Policy Effects of International Taxation on Firm Dynamics and Capital Structure∗

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Abstract

This paper develops and calibrates a dynamic equilibrium model with heterogeneous firms to study the impact of removing the U.S. corporate repatriation tax. I study the impact of the policy reform on firm investment, capital structure, payout policy and tax revenues. Firms in the model make both intensive and extensive margin choices regarding supplying foreign goods markets. I calibrate the model to U.S. data and then run a counterfactual where the repatriation tax is removed. The results show that aggregate U.S. firm productivity rises and more U.S. firms operate as multinationals. Domestic and overseas production by U.S. firms rise and firms borrow more and pay larger dividends to shareholders. These effects on firm variables are coupled with approximate U.S. Government tax revenue neutrality and a 0.5% increase in U.S. welfare.

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

JEL codes: F23, G32, H25, L11

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I Introduction

In December 2017, the U.S. Government passed the Tax Cuts and Jobs Act (TCJA) — a tax bill that brought with it considerable reform to the U.S. corporate tax code. One aspect of the corporate reform package is removing the “repatriation tax”: a tax that the U.S. Government levied on the overseas earnings of its multinational firms. This reform constitutes a move from a *worldwide* tax system — where the U.S. Government was entitled to taxes on its multinationals’ overseas earnings — to a *territorial* system where it stakes no claim to taxes on such earnings.

The question I answer in this paper is: how would U.S. firm investment, capital structure, payout policy and tax payments be affected by the U.S. removing the repatriation tax? When a U.S. multinational generates earnings in a foreign country, it pays taxes to the foreign government. Prior to the U.S. reform, the multinational would also pay taxes to the U.S. Government on these earnings when they were sent back to the U.S. parent, or repatriated. Upon repatriation, the firm would pay the difference between what it has already paid the foreign government and the U.S. domestic corporate tax rate of 35%. My paper quantifies the effect of removing this second layer of taxation, levied by the U.S. Government, on U.S. firms’ overseas earnings.

I study this policy change using a calibrated dynamic equilibrium model; I run a basic counterfactual experiment that yields estimates of its impact. There are three key results of the counterfactual. Firstly, through selection effects, the policy change results in an increase in U.S. firm measured productivity of 0.9%. Secondly, it leads to an increase in U.S. welfare of 0.5% in consumption equivalents. Finally, the policy change is approximately revenue neutral for the U.S. Government, with wage, dividend and domestic corporate tax collections offsetting the lost repatriation taxes.

The heterogeneity of the U.S. firms is motivated by the well-known data fact that exporting firms have a productivity advantage over pure domestics and multinationals have

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1Prior to the policy change, the U.S. was in a small minority of countries that tax their multinationals’ overseas earnings. The other seven OECD nations include Chile, Greece, Ireland, Israel, Korea, Mexico and Poland.

2This deferrability option applied to earnings generated through firms’ core business activities — around 90% of those made by U.S. firms make abroad. Those that it doesn’t apply to include dividends, royalties and interest; I abstract from these types of earnings in my analysis.

3For example, if a U.S. firm generates $X in a foreign country whose domestic corporate tax rate is $r^C_{x}$, it will pay $\tau^C_{x}X$ in taxes to the foreign government. Upon repatriation, it will pay a further $(0.35-\tau^C_{x})X$ to the U.S. Government.
such an advantage over exporters. This data fact was first documented by Helpman, Melitz and Yeaple (2004) [hereafter HMY (2004)]. U.S. firms in the model draw idiosyncratic productivity shocks and make a discrete choice with regard to their level of participation in competitive output markets, both at home and abroad. In particular, they choose whether to exit the industry, operate only domestically, as exporters or as multinationals.

As in HMY (2004), non-exiting firms pay a fixed cost associated with the choice they make, with domestics paying the lowest such cost, followed by exporters and then multinationals. Firms that choose to export incur an iceberg transport cost to send their goods abroad, whereas multinationals produce through a foreign subsidiary, thereby circumventing these costs. A characteristic that emerges in the stationary equilibrium of the model is that a hierarchy of firms eventuates, with the least productive exiting and the most productive being multinationals. I solve and calibrate the model using the stationary equilibrium concept introduced by Hopenhayn (1992); the policy change effects are inferred by re-solving for the new stationary equilibrium with the repatriation tax set equal to zero.

There are three main channels, through which this policy change has an impact; the contribution of each is decomposed when running the territorial counterfactual. The first channel is through more U.S. firms choosing to operate as multinationals in equilibrium; I refer to this as the extensive margin channel. Removing the repatriation tax causes a rise in the value of the multinational discrete choice. Consequently, firms who were of intermediate productivity that were operating as exporters under the worldwide system will find it optimal to outlay the additional fixed cost to establish foreign subsidiaries. Movement towards having more foreign subsidiaries implies fewer deadweight losses through iceberg costs. This channel is quantitatively responsible for 86% of the increase in U.S. multinationals’ repatriations and 83% of the rise in their overseas output associated with the territorial policy change.

A second channel of effect of the policy change is that removal of the tax results in cheaper internally-generated financing for U.S. firms; I call this the financial channel. The financial setup of the model follows the basic internal-external financing tradeoff first used in Gomes (2001). Firms can use internal funds to finance their activities, in addition to drawing on external sources. There are two sources of external financing: debt, which is fully collateralised and comes at a tax advantage, as well as equity, which is issued at a premium over internal funds as in Hennessy and Whited (2005). Under the worldwide system, the repatriation tax acts as a cost to using funds generated through overseas operations for domestic activities. In removing this tax, the optimal choice of capital structure for
U.S. multinationals changes. With these cheaper repatriated earnings, firms decrease their equity issuance to save on the associated premium and increase their borrowing to take advantage of debt tax shields. Cheaper financing also means more cash flow to distribute to domestic shareholders; this channel explains 62% of the increase in dividends to shareholders. Higher dividend payments is one way, through which welfare improves. Moreover, since dividends are taxable in the model, these collections by the U.S. Government partially offset the lost repatriation taxes.

A third channel of impact is greater entry of U.S. firms, which drives selection effects through an equilibrium price channel. Prices adjust to clear output markets in the model; the effects of the policy change on these prices are standard and intuitive. The rise in the fraction of firms operating as multinationals puts upward-pressure on the supply of goods to foreign consumers, which causes the price fetched on such goods to fall. Additionally, the rise in the value to being a U.S. firm causes entry into the industry, which translates into a rise in the domestic wage. The higher domestic wage causes the least productive of firms, who were operating under the worldwide system, to exit the industry after the policy change. The higher productivity results in an increase in domestic output, which makes for another considerable source of income to the Federal Government. These domestic effects are likely unforeseen by U.S. policymakers: they imply that a tax on the most productive firms has an impact on the behaviour of the least productive firms. This equilibrium price effect is a major driving-force behind many of the quantitative changes to aggregate variables: it causes most of the change in domestic output, in addition to around 70% of the effect on Federal tax collections.

This paper contributes to several different strands of literature; the first is the macroeconomics literature that deals with estimating the impact of corporate taxes on aggregate variables and evaluating their impact on welfare. Some early papers by Fullerton, King, Shoven and Whalley (1981) and Ballard, Shoven & Whalley (1985) study the welfare effects of corporate tax reform in general equilibrium contexts. More recently, Devereux, Lockwood and Redoano (2008) study competition between countries in choosing their corporate tax rates to attract investment. Djankov, Ganser, McLeish, Ramalho and Shleifer (2010) and Serrato and Zidar (2016) study corporate tax reforms in an empirical context. My paper is the first to my knowledge to estimate the impact of the worldwide aspect of the U.S. corporate tax code in the context of a dynamic equilibrium model. My estimates help contribute the evaluation of this reform, which is of particular interest to policymakers. Of interest to researchers is that the results contribute to understanding whether
institutional differences across similarly developed countries cause substantial differences in economic performance. This follows from the considerable skew of the OECD towards territorial systems. In addition to studying the territorial policy reform, I run additional counterfactuals to study how particular features of the U.S.’ worldwide system affect firms and the macroeconomy. In particular, I explore the effect of keeping the worldwide system while removing the deferrability option.

The second area I contribute to is the corporate finance literature on taxes. There exist a small set of papers that seek to study the effect of territorial tax reforms on the financial behaviour of firms. Japan and the U.K. switched from worldwide to territorial systems in 2009; Arena and Kutner (2015) study the financial effect in an empirical context. Altshuler and Grubert (2003) study optimal borrowing and repatriation strategies in a theoretical model. Gu (2016) uses a partial equilibrium structural model to obtain a quantitative estimate of how the cross-section of cash holdings of U.S. firms is affected by the worldwide tax system. My study contributes to this area by studying how removing the repatriation tax would affect aggregate U.S. capital structure variables. Would this policy change cause U.S. firms to borrow more or less in aggregate? Questions such as these are important as changes to U.S. firm capital structure have implications for investors and domestic welfare.

A third area of contribution is to the international trade literature, which studies selection effects with regard to modes of servicing foreign markets in the context of heterogeneous firms. Melitz (2003) pioneered this area by studying the export decision. HMY (2004) studied the additional option of being a multinational. Costantini and Melitz (2007), Becker (2013) and Egger and Kreickemeier (2007) study the impacts of policy reforms in the context of these selection models. What fraction of U.S. firms would switch from being exporters to multinationals in response to this territorial policy reform? Through using a quantitative model, my paper is the first to be able to address this question. I go beyond existing papers to include dynamics and intensive margin capital investment into my model, which is a crucial feature, considering the deferrability feature of the U.S. repatriation tax code.

The heterogeneous firm structure of my model allows me to contribute to a fourth area of study: the strand of literature, which seeks to evaluate the effect of policy reforms on the productivity of firms. The classic paper in this area is Olley and Pakes (1996), who study productivity in the telecommunications industry. Restuccia and Rogerson (2008) study the effect of tax reforms using a calibrated model. Arnold and Schwellnus (2008) examine a cross-country panel of firms to find that corporate taxes generally place downward-pressure
on firm productivity. My paper is the first to quantify the U.S. repatriation tax’s effect on
the productivity of its firms. One of the key reasons for the current Administration moving
towards a territorial system is to allow U.S. firms to “compete and thrive anywhere and with
anyone” (Speaker’s Office, 2017). My results show that there is some merit to this claim
that the reform will make U.S. firms more efficient and competitive at the international
level.

The remainder of this paper is structured as follows: section II provides details regarding
the empirical motivation for the model. Section III outlines and solves a simple two period
theoretical model to highlight the main channels of effect of this policy change. Section
IV describes the full dynamic model’s environment, followed by section V that details its
equilibrium. Section VI describes the calibration, section VII provides the results of the
territorial counterfactual and section VIII concludes.

II Motivation

The research question I address in this paper is motivated by two empirical observations.
The first is that firms that service overseas markets typically have a productivity advantage
over those that do not — this prompts the study of the repatriation tax in relation to
U.S. firm dynamics. The second is that, prior to the TCJA, several high-profile U.S.
multinationals have undertaken large domestic debt issuances while deferring repatriation
of foreign earnings, motivating the study of how the current tax system affects capital
structure.

i Motivation 1: Productivity and Firm Selection

A seminal paper by Melitz, Helpman and Yeaple (2004) studied the decision of firms to
service overseas markets via the method of exporting versus through establishing a foreign
subsidiary. They note in the data that firms who export tend to have a productivity advan-
tage over purely domestic firms and that multinationals have an even greater advantage.
The numbers relating to these advantages from their study are given in table 1.
### Table 1: Productivity advantages of different firm types.

<table>
<thead>
<tr>
<th>Firm Type</th>
<th>Advantage over Pure Domestics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multinational</td>
<td>53.7%</td>
</tr>
<tr>
<td>Exporter</td>
<td>38.8%</td>
</tr>
</tbody>
</table>

When deciding on the margin, along which to service overseas markets, U.S. firms weigh-up the costs and benefits associated with each option. When it comes to being an exporter: the benefit is extra sales income from serving an additional market, net of taxes. The costs are the extra operating (transport costs) and capital expenditures that go with sending goods overseas. When it comes to being a multinational: there are likely additional costs in excess of being an exporter, (such as establishing plants overseas). However, the added benefit is proximity of production to the foreign market.

The repatriation tax, prior to its removal, was likely influencing the cross-section of U.S. firms in terms of these selection effects. The productivity advantages presented in table 1 are likely biased quantitatively towards a larger advantage for multinationals and smaller for exporters. That is — when the repatriation tax is removed, the advantage to being a multinational will rise. This will likely have the effect of decreasing the productivity advantage of multinationals and increasing that of exporters. Such a re-shuffling of the U.S. firm cross-section will have implications for macroeconomic aggregates.

#### ii Motivation 2: Repatriation Strategies and Capital Structure

Some large U.S. multinationals have received a great deal of attention from the media in relation to their opportunistic use of repatriation and domestic borrowing strategies to minimise their overall tax burden. For example, figure 1 gives a headline from the Bloomberg website with regard to Apple’s tax minimisation strategy. The company’s strategy in recent years has been to save much of its overseas earnings by holding Treasury bonds, thereby deferring their international tax liabilities, while issuing domestic debt to pay dividends to its shareholders.

Through such tax-minimising strategies, it seems reasonable to think that going territorial would have an impact on the borrowing behaviour of U.S. firms. A first-pass at thinking-through the intuition would likely lead one to the conclusion that borrowing in the aggregate would decrease subsequent to removing the repatriation tax. Large U.S.
multinationals would likely repatriate more of their overseas earnings and choose to pay their shareholders through these internally-generated funds rather than borrowing against them as collateral. At the same time, however, the creation of new multinationals due to the re-shuffling of the firm cross-section may have the opposite effect, as new multinationals may borrow more to fund their overseas expansion. The overall impact of the policy change on capital structure is ultimately an empirical question, which motivates its study in the context of a dynamic model. In the presence of financial frictions, these changes will likely impact the real investment activities of U.S. firms as per the trade-off theory of corporate finance.

III Prologue Model: the Two Period Case

The purpose of this section is to develop a simple, two period model to illustrate two of the main channels, through which the policy change affects the firm decision problem and in turn government tax collections. Specifically, the extensive margin and equilibrium price channels are studied in this section. This two period model is builds-on the setup of Melitz, Helpman and Yeaple (2004) in terms of the endogenous extensive-margin overseas market choice while also using the solution method pioneered by Hopenhayn (1992) of a stationary competitive equilibrium. In effect, this setup gives a two-period open economy version of the canonical firm dynamics model.
The two period model I present is such that industry equilibrium prevails; meaning that demand curves for the Home firms’ product are taken as given and the pertinent prices are determined endogenously. The only optimising agents in this model are the Home firms for the purpose of simplicity. The first subsection, in what follows, describes the environment of the two period model. The second subsection outlines the equilibrium and the third describes the effect of the territorial policy change.

i Two Period Model Environment

The model has two time periods $t \in \{0, 1\}$ and two countries — Home (H) and Foreign (F). At the beginning of the first time period, all firms are incorporated in the Home Country. These firms service the Home market with output, in addition to the Foreign market either through exports or direct production through FDI. There are assumed to be exogeneous demand curves for the Home firms’ output in each of the two countries. The setup is depicted graphically in figure 2.

The government in the Home Country taxes corporate earnings at a rate of $\tau^C$ while that of the Foreign Government is denoted by $\tau^{C^*}$. I assume that $\tau^{C^*} < \tau^C$ to capture the idea that the U.S. has tax rates that are higher than all other OECD nations. I assume that the Home Country has a worldwide system in place for taxing its multinational firms, while the Foreign Country operates with a territorial system, (as do most of the U.S.'
major trading partners). In addition to taxing Home earnings, the Home Government also
taxes dividends at rate $\tau^E$ and repatriated overseas earnings at $\tau^{C,U}$.

### i.1 Home Firm Problem

Firms’ objectives are standard — to maximise the present expected value of dividends to
shareholders net of taxes. I assume that all of the firms’ shareholders are in the Home Coun-
try.\footnote{Recent IRS studies have shown that 13.9% of U.S. firm assets are owned by foreigners as of 2005
(Reuters, 2005). Accounting for foreign owners is important for thinking about the direction, in which U.S.
tax collections move in the counterfactual. This is an avenue for future research; I consider omitting foreign
owners reasonable at this point given that the fraction of their ownership is relatively small.} The firms produce using labour as their only input, (which I assume for tractability
here, this assumption is relaxed later in the dynamic model). At time $t = 0$, the firms
choose whether to operate as a domestic firm (D), an exporter (X), a multinational (M) or
to not operate (E). A firm who operates as a domestic has operations in the Home Country
that exist only for the purpose of serving the Home market. An exporter can produce goods
at Home that are designed for sale in both the Home market and for export to the Foreign
market. A multinational firm establishes a subsidiary in the Foreign Country, from which
it can directly supply the Foreign market.

The motivation for firms opting to establish subsidiaries in the Foreign Country is driven
by the existence of an iceberg transport cost associated with exporting, as in Krugman
(1991). A firm that establishes a subsidiary is able to serve to the Foreign market directly
and to avoid these costs associated with transportation. As will be shown shortly, a non-
trivial fraction of firms in equilibrium can operate as exporters when $x^X < x^M$ — meaning
that the fixed cost of being an exporter is lower than establishing an overseas subsidiary.

<table>
<thead>
<tr>
<th>Extensive Status</th>
<th>Total Fixed Cost Paid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit (E)</td>
<td>0</td>
</tr>
<tr>
<td>Domestic (D)</td>
<td>$x^D$</td>
</tr>
<tr>
<td>Exporter (P)</td>
<td>$x^D + x^X$</td>
</tr>
<tr>
<td>Multinational (M)</td>
<td>$x^D + x^M$</td>
</tr>
</tbody>
</table>

Table 2: Fixed costs incurred from each potential extensive margin choice.

Firms are required to pay a fixed cost along each extensive margin, in which they
decide to operate. Table 2 lists all the total fixed costs required to be paid for each of the
possible discrete choices for firms. There is firm-level heterogeneity along the dimension of
productivities, $\theta$, which enter into their production function, which is given as follows

$$f(\theta, n^c) = \theta(n^c)^\gamma$$

where $n^c$ is labour the firm rents for production along each margin of production $c \in \{H, X, F\}$ and $0 < \gamma < 1$. Firms enter the industry without knowing their productivity draw ex-ante; it is drawn following entry. These draws follow a uniform distribution over the interval $[\bar{\theta}, \overline{\theta}]$.

I assume that firms rent their labour to produce along each extent of operation at some rate $W$, which I assume for simplicity is the same in each country.\(^5\) In effect, this reduces the firm’s intensive-margin input decision to an entirely static problem. The assumption that firms simply rent a factor of input for production along each margin is made to keep the problem tractable. I also assume that firms fetch a price $P^H$ for their output in the Home Country and a price $P^{H*}$ from selling in the Foreign Country. These two prices are taken as given by the firms. The ex-ante value that firms receive from entering this industry is given by

$$V_0 = E_\theta[V_0(\theta)],$$

where $V_0$ is a constant, found by taking an expectation over the permissible productivity draws. The conditional value to entering is given by

$$V_0(\theta) = \max[V_0^E(\theta), V_0^D(\theta), V_0^X(\theta), V_0^M(\theta)],$$

If the firm chooses to exit the industry, their value is given by

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

If instead, the firm chooses to operate as a pure domestic, their value is given by

$$V_0^D(\theta) = (-x^D) + \beta(1 - \tau^E) \left[(1 - \tau^C)(P^H \theta n^H)^\gamma - W n^H\right]$$

where at $t = 0$, the firm raises equity from its shareholders in the amount of $(x^D)$. It then returns a dividend net of taxes at $t = 1$ from the earnings generated by its Home branch.

\(^5\)This assumption can be relaxed and the same insights follow.
At $t = 0$, the shareholders discount this future dividend payment at rate $\beta \in [0, 1]$. When the firm chooses to be an exporter, it receives the value

$$V_0^X(\theta) = (-x^D) + \beta (1 - \tau^E) \left[ (1 - \tau^C) \{ P^H \theta(n^H)^\gamma - W_{n^H} \} \right]$$

$$+ (-x^X) + \beta (1 - \tau^E) \left[ (1 - \tau^C) \{ (1 - i) P^{H*} \theta(n^X)^\gamma - W_{n^X} \} \right]$$

where the parameter $i \in [0, 1]$ represents the iceberg cost associated with exporting goods to the Foreign Country. Notice that the earnings generated through exporting are assumed to be entirely taxable by the Home Government. The interpretation is that the exporting firms sell directly to consumers in the Foreign Country. Given that these firms have no business presence in the Foreign Country, they avoid generating a tax liability to the local government, as in most national tax codes. If the firm chooses to be a multinational, it’s value is given by

$$V_0^M(\theta) = (-x^D) + \beta (1 - \tau^E) \left[ (1 - \tau^C) \{ P^H \theta(n^H)^\gamma - W_{n^H} \} \right] +$$

$$(-x^M) + \beta (1 - \tau^E) \left[ (1 - \tau^{C,U}) \{ P^{H*} \theta(n^F)^\gamma - W_{n^F} \} \right]$$

where the reader should notice that the earnings from the branch in the Foreign Country are taxed at two rates — $\tau^{C,*}$ and $\tau^{C,U}$. 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 $\tau^{C,U}$. 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.

### i.2 Demand Curves

The demand curves for goods produced by the firms in each country are assumed to be continuous and decreasing functions of the prices. I denote the demand curves in Home and Foreign by $Q^{D,H}$ and $Q^{D,F}$ respectively.

### i.3 Timing

For period $t = 0$, the timing is

1. Enter the industry,
2. Draw productivity shock $\theta,$
(3) Make the discrete choice,
(4) Raise external financing,
(5) Pay fixed cost.

Then for period \( t = 1 \), the order is

(1) Hire labour along each extent of production,
(2) Produce output,
(3) Sell output in each market
(4) Distribute dividends to shareholders,
(5) Pay taxes to relevant authorities.

### ii Two Period Model Equilibrium

#### ii.1 Firm Problem Solution

In the analysis of this subsection, I restrict attention to a particular case in the analysis — that where there are positive regions over the productivity interval under the worldwide system for each discrete choice. There are naturally many other cases that can prevail, for the purpose of brevity, I defer these to Appendix A. The restrictions I place on the parameters of the problem here are

\[
\begin{align*}
\frac{x^X}{(PH^s[1 - i])^{\frac{1}{1 - \gamma}}} &> \frac{x^D}{(PH)^{\frac{1}{1 - \gamma}}} \\
\frac{x^M}{(1 - \tau C^s)} &> \frac{x^X}{[(1 - i)^{\frac{1}{1 - \gamma}}(1 - \tau C)]}
\end{align*}
\]  

The conditions intuitively say that the fixed cost of assuming the next level of discrete choice is expensive, in fixed cost terms, relative to the benefit. If one or more of these conditions were to not hold, some of the discrete choices would never be chosen by firms, as it would be sufficiently low cost to simply upgrade to the next level and receive the associated benefits. In addition to ensuring that a non-zero region appears for each discrete choice in the solution, these assumptions are also consistent with fixed cost estimates I obtain in calibrating the dynamic model later on.
Figure 3: Solution under wide regime

The solution under the worldwide system under the parameter assumptions made is presented in figure 3. The solution resembles that, which eventuates from Melitz, Helpman and Yeaple (2004). Note that there are implicit assumptions placed on the parameters to ensure that the cutoff values listed in the solution side within the interval of permissible productivities, $[\bar{\theta}, \bar{\theta}]$. The cutoffs in the figure are functions of the parameters, prices and tax rates in the problem. I denote the overall mass of firms in the problem by $M$. Given that the productivities are assumed to be $u[\bar{\theta}, \bar{\theta}]$, the mass distribution over productivities is everywhere $M/(\bar{\theta} - \theta)$.

A particular ordering of firms prevails, which is based on their productivities on the interval of possible $\theta$ values. The firms that are least productive are unable to justify the cost of establishing a Home branch, which induces them to exit the industry. Firms at the next-highest grouping of productivities outlay the extra cost to operate as exporters. Firms that are even more productive have a sufficiently high return to inputs that, it is optimal to pay the higher fixed cost $x^M$ to establish a Foreign subsidiary in order to avoid incurring the iceberg cost of exporting.

### ii.2 Industry Equilibrium

The definition of the industry equilibrium is given as follows. It is defined as a list $\{P^H, P^H, \mu, M\}$ such that

1. Home firms optimise taking prices as given,
2. The free-entry condition for Home firms holds, i.e. $V_0 = 0$,
3. $\mu(\theta)$ is the distribution of firms in period $t = 1$,.
(4) $\mathcal{M}$ is the mass of Home firms,

(5) $P^H$ and $P^{H*}$ are the prices that clear the Home and Foreign goods markets respectively.

iii Policy Counterfactual

I study the policy counterfactual in two stages — first, I hold the prices constant at the pre-change levels to study the pure extensive-margin investment effect. Then I allow the prices to adjust to capture the additional industry equilibrium effects.

iii.1 Effect without Price Changes: Extensive Margin Channel

When the Home Country switches to a territorial system, the appears as in figure 4. The red lines correspond to the outcome of the policy change, while the shadowed blue lines show where the cutoffs were prior to the policy change. In presenting this solution, I assume that the prices of output fetched at Home and in Foreign from output are held constant. This figure is designed to give an idea as to how Home firm behaviour would change, without the disciplining device of price changes.

![Figure 4: Solution under territorial regime without Price Changes](image)

The main effect is that some firms, who were of an intermediate productivity that chose to be exporters under the worldwide system, will now find it optimal to operate as multinationals. Removal of the second layer of taxation from multinationals foreign earnings increases the value of the associated discrete choice. As a result, more firms in the distribution will be able to justify the higher fixed cost.
iii.2 Effect with Price Changes: Equilibrium Price Channel

To deduce the full impact of the policy change, one needs to consider the effect on the prices fetched by Home firms from sales at Home and abroad. Unfortunately, closed-form solutions for the two prices cannot be obtained. However, if one applies the implicit function theorem to the market clearing condition for the Foreign goods market, one can infer that \( \frac{\partial P^H}{\partial \tau_{C,U}} > 0 \). That is — a rise in the repatriation tax rate by the Home Country necessitates an increase in the Foreign goods price. The intuition is that a higher tax rate disincentives Home firms from operating as multinationals. Some multinationals will instead choose to operate as exporters. As a consequence, there is downward pressure on output available for sale in the Foreign Country, given that exporters lose a fraction of their output through iceberg costs.

To deduce the effect on the Home output price, one can again apply the implicit function theorem, this time to free-entry condition for Home firms. The application reveals that \( \frac{\partial P^H}{\partial \tau_{C,U}} > 0 \) provided that the upper bound on the support of the productivity distribution is not excessively high. This follows from the fact that \( P^H \) is used to pin-down the free-entry condition. If \( \bar{\theta} \) is very high, then the value function for Home firms will be very responsive to rises in \( P^H \). This then has the potential to translate into a situation where the increase in \( P^H \) from the higher tax may necessitate a decrease in \( P^H \) to compensate.

Figure 5 presents graphically how the price changes impact the firm distribution, under the assumption that the price changes are relatively small: the new prices and firm mass are marked with tildes. These small price changes ultimately ensure that the four regions of exit, domestic, exporter and multinational are all preserved after the policy change. If the price changes were more extreme, notice that some of these regions may disappear. A natural question, which arises, is what would drive the price changes to be large or small? The short answer is the three tax rates — \( \tau_C, \tau^C \) and \( \tau_{C,U} \) — with particular focus on their sizes relative to each other. The price changes act as a disciplining device, which serve to moderate the benefit to firms of this policy change. If, prior to the policy change \( \tau_{C,U} = \tau_C - \tau^C \), then the smaller is \( \tau^C \), the larger the extensive-margin impact of going territorial. This then translates into a larger price effect.

The red dotted lines in 5 illustrate how the cutoffs change when these price effects are

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6To deliver a solution of this form in the wake of the policy change, I also make the assumption given in equation (1) for the new prices.
also considered. The shadowed red and blue lines show the post-change outcome without price effects and the pre-change environment respectively.

There are three things to notice when comparing the results of figures 4 and 5. Firstly, the rise in the fraction of firms operating as multinationals from the policy change is more moderate when accounting for the price effects. The reduction in the repatriation tax is partially countered by a fall in the Foreign price, which reduces and mitigates the increase in the benefit of switching discrete choices. Secondly, figure 5 sees changes in the lower two cutoffs, which contrasts against the result in figure 4, which sees them remain the same. Finally, the mass of firms rises when the prices are allowed to change.

The reduction in the Foreign price results in a rise in the productivity standard required to justify being an exporter over a domestic firm. This, combined with the downward shift of the multinational cutoff causes an unambiguous decline in the fraction of firms operating as exporters. Similarly, the fall in the domestic output price makes it harder for firms at the very bottom of the productivity distribution to justify operation, meaning that the fraction of exiting firms also rises.

A prediction of the changes depicted in figure 5 is that the average productivity of the Home firms, which choose to operate, will rise. This follows from the upward shift of the cutoff between being an exiting firm and a domestic. Notice that the magnitude of the cutoff shift will depend on the size of the price effect; as the price decrease becomes larger, the cutoff shifts further to the right. This effect on productivity of the policy change is likely an effect that would be unforeseen by policymakers, who likely think that this current worldwide system of taxation only affects large multinationals. The reality however is that this current system has almost a protectionist flavour to it in so far as it serves to benefit
unproductive domestic firms.

As the tax is removed, the mass of firms operating in the industry rises. The intuition can be viewed in light of the free-entry condition of the industry equilibrium. Fewer losses of overseas earnings through multinational taxes increase the value to being an entrant into the industry ex-ante. More firms enter, which drives down the Home output price. The rise in the mass of firms is met by higher demand for output due to the lower price.

The effect of the policy change on dividend distributions at \( t = 1 \) is depicted in figure 6. The idea is that downward pressure is put on distributions from the perspective that the prices fetched by firms in each of the two markets are decreasing. Moreover, downsizing by firms in certain regions, (e.g. from exporting to being a domestic), have a negative impact. However, the switching of some firms from exporting to being a multinational push distributions upwards from the perspective that they are being taxed on their earnings from servicing Foreign at a lower rate, in addition to the fact that they now save on iceberg costs. The firms who were multinationals prior to the policy change and remain so afterwards save on repatriation taxes, with the savings being distributed to shareholders. Overall the effect is qualitatively ambiguous, but if the price changes are relatively small, the upward arrows will dominate.

Finally, the effect on Home Government tax collections is the result of several contrasting tensions. In switching to the territorial system, the Home Government loses tax collections on repatriated earnings by multinationals and income taxes on exports due to extensive margin changes. In contrast, it receives more in domestic earnings taxes and those on dividends, (assuming the price change is small). Under the worldwide system, the
Home Government collects taxes $T^H$ given by

$$T^H = \tau^C [P^H Y^H - WN^H] + \tau^C [P^H^* Y^X - WN^X] + \tau^{C,U} [P^H^* Y^F - WN^F] + \tau^E E$$

After switching to the territorial system, the tax collections are given by

$$T^H \uparrow = \tau^C [\tilde{P}^H Y^H - WN^H] + \tau^C [\tilde{P}^H^* Y^X - WN^X] + \tau^{C,U} [P^H^* Y^F - WN^F] + \tau^E E \uparrow$$

where the arrows underneath each expression indicate the direction of the change in the collections on each source of taxable income. Note that the effect on export income is technically ambiguous given that the mass of firms rises from the policy change. The overall effect on Home tax collections depends on the magnitude of the positive changes relative to the negatives. Ultimately, the question of how this policy change will affect the macroeconomy is an empirical question, necessitating a carefully calibrated model to assess the issue quantitatively. The next section outlines the environment of this quantitative model in detail.

**IV Structural Model Environment**

The structural model embeds the discrete choice environment of the simple two period model into a dynamic context. The environment resembles that of Gomes (2001); who includes financial frictions in the basic Hopenhayn (1992) model; but in an open economy setting. There are two countries in the model: Home (H) and Foreign (F). There are six types of agents: Home firms, Home households, the Home Government, Foreign firms, Foreign households and the Foreign Government.

There are two types of consumption goods in the model: those produced by Home firms (referred to as Home goods) and those by Foreign firms (referred to as Foreign goods). There is a representative household in the Home and Foreign Countries; they have preferences over consumption over each of the two good types in addition to receiving disutility from labour. Home firms supply Home goods to the Foreign households both through exports and through multinationals producing directly in Foreign. I abstract from Foreign multinationals and assume all Foreign goods to Home households through exports.
just to keep the setup simple.\footnote{Clearly this U.S. policy change would have an impact on Foreign firms and how they service the Home market in this same discrete choice framework. For computational tractability, I abstract from these considerations here, but address such issues in a follow-up paper called "Cross-Border Effects of U.S. Tax Policy".}

The markets for labour and the two types of consumption goods are assumed to be geographically segmented; a graphical representation is given in figure 7. Home households supply labour to the Home domestic and exporting firms. Foreign households supply labour to the Foreign firms and Home multinational firms.

I assume that only firms are able to transport their goods from one country to the other due to some barrier, which makes it impossible for households to arbitrage price differences. This segmented market structure generates a situation where the wages and consumption good prices can differ across the two countries. The numeraire in the model is set to be the goods produced and sold at Home by the Home firms. I will solve endogenously for the Home wage and the price of Home goods in Foreign. All remaining prices will be fixed to minimise on the computational burden, (more details on this in section V.vi). Figure 8 shows the situation for prices graphically.
i Households

i.1 Home Households

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

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

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

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

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

$$\max_{C^H_t, C^F_t, L_t, s_{jt}} \mathbb{E}_0 \left[ \sum_{t=0}^{\infty} \beta^t U(C^H_t, C^F_t, \bar{L}_t) \right]$$

subject to the constraint

$$P_t C_t + \int \tilde{p}_t s_t \tilde{\mu}_t (dk^H_t, dk^X_t, dk^F_t, db_t, d\theta_t) = L_t W_t (1 - \tau^L) + \int (\tilde{p}_t + [1 - \tau^E]d_t) s_t \tilde{\mu}_t (dk^H_t, dk^X_t, dk^F_t, db_t, d\theta_t)$$

where $W_t$ is the rate, at which the households are compensated for their labour. $\tilde{p}_t$ is the after-dividend stock price for a firm with a given state, $s_t$ is the fraction of shares held and $d_t$ is the net distributions from the a given firm to the household after taxes. The variable $\tilde{\mu}_t (k^H_t, k^X_t, k^F_t, b_t, \theta_t)$ describes the measure of Home firms across the states.

### i.2 Foreign Households

The Foreign Country also has a period utility function of the form $U^*(C^H^*, C^F^*, L^*)$ where these variables with * superscripts correspond to the Foreign household. $L^*$ denotes their supply of labour goods and consumption, $(C^*)$, is a CES aggregator of the two types of goods that Foreign households consume — those produced by Home-based firms and those produced by Foreign-based firms. The expression for $C^*$ is

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

where $C^H^*$ is consumption of Home goods and $C^F^*$ is consumption of Foreign goods and $\eta$ is the same as for the Home household. See that I allow for the share parameter, $\lambda^*$, to differ for the Foreign household. The aggregated price of consumption goods faced by the Foreign household is given by

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

where $P^H^*$ represents the price of goods produced by firms from the Home Country and $P^F^*$ represents the price of goods produced by Foreign firms. The Foreign household
formally solves the optimisation problem

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

subject to the constraint

\[
P_t^* C_t^* = L_t^* W_t^* (1 - \tau^{*L}) + W_t^* \Pi_t^*
\]

where \(W^*\) denotes the wage received by Foreign households and \(\Pi^*\) is aggregate distributions from the Foreign firms to the households, delivered in terms of units of labour. The distributions from firms takes this simple form given that these Foreign firms are assumed to be homogeneous. I also assume that labour income in the foreign country is untaxed as studying the optimal taxation problem for the Foreign Government is beyond the scope of this paper.

ii    Firms

ii.1 Home Firms

In each period at the extensive margin, firms make a discrete choice from the following four options\(^8\)

(1) Exit the industry (E),

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

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

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

As in the two period model, firms pay fixed investment costs associated with production in each of its forms above. Differential fixed costs across discrete choice options (2) – (4) ultimately result in a hierarchy of firms, where the most productive of firms on average

\(^8\)A fifth choice that I’ve considered in earlier versions of this paper is to allow U.S. multinationals to change their tax status to a Foreign multinational through undertaking a corporate inversion. Details regarding a version of the model that include this option as another discrete choice are given in Appendix B. I omit this choice from the current model as it has no significant impact on the counterfactual results. Moreover, as per Boehm, Flaaen & Pandalai-Nayar (2018), less than 1% of U.S. multinationals undertake such a change in a given period.
choose to be multinationals and the least productive sell their capital stocks for scrap and exit the industry.

Firms of intermediate productivity, who wish to expand their production beyond that of a domestic firm, so as to increase their value to shareholders, can choose to be an exporting firm or a multinational. A lower fixed investment cost is incurred to export than to operate with a subsidiary in Foreign, but exporting also incurs a proportional iceberg cost, denoted by $i \geq 0$. Operating with a subsidiary in Foreign saves on this cost.

A Home firm has can hold up to two capital stocks — one in the Home Country and another in the Foreign Country. Specifically, a domestic or exporting firm will have only a capital stock at Home, whereas a multinational will have one at Home for production of goods for domestic sale and another in the Foreign Country for servicing the overseas market. A firm with the status of exporter will produce its goods to be sent overseas using its capital stock in the Home Country. That is — they will utilise their Home capital stock once for production of goods to be sold domestically and then again for sale abroad.

### ii.1.1 Technology

Home firms in this model are assumed to behave competitively and the good they produce is homogeneous. In what follows, time is indexed by subscript $t$. The superscript $c \in \{H, H^*\}$ denotes whether the variable in question is a stock or flow corresponding to production for consumption in the Home Country ($H$) or produced in the Foreign Country ($H^*$).

I omit notation at the firm level for notational ease. The production function they utilise for output has two inputs — the capital stock and labour — it exhibits decreasing returns to scale

$$y^c_t = \theta_t(n^c_t)\gamma(k^c_t)\alpha, \quad 0 < \alpha, \gamma < 1, \quad \alpha + \gamma < 1 \quad (5)$$

where $y^c_t$ is firm output, $k^c_t$ is the capital stock and $\theta_t$ is an idiosyncratic productivity shock. Notice that the productivity shock has no $c$ superscript — I assume it is the same in each production function for simplicity in keeping the size of the state space small. The

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9Extending this model to the case of differentiated products with monopolistic competition is again another direction for future research.

10It is obviously important to think about complementarities between the different capital stocks when analysing multinational firms. Getting the specification correct is difficult and can become arbitrary though. As a result, I abstract from such an interaction in this version of the paper.
productivity shock is assumed to be distributed as follows
\[ \log(\theta_t) = \rho \log(\theta_{t-1}) + \sigma_\theta \epsilon_t, \quad \epsilon_t \sim N(0, 1) \] (6)

where \(0 < \rho_\theta < 1\) captures persistence in the shock process while \(\sigma_\theta > 0\) measures volatility. The probability distribution function for the technology shock is denoted by \(G(\theta_t|\theta_{t-1})\). The law of motion for the capital stocks the firm holds depends on its status. Should the firm be a multinational, the laws of motion follow
\[ k_{t+1}^c = i_t^c - (1 - \delta)k_t^c \] (7)

where \(i_t^c\) denotes investment at time \(t\) in \(c \in \{H, H^*\}\) and \(0 < \delta < 1\) represents the common depreciation rate. Moreover, should a firm opt to be a domestic for the period, its sole capital stock, \(k_t^H\), will also follow the above. An exporter’s law of motion, however, is slightly more complicated due to the assumption that it utilises \(k_t^H\) twice in any given period. That is — the firm produces output for sale in the Home Country and for export using the same capital stock, albeit with different levels of labour hired. Consequently, the law of motion for an exporter’s capital stock will follow
\[ k_{t+1}^H = i_t^H - (1 - \delta)^2k_t^H \]

where the squared depreciation term follows from the double-utilisation of the capital stock. The interpretation is that the firm uses the same factory to produce its domestic goods and export goods.\(^{11}\)

Finally firms pay an adjustment cost for changing each of their capital stocks
\[ \Phi^c(i_t^c, k_t^c) = \frac{\phi}{2} \left( \frac{i_t^c}{k_t^c} \right)^2 k_t^c, \] (8)

\(^{11}\)I’ve also tried other ways of specifying the exporter production process — specifically by assuming that they hold a separate capital stock for production of export goods. The interpretation of this alternative would be that exporters have two separate plants — one for production of domestically-sold goods and another for exported goods. This assumption seems far from reality however, in addition to adding another continuous state variable to the problem. Another alternative could be to assume that all of the exporter’s production takes place at once and then some fraction of the output is sent overseas. The issue with this is that, given that firms are price takers in this model, this will expose exporters to corner solutions based on the size of \(P^H\) relative to \(P^{H^*}\). It is possible in this scenario for exporters to never sell their goods domestically, which again doesn’t seem to square very well with the real world.
which is of a standard convex form designed to preserve concavity of the firm period payoff function. It is worth mentioning that the combination of the capital adjustment costs and persistent productivity distribution promote the idea that a firm’s status is persistent over time.

### ii.1.2 Stochastic Repatriation Tax Rate

I assume that the Home firms are exposed to idiosyncratic shocks to their repatriation tax rate under the worldwide system to capture the notion of anticipation of “repatriation tax holidays”. Specifically, multinationals may find it optimal to save-up large amounts of earnings abroad in anticipation of a reduction in their effective repatriation tax rate in some future period. This feature is added to the model with an eye to avoiding over-stating the effects of the counterfactual results. Notice that this shock is assumed to be idiosyncratic to the firms, rather than an aggregate shock, for computational tractability.\(^ {12} \)

I denote the time-varying repatriation tax rate as \( \tau_{t}^{C,R} \). Assume for the moment that the rate is drawn from some transition function denoted by \( Q_{\tau}(\tau^{C,R}) \), (which will be discretised later).

### ii.1.3 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

\[
\mathbb{E}_{0} \sum_{t=0}^{\infty} \beta^{t}(1 - 1_{d_{t} \geq 0 \tau^{E}})d_{t}
\]

(9)

where \( 0 < \beta < 1 \) represents the discount factor of the firm, \( d_{t} \) is the period \( t \) dividend it pays and \( \tau^{E} \) 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

\[
d_{t} = e_{t} - 1_{e_{t} < 0}[\zeta(e_{t})]
\]

(10)

where \( e_{t} \) is the dividend to households prior to the payment of equity issuance costs and \( \zeta(e_{t}) \) is a convex function of the pre-cost dividend. If \( e_{t} \) is negative — denoting a seasoned

\(^{12}\) Obviously it is more natural to think about such a shock as being common to all firms. Extending the model to this case will be very burdensome computationally and is an avenue for future research.
equity issuance — then the firm will pay some issuance cost. The issuance cost is of the form

\[ \zeta(e_t) = \zeta_1 |e_t| + \zeta_2 e_t^2 \]  

(11)

for \( \zeta_1, \zeta_2 > 0 \), which says that the equity issuance premium is comprised of a cost proportional to the size of the issuance in addition to a squared term. Notice, I choose to include the squared term in the issuance cost so as to enable the model to pin-down an internal optimal solution for cash holdings when \( b_{t+1} < 0 \). One can think of the cost as capturing factors such as floatation fees paid to underwriters in addition to information asymmetries.

ii.1.4 Borrowing

Home firms are able to borrow riskless collateralised debt in each period in the Home country. I abstract from borrowings in the Foreign country to keep the state space small. I consider the assumption regarding the debt being riskless to be relatively innocuous given the emphasis on 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

\[ b_{t+1} \leq \xi^H h_{t+1}^H + \xi^{H^*} h_{t+1}^{H^*} \]  

(12)

where \( b_{t+1} \) represents net debt chosen in period \( t \) to be repaid at \( t + 1 \). \( 0 < \xi^c < 1 \) for \( c \in \{ H, H^* \} \) is the fire-sale value of the capital stock for given \( c \). The right-side of inequality (12) says 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. Notice that the right-side of (12) contains the fire-sale values of both of its permissible capital stocks.

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 $b_{t+1} (1 - 1/(1 + r)) \tau^C$.

<table>
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<tr>
<th>Multinational</th>
<th>Moody’s</th>
<th>S&amp;P</th>
<th>Fitch</th>
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<td>AA</td>
<td>AA-</td>
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<td>AAA</td>
<td>AAA</td>
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Table 3: Credit ratings (long term debt) of 20 largest U.S. multinationals

ii.1.5 Fixed Costs of Production and Firm Entry

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

Notice that these fixed costs are paid in each period. An alternative specification could involve firms paying a one off fixed capital expenditure and then paying fixed operating costs in the periods subsequent. Identification of these two different costs, however, would prove difficult in the calibration exercise. Moreover it would be unlikely to substantially
change the results from a qualitative viewpoint; the removal of the tax will still drive similar results in terms of extensive-margin switching of firms.

A mass of new entrants come into the industry each period, where the rate of entry is denoted by $R$. New entrants are required to pay a fixed cost denoted by $x^T$. Their initial productivity draw comes from a probability distribution function given by $\bar{G}(\theta)$; similarly, their draw of the initial repatriation tax rate comes from distribution denoted by $\bar{H}(\tau^{H,U})$. I take the distribution to be a uniform over the productivity draws.\textsuperscript{13} I take $\bar{H}(\tau^{H,U})$ to be such that there is a 20\% chance of getting a zero repatriation tax next period.

The new entrants can issue debt to fund their initial investment; they can also use an initial public offering on equity. These new entrants are always assumed to come-into the world as domestic firms, rather than giving them the choice of whether to start-off as multinationals or not, so as to avoid over-stating the quantitative impact of the equilibrium price channel.\textsuperscript{14}

\textbf{ii.1.6 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

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

where $P_t^{H*}$ is the output price fetched in the Foreign Country. Given the chosen level of foreign capital and repatriated earnings, the period dividend for a firm operating as a

\textsuperscript{13}This assumption is made for simplicity. It seems reasonable from the perspective that most start-up firms likely have a uniform prior in terms of their probability of success going into the future.

\textsuperscript{14}An earlier version of this paper allowed the entrants to choose their status to be multinationals straight away. In removing this option, the quantitative estimates of the counterfactual are reduced.
multinational is given by

\[ e^M_t = \left[ (1 - \tau^C) \left( P^H_t \theta_t(k^H_t)^\alpha (n^H_t)^\gamma - W_t n^H_t \right) - i^H_t - x^D - \Phi^H(i^H_t, k^H_t) \right] + \]

\[ \left[ \frac{1 - \tau^C, U - \tau^C, s}{1 - \tau^C, s} \right] u_t - j_t - x^M_t \right] + \left[ \frac{b_{t+1}}{1 + r} - b_t + b_t \left( 1 - \frac{1}{1 + r} \right)^r \right]. \] (14)

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

\[ e^X_t = \left[ (1 - \tau^C) \left( P^H_t \theta_t(k^H_t)^\alpha (n^H_t)^\gamma - W_t n^H_t \right) - i^H_t - x^D - \Phi^H(i^H_t, k^H_t) \right] + \]

\[ \left[ \frac{1 - \tau^C}{1 + r} \right] (1 - i) P^H_t \theta_t(k^H_t)^\alpha (n^X_t)^\gamma - n^X_t - x^X_t \right] + \]

\[ \left[ \frac{b_{t+1}}{1 + r} - b_t + b_t \left( 1 - \frac{1}{1 + r} \right)^r \right]. \] (15)

Notice that the price fetched from export income is equal to \( P^H_t \) rather than \( P^H_t \). Also notice that the tax rate on export income is given by the Home corporate tax rate — this follows from the fact that exporting firms do not have Foreign subsidiaries — meaning that they are unable to minimise their tax burden on such income through deferral. The revenue that the exporting firms receive is scaled by \( (1 - i) \) to account for the iceberg cost associated with sending the goods to the Foreign Country. The period dividends for a purely domestic firm are given by

\[ e^D_t = \left[ (1 - \tau^C) \left( P^H_t \theta_t(k^H_t)^\alpha (n^H_t)^\gamma - W_t n^H_t \right) - i^H_t - x^D - \Phi^H(i^H_t, k^H_t) \right] + \]

\[ \left[ \frac{b_{t+1}}{1 + r} - b_t + b_t \left( 1 - \frac{1}{1 + r} \right)^r \right], \] (16)

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

\[ e^E_t = \xi^H k^H_t + \xi^{H^*} k^{H^*}_t, \] (17)

which states that the firm pays to shareholders the firesale values of its current period capital stocks, less what is owed to debtholders. Taken together, these equations, (13), (14), (15), (16) and (17) show that there are several sources and uses of funds for Home firms. These sources depend on the discrete choice, which has been made by the firm. They potentially include debt markets, equity markets, Home production income, Foreign
production income and export production income.

ii.2 Foreign Firms

Foreign firms produce are assumed to be homogeneous; there is assumed to be a representative firm. They produce using a very simple constant returns to scale production function of the form

\[ Y_{Ft}^* = N_{Ft}^* \]

where \( Y_{Ft}^* \) represents output and \( N_{Ft}^* \) is labour they hire. The optimisation problem they solve is given by

\[
\max_{\{N_{Ft}^*\}} (1 - \tau_C) \left[ P_{Ft}^* (Y_{Ft}^* - X_{t}^*) + (1 - i)P_{t}^F X_{t}^* - W_{t}^* N_{Ft}^* \right]
\]

where \( X_{t}^* \) represents the amount of goods exported to the Home Country. The price these firms fetch for their output in each market is determined competitively and then taken as given by the Foreign firms. These firms fetch prices \( P^F \) and \( P_{t}^F \) for their goods in the Home and Foreign Countries respectively. The earnings these firms generate are taxed at the Foreign domestic corporate tax rate.\(^{15}\) The shareholders of this representative Foreign firms are the Foreign household.

iii Government

iii.1 Home Government

The Home Government has four sources of tax revenue: Home corporate taxes, Home repatriation taxes, dividends and labour. The amount of revenue they raise for a given period is as follows

\[
T_t = \tau_C (Y_t^H - W_t N_t^H) + \tau_C (P_{t}^H Y_t^X - W_t N_t^X) + \tau_C U_t + \tau E_t^+ + \tau L_t
\]

where \( T_t \) is their aggregated tax collections, \( Y_t^H \) is production by Home firms, \( N_t^H \) is labour hired by Home firms for production of domestic goods, \( Y_t^X \) is production by exporting Home

\(^{15}\)It is clear to see that these firms will generate zero earnings due to the assumption of constant returns to scale and competition. Nonetheless, I include the tax payment to the Foreign Government for completeness.
firms, $N_t^X$ is labour hired by Home firms for production of export goods, $U_t$ is aggregate repatriations by Home firms and $E_t^+$ is aggregate dividends paid to Home households. I assume that the Home Government is unable to issue sovereign bonds to keep the problem parsimonious.

### iii.2 Foreign Government

The Foreign Government is assumed to have two sources of tax income — their domestic corporate taxes and personal taxes. The expression for their tax revenues is given by

$$P^F_t T_t = \tau^C [P^F_t (Y^F_t - X_t^*) + P^F_t X_t^* - W_t^* N_t^F] + \tau^C (P_t^H Y^H_t - W_t^* N_t^F) + \tau^L W_t^* L_t^*$$

(20)

where $T_t^*$ is tax collections by the Foreign Government, $Y^H_t$ is aggregate production by Home multinationals in the Foreign Country and $N_t^F$ is aggregate labour hired by Home firms in Foreign.

### iv Timing

Here the timing of each period in the dynamic model is described.

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

2. Receive the period $t$ productivity draw and repatriation tax shock — $\theta_t$ and $\tau_C, \tau_U$ respectively.

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

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

5. Home entrants pay a fixed cost to enter.

6. Home entrants choose intensive margin investment in addition to financial variables.

7. Home and Foreign households choose how much to consume and work.

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

V Structural Model Equilibrium

Here I consider the stationary competitive equilibrium of the model. I describe the equilibrium behaviour of households and firms in turn, following which the definition of the equilibrium is outlined.

i Households

i.1 Home Households

I assume a simple functional form for the period utility function of the Home household of

\[ U(C^H, C^F, L) = \log(C^H, C^F) + \chi(1 - L). \] (21)

where \( \chi > 0 \) is a parameter that governs their disutility of labour. Given that there are no aggregate shocks in this model, the problem of the Home household essentially simplifies down to a static problem, just as in Gomes (2001), of the form

\[
\max_{C_t, L_t} \log(C_t) + \chi(1 - L_t)
\]

subject to the constraint

\[
P_t C_t = L_t W_t (1 - \tau^L) + E_t^+ (1 - \tau^E) - E_t^-.
\]

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

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

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

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

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

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

### i.2 Foreign Households

Rather than assuming a utility function for the Foreign household and solving endogenously for their optimal consumption and labour supply, I choose to instead assume that in equilibrium, their labour supply is supplied perfectly elastically at the wage $W^*$. That is, the quantity of labour in the Foreign market is determined by the intersection of the flat labour supply curve and the amount demanded by the Home multinationals and Foreign firms. I make this assumption for the purpose of simplicity; in particular, I will calibrate the value of $W^*$, which will be taken as given by the firms operating in the Foreign Country. The interpretation is that the Home firms are “small” when it comes to hiring of labour in Foreign and they are unable to influence the local wage rate. The consumption of the Foreign household can then be read-off the Foreign budget constraint as

\[ C_t^* = \frac{W_t^* L_t^* (1 - \tau^L)}{P_t^*} + \frac{W_t^* \Pi_t^*}{P_t^*}. \]
ii Firms

ii.1 Incumbent Home Firm Problem Recursive Formulation

Denote the incumbent firm value function at period \( t \) by \( V_t(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) \). We can then write it in the following form

\[
V_t(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = \max_{s \in \{E,D,X,M\}} V_{t,s}^{s}(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U})
\]

where the index \( s \) is over all the potential discrete choices the firm can make at time \( t \).

The firm’s solution to this extensive margin decision will be a set of cut-off productivity levels, which will be functions of its other state variables. The difference of this model from the simple two period model of section IV is that the discrete choices of the firm will now depend on its current state.

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

\[
V_t^E(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = (1 - 1_{d_t^E \geq 0})d_t^E(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U})
\]

\[
d_t^E(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = \xi_t^H k_t^H + \xi_t^{H*} k_t^{H*} - b_t,
\]

which notice is a weakly positive number due to the collateral constraint given in equation (12). Next if the firm chooses to operate only as a domestic firm then the continuation value is given by

\[
V_t^D(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = \max_{\{k_{t+1}^H, b_{t+1}, e_t^D\}} (1 - 1_{d_t^D \geq 0})d_t^D(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U})
\]

\[
+ \beta E_t[V_{t+1}(k_{t+1}^H, 0, b_{t+1}, \theta_{t+1}, \tau_{t+1}^{C,U})]
\]

such that

\[
d_t^D(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = e_t^D(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) - 1_{e_t^D < 0} \zeta_t^D(e_t^D(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}))
\]

\[
e_t^D(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = (1 - \tau_t^C)\left(P_t^H \theta_t(k_t^H)^\alpha (n_t^H)^\gamma - W_t n_t^H\right) - x_t^D - \phi_t(\alpha_t, \phi_t)
\]

\[
+ \xi_t^{H*} k_t^{H*} + \frac{b_{t+1}}{1+r} - b_t + b_t \left(1 - \frac{1}{1+r}\right) \tau_t^C
\]

\[
b_{t+1} \leq \xi_t^H k_{t+1}^H.
\]
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. Notice also that the non-multinational firm receives the liquidation value of the Foreign and export capital stocks it enters the period with should it be positive, from downsizing its operations. The recursive formulation for an exporter is given by

\[ V_X^t(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t) = \max_{\{k^H_{t+1}, k^{H*}_{t+1}, b_{t+1}, \theta_{t+1}, \tau^C_{t+1}\}} (1 - 1_{d^E_t \geq 0}) d^X_t(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t) \]

\[ + \beta E_t[V_{t+1}(k^H_{t+1}, 0, b_{t+1}, \theta_{t+1}, \tau^C_{t+1})] \]

such that

\[ d^X_t(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t) = e^X_t(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t) - 1_{e^X_t < 0}(e^X_t(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t)) \]

\[ e^X_t(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t) = (1 - \tau^C)\left(P^H_t \theta_t(k^H_t) \alpha(n^H_t)^\gamma - W_t n^H_t\right) - x^D - i^H - \Phi^H(i^H, k^H_t) \]

\[ + (1 - \tau^C)\left(1 - i\right)P^H_t \theta_t(k^H_t) \alpha(n^X_t)^\gamma - W_t n^X_t\] \[ - x^X \]

\[ + \xi^H k^{H*} + b_{t+1} - b_t \left(1 - \frac{1}{1 + \rho}\right) \tau^C \]

\[ b_{t+1} \leq \xi^H k^{H*}_{t+1}. \]

Notice that the firm who chooses to be an exporter has the ability to borrow up to the firesale value of its domestic good production and export production capital stocks. The value of the firm choosing to be a multinational this period is given by

\[ V^M_t(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t) = \max_{\{k^H_{t+1}, k^{H*}_{t+1}, b_{t+1}, d^M_t, \theta_{t+1}, \tau^C_{t+1}\}} (1 - 1_{d^M_t \geq 0}) d^M_t(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t) \]

\[ + \beta E_t[V_{t+1}(k^H_{t+1}, k^{H*}_{t+1}, b_{t+1}, \theta_{t+1}, \tau^C_{t+1})] \]
The period dividends net of taxes/production costs are given by

\[
d_t^M(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t) = e_t^M(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t) - \epsilon_t^M < 0 (e_t^M(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t))
\]

\[
e_t^M(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t) = [(1 - \tau^C) (P_t H \theta_t (k^{H*}_t)^\alpha (n^H_t)^\gamma - W_t n^H_t) - i^H_t - x^D - \Phi^H(i^H_t, k^H_t)]
\]

\[
+ \left[\frac{(1 - \tau^C U - \tau^C_s)}{1 - \tau^C} u_t - j_t - x^M \right] + \left[\frac{b_{t+1}}{1 + r} - b_t + b_t \left(1 - \frac{1}{1 + r} \right) \tau^C \right]
\]

\[
u_t = (1 - \tau^C) (P_t H \theta_t (k^{H*}_t)^\alpha (n^H_t)^\gamma - W_t n^H_t) + j_t - i^H_t - \Phi^H(i^H_t, k^H_t)
\]

\[j_t, u_t \geq 0\]

\[b_{t+1} \leq \xi^H k^H_{t+1} + \xi^{H*} k^{H*}_{t+1}.
\]

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.

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, \((k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\) due to the relatively complicated nature of the problem. The optimal policy functions are denoted by \(k^H_{t+1} = h^H_k(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\), \(i^H_t = h^H_i(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\), \(k^{H*}_{t+1} = h^{H*}_k(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\), \(i^{H*}_t = h^{H*}_i(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\), \(u_t = h_u(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\), \(e_t = h_e(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\) and \(b_{t+1} = h_b(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\). I define another choice variable \(z_t(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\), 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 domestic, exporter or multinational firm). Finally the output policy functions are denoted by \(y^H_t = h^H_y(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\), \(y^X_t = h^X_y(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\) and \(y^F_t = h^F_y(k^H_t, k^{H*}_t, b_t, \theta_t, \tau^C_t, \tau^U_t)\).

### ii.2 New Entrant’s Problem

Recall that the firm pays the initial fixed cost of \(x^T\) to enter the industry. A Home firm who enters the industry is allowed to invest at the intensive margin in a Home capital stock;
they are prohibited however from investing in a capital stock for the Foreign Country. I make this assumption to ensure that the results of the counterfactual are not over-stated with regard to the equilibrium price channel. That is — if firms could enter the industry with large overseas capital stocks, the quantitative results will be biased upwards. New entrants are thus assumed to enter the industry initially as domestic firms; following their entry period, they can decide whether or not to invest in an overseas capital stock as well.

The recursive formulation for a new entrant is thus given as follows

\[ V_t^T = \max_{k_{t+1}, i_t} -i_t^H - x^T + \frac{b_{t+1}}{1+r} + \beta \left( \int_{\theta_{t+1}, \tau_{t+1}^{C,U}} V_t(k_{t+1}, 0, b_{t+1}, \theta_{t+1}, \tau_{t+1}^{C,U}) \bar{G}(d\theta_{t+1}) \bar{H}(d\tau_{t+1}^{C,U}) \right) \]

which is solved subject to

\[ b_{t+1} \leq \xi^H k_{t+1}^H \]
\[ i_t^H = k_{t+1}^H. \]

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

**ii.3 Cross-Sectional Distribution of Home Firms**

Denote the cross-sectional distribution of Home firms at time \( t \) by \( \mu_t(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) \); it evolves according to the following law of motion

\[
\mu_{t+1}(k_{t+1}^H, k_{t+1}^{H*}, b_{t+1}, \theta_{t+1}, \tau_{t+1}^{C,U}) = R_t \int_{\tau_{t+1}^{C,U}, \theta_{t+1}, b_{t+1}, \tau_{t+1}^{C,U}} \frac{1}{h_{k^H}^E} = h_{k^H}^E = k_{t+1}^{H*}, h_E^B = b_{t+1} \bar{G}(d\theta_{t+1}) \bar{H}(d\tau_{t+1}^{C,U}) \\
+ \int_{\tau_{t+1}^{C,U}, \theta_{t+1}, b_{t+1}, \tau_{t+1}^{C,U}} \Gamma[(k_{t+1}^H, k_{t+1}^{H*}, b_{t+1}, \theta_{t+1}, \tau_{t+1}^{C,U}, (k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U})] \mu_t (dk_t^H, dk_t^{H*}, db_t, d\theta_t, d\tau_t^{C,U})
\]
where $\Gamma[(k_{t+1}^H, k_{t+1}^{H*}, b_{t+1}, \theta_{t+1}, \tau_{t+1}^{C,U}), (k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U})]$ represents the probability of an incumbent transitioning between the two sets of states. Specifically this is given by
\[
\Gamma[(k_{t+1}^H, k_{t+1}^{H*}, b_{t+1}, \theta_{t+1}, \tau_{t+1}^{C,U}), (k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U})] = \frac{1}{h_{k_H}(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = k_{t+1}^H, h_{k_H*}(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = k_{t+1}^{H*}, h_b(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = b_{t+1}} \cdot (1 - z_t(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U})) G(\theta_{t+1} | \theta_t) H(\tau_{t+1}^{C,U} | \tau_t^{C,U})
\]

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 $R_t$ is the rate of entry into the industry, which is defined such that
\[
\int_{\tau_{t}^{C,U}, \theta, b, k_{t}^{H*}, k_{t}^{H}} \mu_t(dk_t^H, dk_t^{H*}, db_t, d\theta_t, d\tau_t^{C,U}) = 1,
\]

which guarantees that $\mu_t(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U})$ gives a probability distribution over the state space.

ii.4 Foreign Firms

The solution to the Foreign firms’ problem is simple. The optimal labour hiring decision of the representative firm gives rise to the relationship between the prices that they receive in equilibrium and the wage rate in Foreign. Specifically
\[
P_t^{F*} = W_t^* (24)
\]
\[
(1 - i)P_t^{H*} = P_t^{F*}.
\]

Notice that these two relationships must hold in order to ensure that the Foreign firms face an interior optimal solution — where they serve both the Foreign and Home markets. The interpretation of the Foreign firm solution is that they supply their goods perfectly elastically to the two markets they serve.

iii Demand for Corporate Debt

Rather than assuming that households in the Home Country supply funds to firms in exchange for their corporate one period bonds, I assume that there is some exogenous
supply of such funds at the domestic level. The supply of these funds is perfectly elastic at the riskless rate of \( r \), at which the bonds are issued. One could think of these funds as coming from domestic investors or institutions, which are separate from the households that supply labour. I make this assumption for the purpose of simplicity in solving the model.

iv Stationary Equilibrium Definition

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

\[
\{ P, P^*, P^H, P^F, P^{H*}, P^{F*}, W, W^*, \mu, R, M \}
\]

such that the following conditions hold

1. Home and Foreign households optimise,
2. The free entry condition for Home firms holds

\[
V_t^T = 0.
\]
3. \( \mu \) is an invariant stationary distribution of Home firms,
4. \( R \) is the rate of entry/exit of Home firms,
5. \( M \) is the total mass of Home firms,
6. \( P \) is the equilibrium price index at Home,
7. \( P^* \) is the equilibrium price index in Foreign,
8. \( P^H \) clears the Home goods market at Home, with market clearing given by

\[
Y^H - X = C^H + T + E^+ - E^- + \zeta(E^-) + \sum_{c \in \{H,X,F\}} [I^c + \Phi^c] + U + J \\
+ M [x^D (1 - R) + x^X (1 - R - F) + x^M F + x^T R]
\]

where \( I^c \) is the aggregate investment along margin \( c \), \( \Phi^c \) is aggregate adjustment cost along margin \( c \), \( N^c \) is aggregate hiring along margin \( c \), \( U \) and \( J \) are aggregate
repatriations and funds sent to subsidiaries respectively and $F$ is the fraction of multinationals in the stationary distribution.

(9) $P^{H*}$ is the equilibrium price of goods made by Home firms sold in the Foreign Country, with market clearing given by

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

(10) $P^F$ is the equilibrium price of goods made by Foreign firms sold in the Home Country, with market clearing given by

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

(11) $P^{F*}$ is the equilibrium price of goods made by Foreign firms sold in the Foreign Country, with market clearing given by

$$Y^{F*} - X^* = C^{F*} + T^*$$

(12) $W$ is the equilibrium wage in the Home Country, which has market clearing

$$N^H + N^X = L$$

(13) $W^*$ is the equilibrium wage in the Foreign Country, with market clearing

$$N^{H*} + N^{F*} = L^*$$

v Balance of Trade

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

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

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

vi Endogenous and Exogenous Prices

As alluded to at the start of section IV, some of the prices in the model are solved for endogenously, while others are fixed to minimise on the computational burden. The setup of the Foreign firm and household problems are specified such that I am able to fix the following prices — $W^*, P^F, P^{F*}$. In particular, the labour supply of the household is taken to be perfectly elastic at the Foreign wage and the supply of goods by the Foreign firms is perfectly elastic at the relevant prices. In this sense, the aforementioned markets can still be interpreted as clearing in the model, without the need to solve for them endogenously. I calibrate $W^*$ using data (to be discussed in the calibration section of the paper) and the prices of Foreign goods are related via equation (24). Then in running the counterfactual experiments, I keep these three prices fixed, with the interpretation being that U.S. firms are unable to affect prices pertaining to Foreign agents.

VI 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. 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 fit of the model moments to those in the data.

i Parameters Calibrated Outside the Model

To reduce the computational burden associated with the model estimation, I match 18 parameters outside the model by drawing directly on data and other sources. Table 4 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
A 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.

<table>
<thead>
<tr>
<th>Name</th>
<th>Symbol</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rate</td>
<td>$r$</td>
<td>0.05</td>
<td>T-bill rate</td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta$</td>
<td>0.95</td>
<td>$1/(1+r)$</td>
</tr>
<tr>
<td>Variety parameter</td>
<td>$\eta$</td>
<td>0.50</td>
<td>Standard</td>
</tr>
<tr>
<td>Share of Home goods in Home</td>
<td>$\lambda$</td>
<td>0.85</td>
<td>U.S. national accounts</td>
</tr>
<tr>
<td>Capital share</td>
<td>$\alpha$</td>
<td>0.30</td>
<td>Gomes (2001)</td>
</tr>
<tr>
<td>Labour share</td>
<td>$\gamma$</td>
<td>0.65</td>
<td>Gomes (2001)</td>
</tr>
<tr>
<td>Depreciation rate</td>
<td>$\delta$</td>
<td>0.15</td>
<td>Ratio of depreciation to assets in Compustat</td>
</tr>
<tr>
<td>Technology persistence</td>
<td>$\rho_\theta$</td>
<td>0.87</td>
<td>OP (1996) regressions</td>
</tr>
<tr>
<td>Technology standard deviation</td>
<td>$\sigma_\theta$</td>
<td>0.32</td>
<td>OP (1996) regressions</td>
</tr>
<tr>
<td>Home firesale fraction</td>
<td>$\xi^H$</td>
<td>0.59</td>
<td>Hennessey and Whited (2007)</td>
</tr>
<tr>
<td>Foreign firesale fraction</td>
<td>$\xi^{H*}$</td>
<td>0.59 $\xi^H$</td>
<td>Hennessey and Whited (2007)</td>
</tr>
<tr>
<td>Foreign earnings tax</td>
<td>$\tau^{C*}$</td>
<td>0.25</td>
<td>OECD average</td>
</tr>
<tr>
<td>Home earnings tax</td>
<td>$\tau^C$</td>
<td>0.35</td>
<td>U.S. rate</td>
</tr>
<tr>
<td>Home dividend tax</td>
<td>$\tau^L$</td>
<td>0.12</td>
<td>Hennessey and Whited (2007)</td>
</tr>
<tr>
<td>High Home repatriation tax</td>
<td>$\tau^{C,R}_H$</td>
<td>0.10</td>
<td>Statutory rate ($\tau^C - \tau^{C*}$)</td>
</tr>
<tr>
<td>Low Home repatriation tax</td>
<td>$\tau^{C,R}_L$</td>
<td>0.00</td>
<td>Tax holiday</td>
</tr>
<tr>
<td>Transition probability</td>
<td>$Q_\tau(\tau^{C,R}_L, \tau^{C,R}_H)$</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Transition probability</td>
<td>$Q_\tau(\tau^{C,R}_L, \tau^{C,R}_H)$</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Transition probability</td>
<td>$Q_\tau(\tau^H, \tau^{C,R}_H)$</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Transition probability</td>
<td>$Q_\tau(\tau^{C,R}_L, \tau^{C,R}_H)$</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>Home labour tax</td>
<td>$\tau^L$</td>
<td>0.25</td>
<td>Hennessey and Whited (2007)</td>
</tr>
<tr>
<td>Foreign wage</td>
<td>$W^*$</td>
<td>0.65</td>
<td>OECD data</td>
</tr>
<tr>
<td>Iceberg cost</td>
<td>$i$</td>
<td>0.04</td>
<td>Obstfeld and Rogoff (2000)</td>
</tr>
</tbody>
</table>

Table 4: Parameters matched/selected outside the model

The parameter $\eta$ is chosen such that the Armington elasticity of substitution between varieties of goods in the Foreign Country is around 2. This value sits within the relatively wide range of values found in the literature, which seeks to estimate this elasticity, (for more details see Ruhl (2008)).

The production function parameters are chosen such that the function of Home firms have slightly decreasing returns to scale. As in Gomes (2001), the capital share is taken
to be 0.30 and that for labour is 0.65. 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 using Compustat by using the Olley & Pakes (1996) procedure for estimating firm-level productivities. The estimated parameters from these regressions yield $\rho_\theta$ and $\sigma_\theta$ as being equal to 0.90 and 0.32. These two parameter values are relatively standard and consistent with the literature. I then discretise the productivity 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 12%. The corporate tax rate in the Foreign Country is set equal to 25%, which is the OECD average corporate rate. The labour tax rate in the Home Country is taken to be the effective personal tax rate from Hennessey and Whited (2007) of 25%.

I discretise the stochastic process for the repatriation tax to have two values — a high tax rate ($\tau_{C,R}^H$) and a low one ($\tau_{C,R}^L$). I choose the two rates to be the statutory rate and a zero rate respectively, to resemble normal times and tax holidays pre-reform. I select the transition probabilities such that a holiday can not be experienced for more than one period in a row and there is a 20% chance of a holiday during normal times. These probabilities are selected with the idea that a holiday comes roughly once every five years for a firm and that pressures/constraints on policymakers will prevent two tax holidays in a row.

For the liquidation fraction in the Home Country, $\xi^H$, 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 $x^D$ and $\xi^H$ both separately. This concern arises from the fact that $\xi^H$ and $x^D$ both have an important bearing on the choice for firms to exit the industry in a given period. Given that $\xi^H$ is a fraction, it is more reasonable to take this value as fixed and determine $x^D$ within the model. The liquidation parameter on the Foreign and export capital stocks are assumed to be the same as $\xi^H$ for simplicity. The wage rate in Foreign is calibrated to ease the computational burden of the problem. A value of 0.65 is chosen.

I arrive at this value using the OECD statistics database on average annual wages across member nations. I take the average annual wage of the U.S. relative to each of the other member nations. Again, recall that this should be thought of as a parameter in the model as it remains unchanged in the counterfactual experiments.

Finally, a conservative value for the iceberg export cost fraction, $i$, of 3.8% is chosen. I interpret this parameter as representing a transport cost and as a consequence, take this
value from Obstefeld and Rogoff (2000) as the average value weighted freight cost for U.S. exports. I choose to fix this parameter outside of the model, as it is likely that the internal estimation procedure would have difficulty identifying it separately from the fixed cost of operating as an exporter.

ii Parameters Calibrated Inside the model

The remaining eight parameters in the model are calibrated within the model to match eight moments. I draw on four data sources for the pertinent moments: the first is Compustat; the data sample is over 1980 – 2012. I use this source to estimate the relevant moments relating to the capital structure of U.S. firms. The second is HMY (2004) for the productivity advantages of multinationals and exporters. The third source is previous studies in international economics, which document key moments of interest, (in particular Alessandria, Choi & Ruhl (2014) and Boehm, Flaaen & Pandalai-Nayar (2017)). The final source is the BEA data on the FDI activities of U.S. multinationals. Table 5 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 $x^D$, 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 $x^D$ 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.

The fixed cost of exporting, $x^X$, is identified by matching the productivity advantage of exporting firms. As this fixed cost gets larger, more firms will find it optimal to switch from being purely domestic to exporters. Consequently, the moment will become larger as firms will need to be more productive to justify exporting. By a similar logic, the productivity difference between multinationals and domestics is used to identify $x^M$.

The exit/entry rate of firms is used to pin-down the fixed cost of entry $x^T$, 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 (23), which will lead to a corresponding decrease
in the equilibrium wage to ensure the free-entry condition holds.

I appeal to the mean ratio of net investment relative to assets to calibrate the adjustment cost parameter $\phi$. 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 $\phi$ 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 proportional equity issuance cost parameter, $\zeta_1$. Given that this cost is proportional to the size of firms’ equity issuances, a higher value of $\zeta_1$ would be expected to reduce this moment. I utilise the standard deviation of the equity issuance to book ratio to pin-down $\zeta_2$ as the squared term in the equity issuance function has implications for this second 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 $\Theta = (x^D, x^X, x^M, x^T, \phi, \zeta_1, \zeta_2)$ are the parameters to be estimated, $\mu^d$ 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 $\Theta$ change the objective function $J(\Theta)$. Given that the model solves for equilibrium, changes in parameters will typically lead to very moderate changes in the objective. For example, an increase in $x^M$ 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 being a multinational 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 wage in the stationary equilibrium will increase. Moreover, a smaller supply to the Foreign output market causes $P^{H*}$ to rise, partially mitigating the downward pressure on multinational activity induced by the higher fixed cost. Similar reasoning can be applied to variations in the other parameters. Ultimately, these equilibrium effects on the prices serve to ensure that the objective function is well-behaved, preventing small changes in the parameters from inducing extreme changes in $J(\theta)$. 

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The estimated value of the fixed cost in the Home Country is found to be 0.70, while that associated with exporting is found to be 0.45. Firms that export will therefore pay a total fixed cost of 1.15. That for being a multinational is 1.28, meaning a combined costs of 1.98. These numbers together see that there are non-zero regions for each of the discrete choices. The very high overall fixed cost of being a multinational seems reasonable from the perspective that these firms are in the minority.

New entrants pay a fixed cost of entry of 1.50, which is relatively large at first sight. Recall however that these firms have the choice to be a domestic, exporter or multinational upon establishing the firm. In equilibrium, for this parameter specification, the entrants choose to be exporters. So it seems somewhat reasonable to think that the upfront cost of establishing a firm, which has the capacity to export is high relative to the fixed capital expenditure it pays in each period after the commencement of operations.

The adjustment cost of investment in the U.S. and Foreign countries is estimated to be relatively small in magnitude — with a value of 0.01 — 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 or export capital stock is lower than that domestically, driving my estimate to be somewhat lower relative to the literature.

The equity issuance cost parameter $\zeta_1$ comes-out to be consistent with the literature, with the premium associated with issuing seasoned equity being around 10% 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

<table>
<thead>
<tr>
<th>Name</th>
<th>Symbol</th>
<th>Value</th>
<th>Moment Targeted</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x^H$</td>
<td>Home fixed cost</td>
<td>0.70</td>
<td>Mean leverage ratio</td>
</tr>
<tr>
<td>$x^X$</td>
<td>Export fixed cost</td>
<td>0.45</td>
<td>Exporter productivity advantage</td>
</tr>
<tr>
<td>$x^M$</td>
<td>Foreign fixed cost</td>
<td>1.28</td>
<td>Multinational productivity advantage</td>
</tr>
<tr>
<td>$x^T$</td>
<td>Fixed cost of entry</td>
<td>1.50</td>
<td>Entry/exit rate</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Adjustment cost scaling</td>
<td>0.01</td>
<td>Mean investment to book ratio</td>
</tr>
<tr>
<td>$\zeta_1$</td>
<td>Equity issuance cost</td>
<td>0.10</td>
<td>Mean issuance to book ratio</td>
</tr>
<tr>
<td>$\zeta_2$</td>
<td>Equity issuance cost</td>
<td>0.01</td>
<td>Std. dev. issuance to book ratio</td>
</tr>
</tbody>
</table>

Table 5: Parameters matched inside the model
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 and exporters in my model. There is a moderate degree of curvature in the issuance cost function with $\zeta_2$ being estimated to be 0.01.

### iii Fit of the Model to the Data

<table>
<thead>
<tr>
<th>Moment</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean debt to book ratio</td>
<td>18.77%</td>
<td>19.63%</td>
</tr>
<tr>
<td>Mean investment to book ratio</td>
<td>5.80%</td>
<td>8.53%</td>
</tr>
<tr>
<td>Mean equity issuance to book ratio</td>
<td>5.60%</td>
<td>6.23%</td>
</tr>
<tr>
<td>Std. dev. of equity issuance to book ratio</td>
<td>21.41%</td>
<td>23.38%</td>
</tr>
<tr>
<td>Productivity difference between exporting and domestic firms</td>
<td>38.80%</td>
<td>34.00%</td>
</tr>
<tr>
<td>Productivity difference between multinational and domestic firms</td>
<td>53.70%</td>
<td>56.02%</td>
</tr>
<tr>
<td>Exit rate</td>
<td>9.55%</td>
<td>14.22%</td>
</tr>
</tbody>
</table>

**Table 6**: Model moments versus data moments.

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 6 provides the comparison of the model to the data. In addition to the seven moments targeted to pin-down the parameters described in the previous subsection, I also examine the proximity of the model to four untargeted data moments.

In terms of the targets; the model gives a decent match of moments that are related to leverage, investment, equity issuance and firm heterogeneity. The mean leverage ratio is slightly higher in the model than the data. This result is likely tied to the fact that the equity issuance costs are relatively high; firms who need to issue new equity lever themselves a lot to minimise the size of the issuance. The mean investment ratio is also
Table 7: Transition probabilities

<table>
<thead>
<tr>
<th>Data Transition Probabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>t/t+1</td>
</tr>
<tr>
<td>Domestic</td>
</tr>
<tr>
<td>Exporter</td>
</tr>
<tr>
<td>Multinational</td>
</tr>
<tr>
<td>Entrant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model Transition Probabilities (All Untargeted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>t/t+1</td>
</tr>
<tr>
<td>Domestic</td>
</tr>
<tr>
<td>Exporter</td>
</tr>
<tr>
<td>Multinational</td>
</tr>
<tr>
<td>Entrant</td>
</tr>
</tbody>
</table>

a little above the target, which may indicate that firms over-invest in capital in order to minimise the chance of an issuance. The model also gives a decent fit of the productivity advantages of exporters and multinationals.

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 close in the model to the data. The fraction of firms issuing equity in the model sits at 40% 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 in the high 30% – low 40% range. Given that the model is able to accurately match these three moments, the reader can be confident that it is accurately capturing the financial behaviour of U.S. firms.

The last set of untargeted moments in table 6 are the fraction of exporters and the fraction of multinational firms. These numbers are 16% and 6% in the data respectively. The fraction in the model for exporters is close at around 20% while that in the model for multinationals is around 10%.

This subsection presents one more description — table 7 — comparing the fit of the data moments to the model. In particular, the table shows the transition matrix between all of the different firm statuses, (between exit, domestic, exporter and multinational). These data are taken from Boehm, Flaaen & Pandalai-Nayar (2017).\(^{16}\) Note that all of the

\(^{16}\)Note that the authors also show the transitions to/from being foreign-incorporated multinationals. These numbers are very small though and as mentioned earlier, including a further discrete choice for a corporate inversion does little to affect the results of the counterfactual quantitatively. I re-normalise their
transition probabilities generated in this table are untargeted in the calibration exercise. The model does a decent job of capturing these transitions, in particular, in the qualitative sense. Even many of the magnitudes are relatively close. The model struggles however with some of the exporter status transitions. It captures too little persistence in the export status and over-estimates the transition to multinational from this status. The driving factor for this discrepancy is likely the assumption that the adjustment costs on the Home and Foreign capital stocks are the same. In addition, there may be some complementaries between the capital stocks a firm holds in each country. With all these factors considered, the model does reasonably well at matching these transitions.

VII Counterfactual Results

In this section, I report the results from solving for the stationary equilibrium of the model under two tax regimes. Firstly I solve the model under the baseline calibration described in the previous subsection where firms draw stochastic repatriation tax rates, with one possible draw being the statutory rate and the other being a tax holiday. Then for the counterfactual, I set the statutory rate equal to zero, meaning that no U.S. multinationals ever incur U.S. taxes on their overseas earnings.

There are several subsections that follow. The first explores the effect of the policy change on the optimal policy functions of firms. The second studies the effects on the cross-section and the third looks at the effect on aggregates. The fourth decomposes the changes to variables amongst the three main channels of effect. It is obviously important to study the transition path between the steady states in evaluating this policy reform — this is something I’m still computing that will be included in future versions of the paper.

i Policy Functions

Before turning to examine the impact of the policy change on the cross-section and aggregate variables, I briefly study how it affects the decision problem of firms. Figures 9 through 12 show how the optimal discrete choices differ as some of the state variables change. In each of these figures, I fix the U.S. capital stock to a medium value, fix the repatriation tax draw to be the statutory rate and plot the Foreign capital stock relative to the firm’s debt obligation. I depict the pre and post-reform policy functions for both a

probabilities conditional on a firm not choosing to become a foreign multinational.
low productivity shock (figures 9 and 10) and a high productivity shock (11 and 12).

These figures are meant to bear some resemblance to the two-dimensional cutoff pictures, which were shown in the prologue model section of the paper. The point to emphasise here though is that the discrete choice made by the firm here in this dynamic structural model is much more complicated than in the simple HMY (2004) model. Specifically, the choice that a firm makes is no longer solely dependent on their productivity draw for the period — it now depends on the firm’s entire state vector.

First I describe figures 9 and 10: a comparison of these two figures gives some idea of how the policy change affects firms at the bottom-end of the productivity distribution. Looking from left to right across these two pictures, see that firms that have a low debt obligation opt to be domestic firms, while firms with a relatively higher obligation choose to exit the industry. Recall the the firms’ objective in the model is to maximise the expected discounted value of equity. A low productivity firm can not justify the additional fixed cost required to become an exporter or a multinational: rationalising their choice to be a domestic for low debt: the firm proceeds to liquidate its Foreign capital stock.

As the firm’s debt obligation increases, the value of equity decreases until it eventually reaches the point where the limited liability constraint for the shareholders binds and the firm exits. Notice that the exit region is not a perfect square — reflecting the idea that firms with larger capital stocks can maintain positive equity value for higher debt obligations.

Comparing the two figures, see that the size of the exit region expands in the post-reform scenario. The intuition behind this change mirrors that of the prologue model: an entry effect drives-up the domestic wage, which causes the lowest cutoff to shift upwards. That is — for a lower debt obligation, a firm will find it optimal to exit the industry.

In moving to study figures 11 and 12, notice that the image looks similar with the difference that a high productivity firm opts to be a multinational for a small debt obligation while a highly-levered firm chooses to downsize and be a domestic. In implementing the policy reform, the size of the multinational region expands — the is the dynamic model analogue of the upper-cutoff in the prologue model shifting downwards.

Next I move to think about capital structure policy functions. Figures 13 and 14 illustrate the effect of the territorial policy change on the borrowing decisions of U.S. multinationals. Figure 13 depicts the value attained by shareholders in the firm for a fixed state vector with a low value of the foreign capital stock; figure 14 shows the same for a high foreign capital stock. One can think of the former figure as depicting the optimal solution to the tradeoff theory for a small multinational, whereas the latter does so for a
Figure 9: \((k^H_t, k^F_t, b_t, \theta_t, \tau^{C,R}_t) = (k^H_M, k^F_t, b_t, \theta_L, \tau^{C,R}_H)\) pre-reform.

Figure 10: \((k^H_t, k^F_t, b_t, \theta_t, \tau^{C,R}_t) = (k^H_M, k^F_t, b_t, \theta_L, \tau^{C,R}_H)\) post-reform.
Figure 11: \((k^H_t, k^F_t, b_t, \theta_t, \tau^C,R_t) = (k^H_M, k^F_t, b_t, \theta_H, \tau^C,R_H)\) pre-reform.

Figure 12: \((k^H_t, k^F_t, b_t, \theta_t, \tau^C,R_t) = (k^H_M, k^F_t, b_t, \theta_H, \tau^C,R_H)\) post-reform.
These two figures show that multinationals’ borrowing behaviour is affected in a non-uniform way when removing the repatriation tax. The reform increases the marginal productivity of the foreign capital stock for the multinational with the small $k^F_t$. Consequently, the firm increases their overseas investment. This has the effect of raising the amount of collateral, against which the firm can borrow. As a consequence, they increase their borrowing to take advantage of debt tax shields. In contrast, the large multinational with the high foreign capital stock over-accumulates foreign capital under the worldwide system — they defer repatriation to minimise their tax burden. When the reform is implemented, they decrease their foreign capital holdings, thereby reducing their collateral and thus decrease their borrowing.

\section*{ii Cross-Sectional Variables}

The effect of moving to the territorial tax system on the cross-section of firms is summarised in table 8. Focusing firstly on the composition of firms in terms of servicing of the Foreign market, notice that the fraction of exporters falls by around 1\%, while that of multinationals increases by approximately the same proportion. This result is driven by switching at the extensive margin: removing the repatriation tax decreases the standard for undertaking FDI and establishing a foreign subsidiary. The larger increase in the fraction of multinationals is driven by exporters in addition to some non-multinationals.
## Table 8: Cross-sectional counterfactual results.

<table>
<thead>
<tr>
<th>Moment</th>
<th>Pre-reform</th>
<th>Post-reform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean debt to book ratio</td>
<td>19.63%</td>
<td>20.24%</td>
</tr>
<tr>
<td>Mean investment to book ratio</td>
<td>8.53%</td>
<td>7.61%</td>
</tr>
<tr>
<td>Mean equity issuance to book ratio</td>
<td>6.23%</td>
<td>5.90%</td>
</tr>
<tr>
<td>Std. dev. of equity issuance to book ratio</td>
<td>24.09%</td>
<td>30.71%</td>
</tr>
<tr>
<td>Exit rate</td>
<td>14.22%</td>
<td>14.35%</td>
</tr>
<tr>
<td>Fraction of firms issuing equity</td>
<td>39.88%</td>
<td>40.21%</td>
</tr>
<tr>
<td>Std. dev. of debt to book ratio</td>
<td>38.19%</td>
<td>38.89%</td>
</tr>
<tr>
<td>Fraction of exporting firms</td>
<td>20.13%</td>
<td>19.26%</td>
</tr>
<tr>
<td>Fraction of multinational firms</td>
<td>10.02%</td>
<td>11.39%</td>
</tr>
</tbody>
</table>

Removing the repatriation tax makes the value to operating as a U.S. multinational and hence as a U.S. firm higher, resulting in entry into the industry. As more firms enter the industry, the U.S. wage increase such that, in the stationary equilibrium, the entry and exit rates are equalised; the rate of entry and exit increases by around 0.15%. The implication is that there are more, younger firms in the new stationary equilibrium. The average investment rate decreases from 8.5% under the worldwide system to 7.6% under the counterfactual. The largest of firms decrease their investment due to the lower price of foreign output and higher domestic wage, which outweighs any increase in intensive margin investment by smaller firms.

In terms of capital structure, the mean leverage ratio increases by around 0.8%. As a fraction of their total asset book value, firms now borrow more on average. One can interpret this result as showing that the average firm is closer to the top of their collateral constraint, (which recall had an upper-limit of around 60% of book value in the quantitative exercise). Although large multinationals decrease their leverage due to higher repatriations, this effect is outweighed by the creation of new multinationals and higher overseas investment by smaller firms.

The fraction of firms issuing equity increases by 0.3% following the policy change, which follows that there are more multinational firms incurring the higher extensive margin fixed cost. Given the relatively high estimated cost of 10% of the issuance size, firms turn to repatriated overseas earnings. Notice though that conditional on undertaking an equity issuance, its size relative to book value is smaller under the territorial system with a
decrease a little over 0.3% in the mean given that repatriated earnings become a cheaper source of financing. The policy change also brings with it a rise in the variation in issuance needs.

<table>
<thead>
<tr>
<th>Firm Type</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multinationals</td>
<td>-1.62%</td>
</tr>
<tr>
<td>Exporters</td>
<td>0.57%</td>
</tr>
<tr>
<td>Domestics</td>
<td>0.71%</td>
</tr>
<tr>
<td>Exiters</td>
<td>0.25%</td>
</tr>
<tr>
<td>All operating</td>
<td>0.25%</td>
</tr>
</tbody>
</table>

Table 9: Percentage change in average productivities.

Table 9 shows how the average productivities of firms of each type of operation are affected by the tax policy change. I define the average productivity across all operating firms as the sum of the input-weighted productivities of firms that choose not to exit across the stationary distribution, (as in Hsieh & Klenow, 2009).

Removal of the repatriation tax induces the cutoff for being a multinational to fall, which results in a decrease in their average productivity of 1.6%. The rise in the entry/exit rate causes the average to rise for both exiting firms and pure domestics by 0.25% and 0.71% respectively. A relatively large increase in the standard for being an exporter ensues with a rise in average productivity of 0.71%. The culmination of these effects is a rise in the overall average by around 0.25%. Given that this representative industry is to be interpreted as the macroeconomy, these productivity gains are considerable. Given that all the remaining firms in the economy are more productive, they are better able to utilise their factors of production, which will have implications for the level of output in the economy.

### Aggregate Variables

Table 10 presents the percentage changes in aggregate variables from the U.S. territorial policy change. Removing the tax increases the value to entering the industry with everything else held constant. As a result, the mass of entrants into the U.S. industry rises by 3%. The rise in entry induces a rise in the demand for labour in domestic market. In order to equilibrate demand and supply, the equilibrium wage rate rises by around 0.8%.

As firms shift away from export servicing of the Foreign market and towards FDI through establishing overseas subsidiaries, the supply of exports falls by 5% and output
produced in the Foreign Country by U.S. multinationals rises by 15%. One of the benefits associated with this re-shuffling of the U.S. firm distribution is that iceberg costs are saved, with the total amount of such costs falling by around 10%, (not shown).

As the mass of entrants into the industry increases, the size of the U.S. capital stock increases by 2.6%. This result is additionally driven through the financial effect: firms that switch from being exporters to multinationals can conceivably reduce their marginal cost of domestic investment as they gain access to cheaper financing through repatriations. The rise in the rate of exit in the economy induces a higher aggregate productivity level of 0.9%. These effects on factor inputs and productivity culminate in an increase in U.S. output of a little over 1%.

In terms of financial variables, saving on iceberg costs and repatriation taxes causes a rise in dividend payments by U.S. firms to households of 3.5%. In addition to paying out more of the excess cashflow to shareholders, firms also save more in aggregate, with cash of parents rising by 3.6%. Firms hold more cash to increase their buffer against having to issue new equity in subsequent periods. Firms increase their borrowing substantially by 7.5% in order to take greater advantage of debt tax shields and issue less equity by 1.9%.

U.S. welfare rises as a result of this policy change. Quantitatively, I measure the effect on welfare by considering consumption equivalent variation. If labour supply were held at the same level as under the worldwide system, consumption prior to the policy change would need to increase by around 0.5% in order to achieve the same level of utility realised under the territorial system. This positive change is driven by the higher distributions to the representative household, the higher wage rate in addition to the lower incidence of
equity issuances by firms.

The rise in taxes on labour income, U.S. earnings and dividend payment taxes is enough to offset the lost taxes on repatriated earnings and those from exporters switching to being multinationals. The policy change is close to being revenue-neutral, with a slight increase in the U.S. Government’s tax collections by around 0.08%. When this result is combined with the aforementioned point regarding the welfare gain, this particular policy reform appears to be a very favourable one towards the U.S. economy. It is beneficial for firms, households and need not come at a cost with regard to the budget bottom-line.

iv Channel Decomposition

This subsection seeks to decompose the effects on aggregate variables into the three main channels of effect: the extensive margin channel, the financial channel and the equilibrium price channel. I decompose the effects of each channel by running two additional counterfactual experiments as follows

(a) Set the repatriation tax rate equal to zero and solve the model holding the prices and extensive margin choices constant.

(b) Set the repatriation tax rate equal to zero and solve the model holding the prices constant only.

The effect of the financial channel is then inferred by comparing the stationary equilibrium under experiment (a) with the worldwide system equilibrium. The extensive margin channel’s effect comes from comparing experiment (b) with (a) and finally the equilibrium price effect is inferred from comparing the full territorial solution with experiment (b). Table 11 shows the results of the decomposition on aggregate variables. Notice that the numbers depicted show the change in the aggregate coming from the relevant channel as a percentage of the overall change in the aggregate coming from comparing the full territorial equilibrium to the worldwide equilibrium.

Decomposing the counterfactual to isolate the financial channel in some sense serves as a test of the model against the “one time repatriation tax holiday” implemented by the U.S. Government in 2004. Dharmapala, Foley & Forbes (2011) found that, in response to the policy effort, little eventuated in terms of stimulating domestic investment and production. Most of what firms repatriated was used to pay dividends to shareholders. Table 11 shows that 65% of the increase in dividends is driven by the financial channel, while it’s only
responsible for around 6% of the increase in the domestic capital stock. When looking only at incumbent multinationals, removing the repatriation tax doesn’t induce much in the way of real effects, which seems to agree with the responses to the tax holiday.

Notice also that the Foreign capital stock and output decrease through the financial channel. Under the worldwide system, multinational firms over-invest in overseas capital as they save their Foreign earnings in order to defer payment of their U.S. taxes. As a result, they also borrow less subsequent to the policy change — aggregate borrowings decrease by around 0.8% when accounting for the financial channel alone.

The extensive margin channel is responsible for around 80 – 85% of the changes in U.S. firm Foreign variables such as their overseas capital, output and repatriations. Notice also that this channel leads to a decrease in the U.S. capital stock: as more firms expand their investment abroad at the extensive margin, they pull-back on domestic investment in order to equate the marginal productivities of their capital stocks. Greater incentive for FDI through this channel drives 20% of the decrease in export production domestically. Additionally, this channel causes firms to hold less cash, as firms outlay more to pay the higher flow fixed cost of being a multinational, there are fewer domestically-made cash flows available for precautionary savings. The extensive margin channel is the predominant driving-force behind the increase in the borrowings of parent firms. Notice that more firms being multinationals means more firms with Foreign capital stocks, against which they can borrow. As a result, they increase their borrowings to take advantage of the associated debt tax shields.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Financial Channel</th>
<th>Extensive Margin Channel</th>
<th>Equilibrium Price Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. capital</td>
<td>6.5%</td>
<td>-6.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Foreign capital of U.S. multinationals</td>
<td>-2.2%</td>
<td>80.2%</td>
<td>20.0%</td>
</tr>
<tr>
<td>U.S. output</td>
<td>5.1%</td>
<td>-4.9%</td>
<td>99.8%</td>
</tr>
<tr>
<td>Foreign output by U.S. multinationals</td>
<td>-1.2%</td>
<td>83.0%</td>
<td>18.2%</td>
</tr>
<tr>
<td>Repatriations</td>
<td>1.7%</td>
<td>85.5%</td>
<td>12.8%</td>
</tr>
<tr>
<td>Exports</td>
<td>0.0%</td>
<td>20.5%</td>
<td>79.5%</td>
</tr>
<tr>
<td>Parent debt</td>
<td>-30.4%</td>
<td>125.5%</td>
<td>4.9%</td>
</tr>
<tr>
<td>Parent cash</td>
<td>13.5%</td>
<td>-10.0%</td>
<td>96.5%</td>
</tr>
<tr>
<td>Dividends</td>
<td>62.3%</td>
<td>7.0%</td>
<td>30.7%</td>
</tr>
<tr>
<td>Equity issuance</td>
<td>13.0%</td>
<td>11.2%</td>
<td>75.8%</td>
</tr>
<tr>
<td>Tax payments</td>
<td>25.1%</td>
<td>5.0%</td>
<td>69.9%</td>
</tr>
</tbody>
</table>

Table 11: Decomposition of the three channels on aggregates.

Finally, the equilibrium price channel is the major contributor to the domestic real effects that result from the policy change. The increase in the domestic wage drives 100% of the change in U.S. capital and output. The decrease in the foreign output price drives nearly 80% of the decrease in exports. A perhaps unexpected result is that this channel also drives almost all of the increase in cash holdings of parents. The higher domestic labour costs drive a greater chance of firms at the bottom-end of the productivity distribution needing to issue new equity in a given period: they save more as a precaution. This increased saving helps to offset new equity issuances, with 76% of the decrease coming through this channel.

**VIII 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 recently been implemented as a solution to increasingly complex tax code and potentially distorted incentives for firms provided by the current setup. 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 previous worldwide tax system was compared to that corresponding to a territorial alternative. Results suggest that this policy change would be welfare improving, causing an increase in welfare of 0.5%, as measured by consumption equivalents. The benefits reaped by firms, households and investors from this policy change would be complemented by approximate neutrality in U.S. Government tax collections.

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. Further avenues for research involve thinking about the optimal repatriation tax rate for the U.S. in the context of a Ramsey problem. Moreover, thinking about how other countries would respond in the context of a similar setup would be an interesting direction.\textsuperscript{17} This paper has hopefully made a meaningful contribution to the policy discussion and has laid a framework, upon which other studies on this issue can build.

References


\textsuperscript{17}This issue is addressed in a follow-up paper called “Cross-Border Effects of U.S. Tax Policy”.

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for tax policy evaluation (pp. 1-5). University of Chicago Press.


Appendix A: Discrete Choices for the Prologue Model

This appendix details the equilibrium discrete choices for the firms for general parameter configurations, (not just the specific case assumed in the main body of the paper). The optimal labour choice for output for sale at Home, for export and in the Foreign Country, conditional upon the relevant discrete choices being made, are given respectively by

\[ n^H = \left( \frac{p^H \theta \gamma}{W} \right)^{\frac{1}{1-\gamma}} \]  

\[ n^X = \left( \frac{p^X (1-i) \theta \gamma}{W} \right)^{\frac{1}{1-\gamma}} \]  

\[ n^F = \left( \frac{p^F \theta \gamma}{W} \right)^{\frac{1}{1-\gamma}} \]

Notice that the solutions given in (25) is independent of all the tax rates in the problem. The intuition follows from two aspects of the problem: firstly the labour hiring decision is a static problem and secondly that the rental cost is an expense, which serves to reduce the firm’s taxable earnings. Each of these optimal labour choices are dependent on the relevant price fetched for the output; an increase in the price in question results in a higher marginal return to labour, causing a rise in the optimal choice. Notice also that a higher iceberg transport cost associated with exports serves to reduce the return to export labour. Bearing (25) in mind, the values for each discrete choice option, where the firm operates,
conditional on $\theta$ can be re-written as

$$V^D_0(\theta) = (-x^D) + \beta(1 - \tau)^E(1 - \tau^C)\Omega(P^H)\frac{1}{1-\gamma}(\theta)^{\frac{1}{1-\gamma}}$$ (26)

$$V^X_0(\theta) = (-x^D) + (-x^X) + \beta(1 - \tau)^E \left[ (P^H)\frac{1}{1-\gamma}(1 - \tau^C) + ((1 - \rho)P^{H*})\frac{1}{1-\gamma}(1 - \tau^C) \right] \Omega(\theta)^{\frac{1}{1-\gamma}}$$

$$V^M_0(\theta) = (-x^D) + (-x^M) + \beta(1 - \tau)^E \left[ (P^H)\frac{1}{1-\gamma}(1 - \tau^C) + (P^{H*})\frac{1}{1-\gamma}(1 - \tau^{C,U} - \tau^{C*}) \right] \Omega(\theta)^{\frac{1}{1-\gamma}}$$

where $\Omega \equiv \left( \frac{\tilde{\gamma}}{\tilde{W}} \right)^{\frac{1}{\tilde{\gamma}}} - W \left( \frac{\tilde{\gamma}}{\tilde{W}} \right)^{\frac{1}{\tilde{\gamma}}}$ is defined for notational ease. Notice that $\Omega > 0$ always for $\gamma < 1$ as assumed above. In making its discrete choice, a firm with productivity $\theta$ will compare all four options — $V^E_0(\theta), V^D_0(\theta), V^X_0(\theta), V^M_0(\theta)$ — and choose the option, which delivers the highest value to shareholders. Table 12 characterises the four possible choices and the conditions, which need to hold relating $\theta$ and the other parameters for the corresponding choices to be optimal.
<table>
<thead>
<tr>
<th>(V_0(\theta))</th>
<th>Condition 1</th>
<th>Condition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V^E(\theta))</td>
<td>(\theta &lt; \left{ \frac{x^D}{\beta(1-\tau^E)(PH)^{1-\gamma}(1-\tau^C)\Omega} \right}^{1-\gamma}) ((V^D(\theta) &lt; V^E(\theta)))</td>
<td>(\theta &lt; \left{ \frac{x^D + x^X}{\beta(1-\tau^E)((1-\tau^C)(PH)^{1-\gamma} + (PH^*{1-i})^{1-\gamma})\Omega} \right}^{1-\gamma}) ((V^X(\theta) &lt; V^E(\theta)))</td>
</tr>
<tr>
<td>(V^D(\theta))</td>
<td>(\theta &gt; \left{ \frac{x^D}{\beta(1-\tau^E)(PH)^{1-\gamma}(1-\tau^C)\Omega} \right}^{1-\gamma}) ((V^D(\theta) &gt; V^E(\theta)))</td>
<td>(\theta &lt; \left{ \frac{x^X}{\beta(1-\tau^E)(1-\tau^C)(PH^*{1-i})^{1-\gamma}\Omega} \right}^{1-\gamma}) ((V^D(\theta) &gt; V^X(\theta)))</td>
</tr>
<tr>
<td>(V^X(\theta))</td>
<td>(\theta &gt; \left{ \frac{x^D + x^X}{\beta(1-\tau^E)((1-\tau^C)(PH)^{1-\gamma} + (PH^*{1-i})^{1-\gamma})\Omega} \right}^{1-\gamma}) ((V^X(\theta) &gt; V^E(\theta)))</td>
<td>(\theta &gt; \left{ \frac{x^X}{\beta(1-\tau^E)(1-\tau^C)(PH^*{1-i})^{1-\gamma}\Omega} \right}^{1-\gamma}) ((V^X(\theta) &gt; V^D(\theta)))</td>
</tr>
<tr>
<td>(V^M(\theta))</td>
<td>(\theta &gt; \left{ \frac{x^D + x^M}{\beta(1-\tau^E)(PH)^{1-\gamma}(1-\tau^C) + (PH^*{1-i})^{1-\gamma}(1-\tau^C,U-\tau^H)\Omega} \right}^{1-\gamma}) ((V^M(\theta) &gt; V^E(\theta)))</td>
<td>(\theta &gt; \left{ \frac{x^M}{\beta(1-\tau^E)(PH^*)^{1-\gamma}(1-\tau^C,U-\tau^H)\Omega} \right}^{1-\gamma}) ((V^M(\theta) &gt; V^D(\theta)))</td>
</tr>
</tbody>
</table>

**Table 12:** Conditions on \(\theta\) summarising when each discrete choice is optimal.
<table>
<thead>
<tr>
<th>$V_0(\theta)$</th>
<th>Condition 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V^E(\theta)$</td>
<td>$\theta &lt; \left{ \frac{x^D + x^M}{\beta(1-\tau^E)(P_{H^<em>}^{\frac{1}{1-\tau^E}}(1-\tau^C)+P_{H^</em>}^{\frac{1}{1-\tau^E}}(1-\tau^C,U-\tau^C^*)}\Omega} \right}^{1-\gamma}$&lt;br&gt;$(V^M(\theta) &lt; V^E(\theta))$</td>
</tr>
<tr>
<td>$V^D(\theta)$</td>
<td>$\theta &lt; \left{ \frac{x^M}{\beta(1-\tau^E)(P_{H^<em>}^{\frac{1}{1-\tau^E}}(1-\tau^C,U-\tau^C^</em>)\Omega} \right}^{1-\gamma}$&lt;br&gt;$(V^D(\theta) &gt; V^M(\theta))$</td>
</tr>
<tr>
<td>$V^X(\theta)$</td>
<td>$\theta &lt; \left{ \frac{x^M - x^X}{\beta(1-\tau^E)(P_{H^<em>}^{\frac{1}{1-\tau^E}}(1-\tau^C,U-\tau^C^</em>)-(P_{H^*}^{\frac{1}{1-\tau^E}}(1-\tau^C))\Omega} \right}^{1-\gamma}$&lt;br&gt;$(V^X(\theta) &gt; V^M(\theta))$</td>
</tr>
<tr>
<td>$V^M(\theta)$</td>
<td>$\theta &gt; \left{ \frac{x^M - x^X}{\beta(1-\tau^E)(P_{H^<em>}^{\frac{1}{1-\tau^E}}(1-\tau^C,U-\tau^C^</em>)-(P_{H^*}^{\frac{1}{1-\tau^E}}(1-\tau^C))\Omega} \right}^{1-\gamma}$&lt;br&gt;$(V^M(\theta) &gt; V^X(\theta))$</td>
</tr>
</tbody>
</table>

Table 12: Conditions on $\theta$ summarising when each discrete choice is optimal (continued).
Appendix B: Allowing for Corporate Inversions

A natural way to incorporate corporate inversions, is to allow such firms to pay an additional fixed cost, denoted say by $x^I$, to be allowed to circumvent the repatriation tax under the pre-reform system. The discrete choice for an inverting firm would have a Bellman equation characterised by

$$V_t^I(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = \max_{\{k_{t+1}^H, k_{t+1}^{H*}, b_{t+1}, d_t^I, u_t\}} \left( (1 - 1_{d_t^I \geq 0}) \tau_t^E d_t^I (k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) ight)$$

$$= \beta \mathbb{E}_t[V_{t+1}(k_{t+1}^H, k_{t+1}^{H*}, b_{t+1}, \theta_{t+1}, \tau_{t+1}^{C,U})]$$

where

$$d_t^I(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = e_t^I(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) - 1_{e_t^I < 0} \zeta(e_t^I(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}))$$

$$e_t^I(k_t^H, k_t^{H*}, b_t, \theta_t, \tau_t^{C,U}) = \left[ (1 - \tau_t^C) \left( P_t^H \theta_t(k_t^H)^\alpha (n_t^H)^\gamma - W_t n_t^H \right) - i_t^H - x^D - \Phi_F(i_t^{H*}, k_t^{H*}) \right]$$

$$+ [u_t - j_t - x^M - x^I] + \left[ \frac{b_{t+1}}{1+r} - b_t + b_t \left( 1 - \frac{1}{1+r} \right) \right] \tau_t^C$$

$$u_t = (1 - \tau_t^C) \left( P_t^H \theta_t(k_t^H)^\alpha (n_t^H)^\gamma - W_t n_t^H \right) + j_t - i_t^{H*} - \Phi_F(i_t^{H*}, k_t^{H*})$$

$$j_t, u_t \geq 0$$

$$b_{t+1} \leq \zeta^H k_{t+1}^H + \zeta^{H*} k_{t+1}^{H*}.$$
innocuous assumption.