the first fixed cost ratio, which generates a non-degenerate region of the productivity space with non-multinational firms operating. The worldwide and territorial solutions are in figures 18 and 19. The fixed cost of producing in the Foreign Country is at a level where some firms who have intermediate productivity levels will be unable to justify the extra fixed cost outlay to operate as a multinational firm.

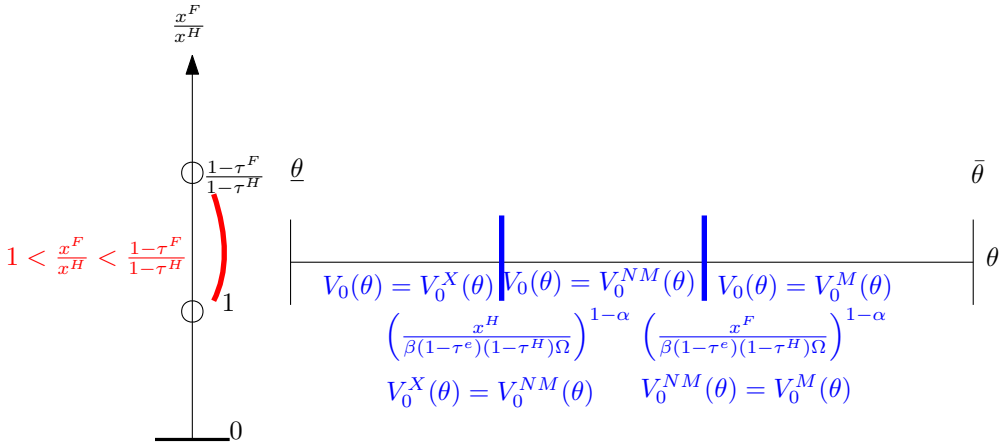

Figure 18: Solution under worldwide system for $1 < x^F/x^H < (1-\tau^F)/(1-\tau^H)$.

In contrast, under the territorial system, again there is a single cut-off value, at which firms are indifferent between not producing and operating as multinationals. This cut-off lies strictly to the left of the lower cut-off under the worldwide system. Under

this scenario, firms over the interval $\left[\left(\frac{x^H+x^F}{\beta(1-\tau^e)[(1-\tau^H)+(1-\tau^F)]\Omega}\right)^{1-\alpha}, \left(\frac{x^H}{\beta(1-\tau^e)(1-\tau^H)\Omega}\right)^{1-\alpha}\right]$ will switch from non-operating to operating as multinationals. Similarly, the firms over $\left[\left(\frac{x^H+x^F}{\beta(1-\tau^e)[(1-\tau^H)+(1-\tau^F)]\Omega}\right)^{1-\alpha}, \left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^H)\Omega}\right)^{1-\alpha}\right]$ will switch from being non-multinationals to multinationals.

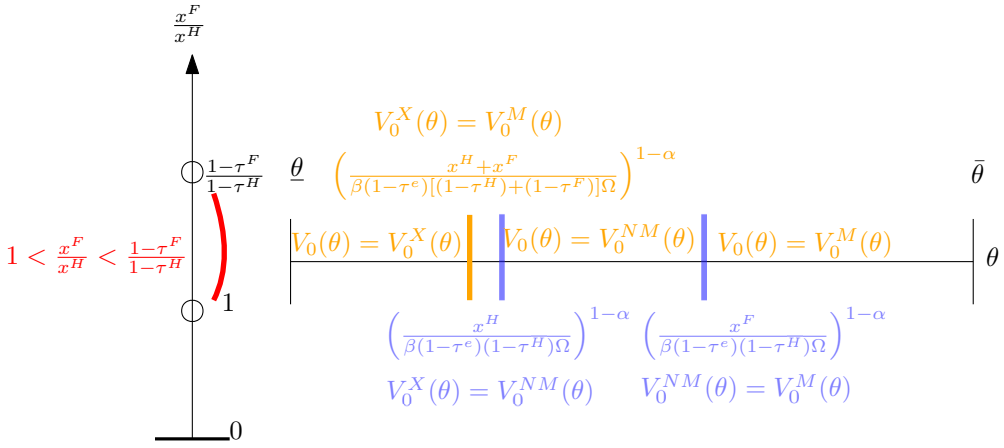

Figure 19: Solution under territorial system for $1 < x^F/x^H < (1-\tau^F)/(1-\tau^H)$.

The final scenario explored in this appendix is the case where $x^F/x^H = (1-\tau^F)/(1-\tau^H)$, the solutions are depicted in figures 20 and 21 for the worldwide and territorial systems respectively. Under this scenario, the solution under the worldwide system is the same as in the previous parameter scenario. However, under the territorial system, the solution differs. After the policy change, there will still be a single cut-off productivity level, but this level will lie to the right of that under the territorial system in the previous parameter configuration.

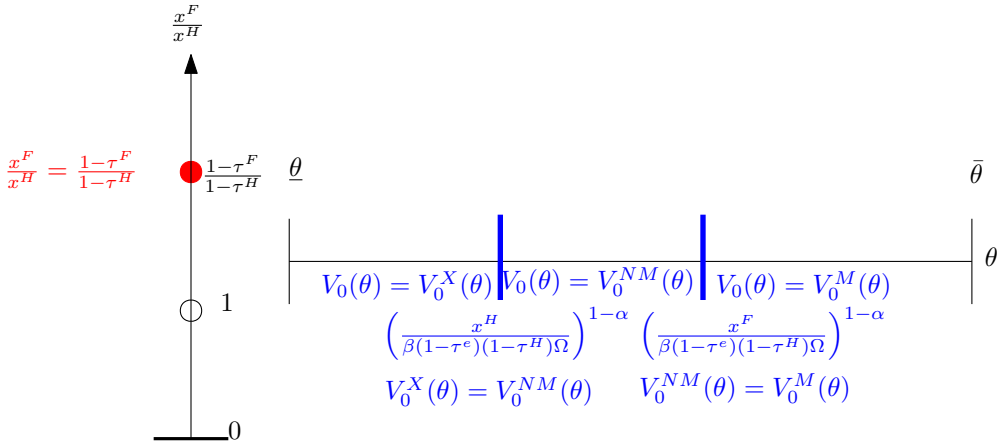

Figure 20: Solution under worldwide system for $x^F/x^H = (1-\tau^F)/(1-\tau^H)$.

Notice also that the cut-off productivity level after the policy change will coincide with the lower cut-off under the worldwide system. At this point, the marginal firm will be indifferent between all three options given that the net present value of dividends arising from operations in each potential branch are zero. In this fixed cost configuration, the fraction $F\left[\left(\frac{x^F}{\beta(1-\tau^e)(1-\tau^H)\Omega}\right)^{1-\alpha}\right] - F\left[\left(\frac{x^H}{\beta(1-\tau^e)(1-\tau^H)\Omega}\right)^{1-\alpha}\right]$ will switch from being non-multinationals under the worldwide system to multinationals under the territorial regime.

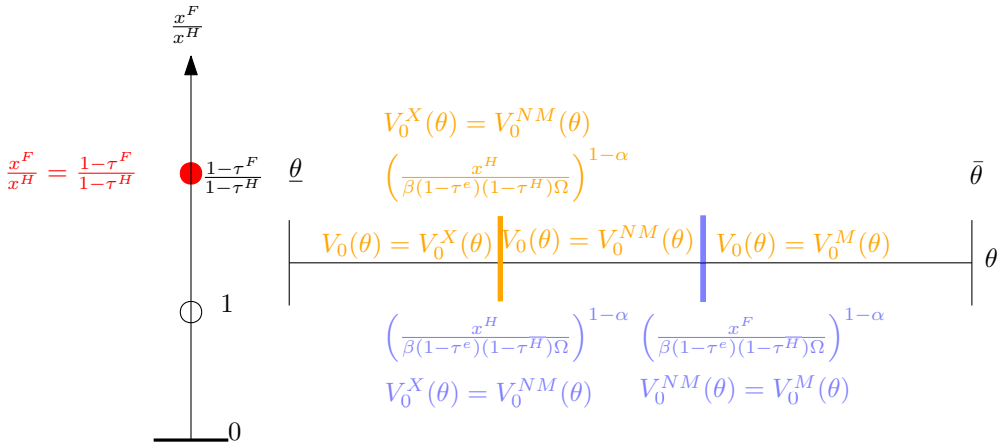

Figure 21: Solution under worldwide system for $x^F/x^H = (1-\tau^F)/(1-\tau^H)$.

B: Model Moment Definitions

Given the definition of the rate of entry in section VI.iv, the moments of the model are simple to define given the stationary distribution. In particular, to find the mean of an arbitrary variable $w_t(k_t^H, k_t^F, b_t, \theta_t)$ in the model, the definition is given by

$$\begin{aligned}\text{Mean}(w_t) &= \int_{\theta,b,k^F,k^F} w_t(k_t^H, k_t^F, b_t, \theta_t)[1 - z_t(k_t^H, k_t^F, b_t, \theta_t)]\mu_t(k_t^H, k_t^F, b_t, \theta_t) \\ &\equiv \bar{w}_t,\end{aligned}$$

where the notation $\bar{w}_t$ denotes the mean of the variable in the stationary distribution. Recall also that $z_t(k_t^H, k_t^F, b_t, \theta_t)$ was defined as an indicator, which equals one when a firm exits the industry. The definition of the variance of the same variable then follows simply as

$$\text{Variance}(w_t) = \int_{\theta,b,k^F,k^F} \left[w_t(k_t^H, k_t^F, b_t, \theta_t) - \bar{w}_t\right]^2 [1 - z_t(k_t^H, k_t^F, b_t, \theta_t)]\mu_t(k_t^H, k_t^F, b_t, \theta_t),$$

as is standard. The exit rate in the model is defined as

$$\text{Exit rate} = \int_{\theta,b,k^F,k^F} z_t(k_t^H, k_t^F, b_t, \theta_t)\mu_t(k_t^H, k_t^F, b_t, \theta_t).$$

The fraction of multinational firms is defined as

$$\text{Multinational fraction} = \int_{\theta,b,k^F,k^F} \mathbb{1}_{\text{multinational}}\mu_t(k_t^H, k_t^F, b_t, \theta_t).$$

Finally the fraction of firms issuing equity in a given period is defined in an analogous manner as

$$\text{Issuance fraction} = \int_{\theta,b,k^F,k^F} \mathbb{1}_{e_t(k_t^H,k_t^F,b_t,\theta_t)<0}\mu_t(k_t^H, k_t^F, b_t, \theta_t).$$

C: Computational Algorithm

I use Fortran and state space discretisation and basic gridsearch to solve the model. The algorithm follows that used to solve Hopenhayn (1992). A loop is run whereby I iterate over P_t, the price of output, until the free-entry condition holds. To find the equilibrium price, the method of bisection is used until convergence is achieved.

Once the equilibrium price is found, the measure of firms is found by using linearity of the stationary distribution in addition to the market clearing condition in the Home output market. In particular, the measure of firms is found such that

$$M^* = \frac{Q_t^{H,D}}{\bar{y}_t^H}$$

where recall that $\bar{y}_t^H$ was defined as the mean level of Home output in the stationary distribution and $Q_t^{H,D}$ is the Foreign output demand as per the demand curve specified in section V.vi, which is given by equation (17).

D: Model Aggregate Definitions

Using the measure of firms M^* in addition to the model moments, the aggregate value of variable $w_t(k_t^H, k_t^F, b_t, \theta_t)$ are calculated as

$$W_t = M^* \bar{w}_t$$

where the capitalised W_t denotes the aggregate across all firms for the period. The definition simply says that the average of the stationary distribution for the variable in question is scaled by the measure of firms found such that industry equilibrium holds.