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

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Abstract

This paper develops a quantitative open economy framework with dynamics, firm heterogeneity and financial frictions to study the impact of corporate tax reforms targeted at multinationals. The model quantifies their impact on productivity, GDP and welfare. Firms draw idiosyncratic shocks, invest in capital, choose optimal financing and select endogenously into servicing an overseas market, either through exporting or FDI. I apply this framework to the removal of the U.S. repatriation tax, an aspect of the Tax Cuts and Jobs Act. The reform's impact trades-off two selection effects — more offshoring versus greater business dynamism from increased profitability. The reform leads to higher U.S. welfare and revenue neutrality. A series of exercises illustrate that the novel features of this framework have significant quantitative implications. The reform's beneficial effects are mitigated considerably when financial frictions are removed and it appears to be welfare reducing when using a static analogue of the model.

Keywords: Dynamics, Financial Frictions, Productivity, Corporate Tax, Firm Heterogeneity, FDI, Repatriation Tax

JEL codes: E62, F23, G32, H25, L11

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I Introduction

The activities of multinational firms account for almost one-third of world GDP and about one-fourth of employment (OECD, 2018a).

Multinational firms are large, profitable and have considerable influence over goods and factor markets. Consequently, their tax treatment often receives special attention from policymakers; recent examples of reforms specifically targeted at these firms are abundant. The U.S. Tax Cuts and Jobs Act (TCJA) of 2017 sought to reduce the U.S. tax burden on domestically-incorporated multinationals to increase their competitiveness (U.S. Speaker's Office, 2017). Cuts to the corporate tax rate in the U.K. in 2015 took place with an objective of attracting FDI from abroad (HM Government, 2013). In 2019 the OECD put forward proposals for coordinated global corporate taxation and a move away from a production-based to a sales-based system (OECD, 2019). How do these tax reforms targeted at multinationals affect the domestic macroeconomy?

This paper develops a new modelling framework that can be used to answer this question quantitatively. The real impact of these reforms in the model is primarily driven by general equilibrium effects and how they shape the behaviour of non-multinational incumbent and newly-created firms. A tax reform that changes the behaviour of multinationals spills-over to affect the entire firm cross-section through adjustments in goods and factor market conditions. These changes to the firm cross-section can then potentially aggregate to have a significant effect on the macroeconomy. The key determinant of the aggregate effects' magnitude is the sensitivity of non-multinationals' investment to these general equilibrium effects.

What influences this investment sensitivity of non-multinational firms? The model emphasises two key dimensions — dynamics and financial frictions. It features intensive and extensive margin investment, through firm-level capital accumulation with adjustment costs and sunk one-time fixed costs for establishing an export segment or foreign subsidiary, respectively. When a targeted tax reform at FDI firms leads to general equilibrium effects, these adjustment and fixed costs make the economy's responses gradual rather than instantaneous. Financial frictions influence the cost of external financing and in turn the marginal cost of investment. Non-multinationals are typically smaller in size than multinationals (Flaaen, 2014), motivating the inclusion of financial frictions in the model since they tend to affect smaller firms to a greater extent (Hennessy & Whited, 2007). After developing this general framework, I utilise it to quantify the impact of a recent policy episode — the removal of the U.S. *repatriation tax* — an aspect of the TCJA.

The quantitative framework features firm heterogeneity in the form of idiosyncratic productivity shocks that are drawn from a persistent distribution. These firms are monopolistically competitive and produce using a constant returns technology using capital and labour in each country. Firms select endogenously into different modes of production based-on their state vector for the period. They can either exit the industry, operate as a purely domestic firm, an exporter, a multinational or an offshoring multinational. Exporters, regular and offshoring multinationals all gain access to a foreign market.

The fixed cost setup follows the structure of Alessandria & Choi (2007, 2014) and Alessandria, Choi, & Ruhl (2014). Firms pay a one-off sunk cost in the period they create a new operating segment and then smaller period-by-period fixed continuation costs each period subsequent. The exporting-FDI tradeoff follows the structure of Helpman, Melitz, & Yeaple (2004) with variable iceberg transport costs for exporting versus higher fixed costs for FDI. Offshoring multinationals produce all their output abroad to take advantage of lower input costs and export some of their goods back to their home market. Each period there is an endogenous measure of new entrant firms into the model, who incur a fixed sunk cost to establish and operate as domestics in their first period of incumbency.

The financial frictions incorporated are standard in the corporate finance literature: debt tax shields (interest tax deductions) and costly equity issuance. Firms can issue one-period debt securities, which are collateralised by the liquidation values of their domestic and overseas capital stocks. In addition they can issue new equity, which incurs a premium that is increasing and convex in the size of the issuance.[1] More borrowing raises value for shareholders through interest tax deductions, while too much of it can increase the cost of equity in the future — optimal leverage trades-off these two effects.[2] This trade-off causes the firms' collateral constraints to occasionally bind, giving a non-degenerate cross-section of firm capital structure.

The model is solved numerically with parameters disciplined by data to capture the interac-

[1] This cost function is designed to capture direct costs (such as underwriting fees) associated with issuing new equity, in addition to indirect costs such as value losses associated with differential firm valuations between insiders and outside investors.

[2] I.e. say a firm receives a low productivity shock at time t and needs to issue new equity. A larger debt repayment from the previous period raises the size of the issuance they undertake.

tions between multinationals and other firms in the cross-section, as well as investment and financial decisions. Firm-level leverage and equity issuance moments are matched to identify the magnitude of financial frictions, while physical capital investment data are used to calibrate adjustment costs. Fixed costs are identified by matching transition probabilities across all the firm operational statuses.

I apply the general framework to a part of the TCJA, which was aimed specifically at U.S. multinationals. The repatriation tax was a rate that the U.S. Government levied on the overseas earnings of U.S.-incorporated firms prior to the Act — it was removed effective January 1^{st} 2018. When a U.S. firm generates earnings in a foreign country, it pays corporate taxes to the local tax authority. Prior to the TCJA, it would also pay taxes to the U.S. Government on these earnings when they were remitted back to the U.S. parent, or repatriated.[3] The rate paid was equal to the difference between the U.S. statutory rate of 35% and the rate the firm had already paid to the foreign government. Foreign corporate taxes are still levied, but U.S. taxes on these overseas earnings of U.S. firms are no longer incurred post-TCJA.

There are two competing channels associated with removing the repatriation tax in my new framework. The first is an offshoring channel, which was feared by the Act's opponents as being adverse for U.S. workers (Bernstein, 2017). In addition to saving on iceberg costs, multinationals also save on their tax bill relative to exporters post-reform. More FDI in the cross-section raises the supply of goods to the overseas market, driving adverse terms of trade effects, which further disincentivise U.S. export production.[4] The second channel is a pro-competitive effect. Immediately, incumbent U.S. multinationals have more earnings to distribute to their shareholders. But at the same time, the promise of a lower tax burden for future potential U.S. multinationals drives increased business dynamism. The reform catalyses an increase in firm creation, which boosts domestic labour demand, thereby putting upward-pressure on the U.S. real wage. These two competing effects make this policy the ideal application in the context of the numerical laboratory this paper develops; which effect dominates is ultimately a quantitative question.

The policy application leads to significant selection effects in the U.S. firm cross section;

[3] This 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.

[4] This offshoring channel is illustrated analytically in the first subsection of a prologue partial equilibrium model deferred to appendix A.

it drives an immediate change in the composition of firms servicing the overseas market. When the tax is removed, an immediate decrease of 2.5% in the fraction of exporting firms eventuates, with the difference being made-up by new multinationals. The rise in entry value drives an immediate rise in the number of U.S. startup firms of 5%, bringing an increase in labour demand. This then lowers domestic goods prices and drives-out the least productive firms in the U.S. economy. The culmination is a rise in aggregate productivity as well as welfare of 1% in consumption equivalents. Given that the positive domestic effects are taxable by the U.S. Government, the reform is also revenue neutral.

Dynamics have a significant impact on the results. A re-calibrated static version of the model generates inferences, which are the opposite qualitatively when studying the reform's steady state impact with the cumulative results of the full dynamic model. The reform's offshoring effect is weaker in cumulative terms and gradual in the dynamic model. Some of the major beneficiaries of the reform are large incumbent exporters who seek to change their status to multinational. These firms downsize their domestic operations gradually in the dynamic model given the presence of capital adjustment costs, thereby slowing the pace of offshoring. Comparing across steady states in a static model misses this concept, leading to around 8% lower U.S. Government tax collections and around a 1% decrease in domestic welfare.

Financial frictions have a significant impact on the results, where they amplify the effect of the reform on the macroeconomy.[5] A re-calibrated version of the fully dynamic model with the equity issuance premium shut-down leads to significantly smaller effects of the quantitative exercise. Removing this friction leads to considerably lower entry effects of the reform. The fraction of newly-created firms that upgrade their status to FDI in the period after their entry is targeted in the calibration by garnishing their average productivity relative to that of incumbents.[6] Firms that become multinationals place a lot of stress on their financial structure and often require new external financing in the period that they upgrade. Costless equity issuance therefore increases the prevalence of the entry to multinational transition, necessitating greater productivity garnishing to hit the target moment.[7] The exercise leads to a 0.2% cumulative welfare gain without financial frictions

[5]The second subsection of the prologue partial equilibrium model in appendix A illustrates this effect on the cross-section analytically.

[6]Matching this moment is crucial for not over-stating the positive domestic effects of the reform.

[7]Simply shutting-down the equity issuance premium parameters and not re-calibrating the model also leads to smaller entry effects. Cheaper financing means that new multinationals are larger in size due to

in contrast with 1% in the model with these frictions.

This paper contributes to several different literatures. The first relates to trade, multinationals and policy reforms; a small subset of these papers study reforms targeted at multinationals. McGrattan & Prescott (2009), Burstein & Monge-Naranjo (2009) and Ramondo (2014) consider the gains from opening-up to FDI from foreign firms. Ramondo & Rodriguez-Clare (2013) study the interaction of openness to FDI and trade simultaneously. Models in the quantitative trade literature are typically static; of those that incorporate dynamics, the emphasis has mostly been on the export margin. Examples include Alessandria, Choi, & Ruhl (2014), Ruhl & Willis (2017), Alvarez (2017), Fitzgerald, Haller, & Yedid-Levi (2016), Brooks & Dovis (2019) and Ravikumar, Santacreu, & Sposi (2017). An exception is McGrattan (2012), who studies FDI openness reforms along the dynamic transition path, but in a model with representative agents. Gumpert, Moxnes, Ramondo, & Tintelnot (2016) find that including FDI in a calibrated model can substantially increase the gains from policy reforms relative to one with trade only. I contribute to this literature by thinking about policy, export and FDI decisions in a dynamic context with heterogeneity.

A second area this work speaks to is the literature in structural corporate finance. My framework nests the closed economy general equilibrium model with heterogeneity and financial frictions of Gomes (2001), while also disentangling debt and equity financing as in Hennessy & Whited (2007). Gourio & Miao (2009) conduct quantitative exercises with respect to dividend tax reforms using a calibrated model of heterogeneous firms and financial frictions. Studies in this area typically have a closed economy partial equilibrium setup. Some prominent examples in the literature include Nikolov & Whited (2014), Riddick & Whited (2009) and Li, Whited, & Wu (2016). Fillat & Garetto (2015) document and then rationalise the regularity that multinationals typically have higher returns using a sunk-cost model of FDI. I contribute to this literature by studying capital structure decisions in a general equilibrium open economy framework.

A third related literature is that studying the impact of the repatriation tax specifically on U.S. firm behaviour. There are a small number of papers that study the issue in the context of partial equilibrium models. Gu (2017) studies the tax's impact on firm cash

a lower marginal cost of capital. This reduces the price of U.S. goods abroad to a greater extent, hurting exporting firms more. This mitigates the entry value gains, pushing-back against the rise in the number of entrants.

holdings. Curtis, Garın, & Mehkari (2017) think about news shocks surrounding the tax to get at anticipatory effects. Albertus, Glover, & Levine (2018) study how the tax and agency conflicts affect the overseas investment of incumbent U.S. multinationals. Papers with an empirical focus include Arena & Kutner (2015), who look at similar reforms to removing the repatriation tax, in the context of British and Japanese firms. Foley, Hartzell, Titman, & Twite (2007) and Harford, Wang, & Zhang (2017) broadly look at the impact of the repatriation tax on cash holdings of U.S. firms. The novelty of my paper is that I investigate the impact of this reform on the incentives for the creation of new multinationals and U.S firms more generally — effects that so far have been largely ignored.

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

II Model Environment

The model is dynamic and in discrete time, (with index t over non-negative integers). The world is comprised of two countries, referred to as Home (abbreviated as H) and Foreign (abbreviated as F). These two countries are asymmetric with the main emphasis being on heterogeneous firms that are incorporated in H. These H firms choose how to service the F goods market, either through exporting or FDI. Firms that are incorporated in F are taken to be representative. All uncertainty in the model is idiosyncratic at the firm-level; there are none in the aggregate.

In what follows, goods for consumption that are made by H firms are referred to as H goods while those made by F firms are called F goods. Households in each country have preferences for both H goods and F goods, which facilitates trade across the two. The model's notation convention is that variables with superscript H are for variables relating to the operations of H firms and those with F superscripts are for F firm operations. Additional $*$ superscripts denote activities that take place in F. For example C_t^H and C_t^{H*} are aggregate consumption of H goods in H and F respectively while C_t^F and C_t^{F*} are aggregate consumption of F goods in H and F respectively. There are six types of agents in the world in total: firms, households and government in H and F. With regard to the heterogeneous H firms, lower-case variables correspond to firm-level variables while those with calligraphic upper-case letters are for aggregates.

i World Markets

There are nine markets throughout the world. Each market is described in table 1. In particular the mobility of the goods are described as either perfectly mobile, immobile or imperfectly mobile across the two countries. Several market prices corresponding to F are taken to be exogenous in order to keep the model's computations tractable. In this sense, the Home-Foreign setup in the model can be interpreted as the U.S. and the rest of the world, where the rest of the world is sufficiently large that F factor prices are taken as given by U.S. firms.

Market	**Mobility**	**Price**	**Price Determination**
Global investment goods	Perfectly mobile	Λ_t	Exogenous
H labour	Immobile	$W_t = 1$	Numeraire
F labour	Immobile	W_t^*	Exogenous
H consumption goods in H	Imperfectly mobile	P_t^H	Endogenous
F consumption goods in H	Imperfectly mobile	P_t^F	Exogenous
H consumption goods in F	Imperfectly mobile	P_t^{H*}	Endogenous
F consumption goods in F	Imperfectly mobile	P_t^{F*}	Exogenous
H riskless bonds	Immobile	R_t	Endogenous
H firm shares	Immobile	z_t	Endogenous

Table 1: World markets and prices

Investment goods are assumed to be perfectly mobile across the two countries with one single integrated global capital market.[8] These investment goods originate from F and are supplied elastically at the corresponding prevailing price. These goods are purchased by the H firms, which then augment their capital stock. After a purchase takes place the H firm owns the investment goods meaning that they receive all future benefits that they generate.

In contrast, consumption goods made by both H and F firms are imperfectly mobile, where

[8]In previous versions of this paper, investment goods have been both imperfectly mobile or completely immobile. These two alternative set-ups lead to different numerical results of the quantitative exercises, but are the same qualitatively.

trade across countries can take place subject to iceberg transport costs, (to be described in more detail later). These assumptions are made to ensure consistency with empirical evidence that capital and other intermediate goods are generally more mobile than final goods, (see Frankel (1985) or Obstfeld & Rogoff (2000)). Prices of H consumption goods are solved for endogenously in each country, while those for F goods are assumed to be exogenous. While the H firms are unable to affect prices of F goods, they do influence the price fetched for their own goods in F. As a result, policy reforms that lead to changes in the supply of H goods to F are disciplined by general equilibrium effects in the form of price changes. These price changes ensure that the effects of such reforms are not overstated in quantitative exercises.

Labour markets across the two countries are taken to be totally segmented, with no movement between the two. The main rationale is to ensure that meaningful statements regarding H welfare effects of policy reforms can be made. The wage in H is taken to be the numeraire while that in F is taken as exogenous.

Finally there are two financial markets in the H economy: one is a market for shares in the H firms and the other is a market for riskless bonds. Both of these markets are such that securities can only be traded amongst agents from H; neither security type can be held by F agents.[9] The riskless rate and firm share prices are both solved for endogenously in the model.

ii Households

ii.1 Home Households

A representative household in H has consumption preferences across both H goods and F goods. Their lifetime utility function is of the form

$$\sum_{t=0}^{\infty} \tilde{\beta}^t \frac{\mathscr{C}_t^{1-\gamma}}{1-\gamma} \tag{1}$$

[9] In the data, the fraction of U.S. financial securities owned by foreigners is in the minority — around 20% in 2018 (U.S. Treasury (2019)). In addition to greatly simplifying the analysis, these assumptions also seem like a reasonable approximation to these data.

where $\tilde{\beta} \in [0,1]$ is the household's discount factor, γ is their coefficient of relative risk aversion. The variable $\mathscr{C}_t$ is an aggregate across H and F goods of the form

$$\mathscr{C}_t = (C_t^H)^{\lambda}(C_t^F)^{1-\lambda}$$

where $\lambda \in [0,1]$ is the household's expenditure share on H goods and $1-\lambda$ is that on F goods. The variables C_t^H and C_t^F represent the aggregate level of consumption by the household on H goods and F goods. While F goods are assumed to be homogeneous, the H goods are of differentiated varieties. Denote the set of available H goods varieties in H by Ω, meaning that the aggregate consumption of H goods can be written as

$$C_t^H = \left(\int_{\omega \in \Omega} c_t^H(\omega)^{\rho} d\omega \right)^{\frac{1}{\rho}}$$

where $\rho \in [0,1]$ governs the elasticity of substitution across H goods varieties: $\sigma = \frac{1}{1-\rho}$. The aggregate price index for H goods can then be written as

$$P_t^H = \left(\int_{\omega \in \Omega} p_t^H(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}}$$

where $p_t^H(\omega)$ is the price charged by the H firm producer of variety ω. The household's budget constraint is given by

$$\begin{aligned} &P_t^H C_t^H + P_t^F C_t^F + \frac{B_{t+1}}{1+R_{t+1}} + \int_{\omega \in \Omega} a_{t+1}(\omega) z_t(\omega) d\omega = \\ &B_t + \int_{\omega \in \Omega} a_t(\omega)[z_t(\omega) + (1-\tau^D) d_t(\omega)] d\omega + (1-\tau^W) + G_t \end{aligned} \tag{2}$$

where B_{t+1} denotes the household's choice of riskless bonds to bring-into period $t+1$, $a_{t+1}(\omega)$ is their choice of shares in H firm producer of variety ω, $d_t(\omega)$ is the dividend distributed to shareholders by producer of variety ω, τ^D is the dividend tax rate and τ^W is the labour income tax rate. Notice that the supply of labour is normalised to unity and recall that the wage is the numeraire. The variable G_t denotes a lump-sum transfer from the H Government to the household.

ii.2 Foreign Households

Given that the focus of the paper is on the impact on the H economy of these targeted tax reforms, I take a take a relatively agnostic stance on the behaviour of F households. The aggregate level of consumption by the F household of the H goods, C_t^{H*}, is an exogenous function of the aggregate price level P_t^{H*}. These are then in turn assumed to be aggregates across the variety-level prices and quantities similarly to those for the H household

$$C_t^{H*} = \left(\int_{\omega^* \in \Omega^*} c_t^{H*}(\omega^*)^\rho d\omega^* \right)^{\frac{1}{\rho}}$$
$$P_t^{H*} = \left(\int_{\omega^* \in \Omega^*} p_t^{H*}(\omega^*)^{1-\sigma} d\omega^* \right)^{\frac{1}{1-\sigma}}$$

where the parameter governing the elasticity of substitution is the same as that for the H household and Ω^* denotes the varieties available in F. In terms of the supply of F labour and global investment goods, I assume for simplicity that the F household supplies each factor perfectly elastically at the prevailing price level, (i.e. W_t^* and Λ_t respectively). Their demand for F goods is also taken to be exogenous.

iii Firms

iii.1 Home Firms

In this section the environment for H firms is described; variety-level notation will be omitted for ease of exposition.

Objective Function

The H firms have the standard objective of optimising over their operating, financing and investment decisions to maximise the expected discounted value of dividends that go to their shareholders (the H households)

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta_t d_t$$

where $\beta_t \in [0, 1]$ is the firm's time-varying discount factor. The expectation operator is taken with respect to the firm's idiosyncratic future stochastic variables. The discount factor β_t corresponds to the stochastic discount factor of the H household, given by

$$\beta_t = \tilde{\beta}^t \left(\frac{\mathscr{C}_t}{\mathscr{C}_0}\right)^{-\gamma}.$$

Notice that in general $\beta_t \neq \tilde{\beta}^t$ unless the model is in its steady state. Along any transition associated with policy reforms, the discount factor that the firm uses will be changing over time based-on the H household's consumption-savings decisions.

Operational Statuses: Extensive Margin Investment

In the spirit of Helpman, Melitz, & Yeaple (2004), H firms have the option to select into different modes of servicing both the H and F markets. Firms make a discrete choice each period, which will depend on their state vector, of what status to assume.[10] The possible statuses for firms are

1. Exit the industry (E),
2. Operate as a pure domestic (D),
3. Operate as an exporter (X),
4. Operate as a multinational (M),
5. Operate as an offshoring multinational (MO).[11]

A firm that exits the industry will liquidate its assets, repay its debts, pay a final dividend to its shareholders and then cease to exist thereafter. A domestic firm produces in H and sells to the household in H only. The remaining three statuses correspond to firms, which are able to service both the H and F markets, but differ in terms of their locations of production. An exporting firm undertakes all of its production in H; it sells part of its output to the H household and the remainder to the F household. The output that is shipped to F incurs a melting iceberg cost, denoted by $d_{HF} \geq 1$, such that d_{HF} units of output must be produced for one unit to reach F.

[10] Although the firms make their discrete choice each period, dependence of this choice on their entire state vector introduces persistence of their status across periods. See the model equilibrium section for more details.

[11] In previous versions of the paper, corporate tax inversions were also permitted, where an H firm was able to re-incorporate as a F firm for an additional fixed cost. Inclusion of this additional status has almost no bearing on the results and so is omitted in this version; further details are deferred to appendix C.

A multinational firm services the H market by producing and selling in H and services the F market through FDI — producing through its F subsidiary in F. Finally an offshoring multinational undertakes all of its production in F and then exports goods back to H for sale in the H market. It is assumed that only incumbent multinational firms have the option to upgrade their status to offshorer in a given period, meaning that a newly-established firm would take several periods to become attain this status. Note also that the offshoring option brings with it iceberg transport costs on the goods shipped-back to H, denoted by $d_{FH} \geq 1$. A firm would pursue this option to take advantage of lower local factor prices in F.

Organisational Structures and Fixed Costs

Firms incur fixed costs associated with their extensive margin operational statuses described above. I follow the setup of a large up-front sunk, followed by period-by-period smaller fixed cost framework of papers such as Alessandria & Choi (2007, 2014) and Alessandria, Choi, & Ruhl (2014). These papers use this setup in the context of new exporting firms: incurring a one-time sunk cost to sell to overseas markets makes the export decision dynamic. I extend this framework to the case with FDI and the various segments that such firms have in their organisational structures to service each market. The total value of fixed cost payments associated with each transitional status are spelled-out explicitly in table 12 in appendix B.

The setup in terms of organisational segments follows a simplified version of Grossman, Helpman, & Szeidl (2006). A firm pays a large up-front sunk fixed cost associated with establishing a new segment in its organisational structure: hereafter be referred to as an establishment cost. The new segment commences operations in the period immediately after the payment of its establishment cost; it takes one period to become operational. Each period thereafter when production takes place through this segment, a smaller period-by-period fixed cost is incurred: hereafter referred to as a fixed continuation cost. Both establishment and continuation fixed costs are denoted in terms of labour units of the country, in which they are incurred. Table 2 depicts the organisational structures of all H firms statuses in the model.

Firms of each status have headquarters in H — their country of incorporation. Headquarters is always responsible for the oversight of the organisation. This specifically involves the firm's financing decisions, in addition to those regarding dividend distributions to its

Status	H **Segments**	F **Segments**
D	Headquarters	–
X	Headquarters	–
	Export segment	–
M	Headquarters	Subsidiary
MO	Headquarters	Subsidiary
		Export segment

Table 2: Organisational structures for each firm status.

shareholders. Headquarters is established when a new firm is created, the fixed establishment cost of which is denoted by f^{HQ}. Each period after a firm's inception, a continuation fixed cost denoted by $f^{HQ,C}$ is incurred regardless of status. Both of these costs are in H labour units.

Whenever production takes place in H, (for statuses D, X, M), all production takes place through the firm's headquarters. A firm that chooses to export some of their output to F is required to establish an export segment in its organisational structure. One can think of this as the segment, which is responsible for physically sending goods abroad. Establishment of the export segment incurs an establishment cost of f^X and a continuation cost of $f^{X,C}$, (both in H labour units), each period of operation thereafter.

A multinational has a subsidiary in F, which is responsible for production of goods for sale to the F household. The firm pays an establishment cost for the subsidiary of f^M. This cost is denoted in terms of H labour units, giving it the interpretation of domestic due diligence costs associated with building a physical presence in F. A continuation cost of $f^{M*,C}$ is incurred from the next period (when operations commence) and is denoted in F labour units. Finally an offshoring multinational still has its overall operations overseen by headquarters in H, but all of its production takes place in F. An establishment cost of f^{MO*} is paid in F labour units to build its export segment in F, which sends goods back to H for sale to the H household. A continuation cost of $f^{MO*,C}$ is paid period-by-period in F labour units when operating.

Certain firm transitions bring with them liquidations of capital stocks associated with closing segments: the proceeds from these liquidations are denoted by $l_t^{s_t}(\vec{\varphi}_t)$ where $\vec{\varphi}$ denotes their state vector and $s_t \in \{D, X, M, MO\}$ denotes their status at t.[12] Firms upgrading

[12]E.g. firms downsizing from $s_{t-1} \in \{M, MO\}$ to $s_t \in \{D, X\}$ will liquidate their F capital stock in the

from $s_{t-1} = X$ to $s_t = M$ are given the option to continue servicing F through their H export segment during their transition period; the same follows for those downgrading from $s_{t-1} = MO$. Those upgrading from $s_{t-1} = M$ to $s_t = MO$ have the option to continue producing in H during their transition period before liquidating their H capital stock.[13]

All continuation costs are assumed to be operating expenses incurred by the firm, meaning that they are tax deductible in the eyes of the relevant fiscal authority. Establishment costs are given the interpretation of capital expenditures, making them non tax deductible. In what follows, the total value of fixed costs paid by a firm with status $s_t \in \{D, X, M, MO\}$ is denoted by $f_t^{s_t}(\vec{\varphi}_t)$. Firms transitioning from X to M or MO to M have the option of whether to export during their transition, meaning that these transitions have two possible total fixed cost values.

Technology

Firms produce using a constant returns to scale production technology in each country; capital and labour are inputs. A firm that operates with statuses D or X will have only a capital stock in H (denoted by k_t^H). A firm with M status has a capital stock in H and F (the latter is denoted by k_t^{H*}), while a firm with MO status has a capital stock in F only. Firms own their capital stocks in each country and each period make optimal investment decisions.

H firms face idiosyncratic uncertainty in the form of productivity shocks. I assume that the productivity level is common to all segments within a firm to keep the state space small. The productivity level is denoted by θ_t and follows the law of motion

$$\log(\theta_t) = \rho_\theta \log(\theta_{t-1}) + \sigma_\theta \epsilon_t, \;\; \epsilon_t \sim N(0, 1) \tag{3}$$

where $0 < \rho_\theta < 1$ captures persistence and $\sigma_\theta > 0$ measures volatility. The productivity level and factor inputs are combined using the production function for $j \in \{H, H*\}$

$$q_t^j = \theta_t (k_t^j)^\alpha (n_t^j)^{1-\alpha}$$

downsizing period for cash flow of $\xi \Lambda_t k_t^{H*}$.

[13]Offshorers liquidate their H capital stock (eventually) to keep the definition of what constitutes a multinational firm clear. Notice that a firm with multinational status can also choose endogenously to reduce its F capital stock close to zero while keeping F subsidiary operational. Such a firm would still be considered to be a multinational.

where $\alpha \in [0,1]$ and q_t^j denotes output. The law of motion for the capital stock is given by

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

where i_t^j denotes investment and $\delta \in [0,1]$ is the rate of deprecation. Firms face a quadratic adjustment cost associated with their investment choices of the form in Cooper & Haltiwanger (2006)

$$\Phi_t^j(k_t^j, i_t^j) = \frac{\phi}{2}\left(\frac{i_t^j}{k_t^j}\right)^2 k_t^j.$$

where $\phi > 0$ is a parameter. Both investment and capital adjustment costs are denoted in terms of units of investment goods, which are sourced from the integrated global market.

External Financing

Headquarters can raise two types of external financing in H: new equity and riskless debt as in Hennessy & Whited (2005). There are two financial frictions, which work together to give determinate capital structure — debt tax shields and costly equity issuance. The former friction makes debt issuance advantageous from the perspective that the associated interest payments are tax deductible. The latter friction means that, when a firm pays a negative net dividend to its shareholders, an addition premium is paid in excess of the cost of using internally-generated funds.

New debt issuance for a firm is denoted by b_{t+1}; this is a stock variable, which is collateralised by the liquidation value of the firm's capital stocks in H and F through the constraint

$$b_{t+1} \leq \xi \Lambda_t (k_{t+1}^H + k_{t+1}^{H*})$$

where $\xi \in [0,1]$ represents a fire-sale liquidation value associated with the firm's capital stocks. This constraint says that the firm's borrowing can be no larger than what creditors would be able to seize in the case where their assets are liquidated. Notice also that collateralising the debt in this way allows H firms to borrow against their overseas assets, a feature that is particularly crucial when evaluating the U.S. repatriation tax reform. Large U.S. multinationals prior to the reform would often defer repatriation to avoid incurring U.S. taxes and borrow domestically against their accumulated overseas assets, (Gangar &

Robinson (2014)). This tax planning strategy would sometimes be called an effective repatriation. Allowing firms to follow this strategy in the model ensures that the quantitative impact of the reform is not over-stated.

Borrowing by firms is undertaken at the riskless rate in H. The bonds are obtained at a discount; firms choose the amount to repay in $t+1$, b_{t+1} and will receive $b_{t+1}/(1+R_{t+1})$ in period t. This implies that the firm's total interest payment will be in the amount of $b_{t+1}\left(1-1/[1+R_{t+1}]\right)$, giving debt tax shields in $t+1$ of

$$b_{t+1}\left(1-\frac{1}{1+R_{t+1}}\right)\tau^{\Pi},$$

where τ^{Π} denote the H domestic corporate tax rate. In terms of new equity issuance, recall that the net dividend that the firm paid to its shareholders in period t was denoted by d_t. When this variable is positive, it has the interpretation that the firm distributes dividends to its shareholders, while when it's negative, the firm is raising new funds from its shareholders. The equity issuance premium that the firm pays when $d_t < 0$ is denoted by $\zeta(d_t)$ and is comprised as a constant, proportional and squared term as a function of the size of the issuance

$$\zeta(d_t) = \zeta_0 + \zeta_1|d_t| + \zeta_2(d_t)^2 \tag{4}$$

for parameters $\zeta_0, \zeta_1, \zeta_2 > 0$. I assume that all external financing issuance takes place in H to keep the state space small. This is not a severely restrictive assumption though since a multinational's headquarters can always send these funds to the F subsidiary. Allowing subsidiaries to raise external funds would allow for many interesting questions surrounding internal capital markets to be answered and is left as an avenue for future research.

Exit and Entry

There are two forms of exit, which take place amongst H firms. The first is exogenous — each firm faces some probability of exiting the industry through a death shock as in Ghironi & Melitz (2005). These probabilities are denoted as $\kappa_{s_t} \in [0,1]$ for $s_t \in \{D, X, M, MO\}$, where notice they are allowed to differ across each of the firm statuses.[14] Should a firm be hit by this death shock, it receives the value associated with exiting the industry given

[14] I use these probabilities to target exit rates for each status in the calibration exercise, (to be discussed in more detail later).

its current state and ceases to exist thereafter. The second type of exit is endogenous — should a firm's state induce a particularly low value associated with an operational status, it can choose to leave the industry voluntarily.

There is an endogenous measure of potential entrants into the industry in period t, denoted by $M_t^T > 0$. Variables with superscript T correspond to newly-entered firms. These firms pay the fixed establishment cost for their headquarters in H and then decide how much to invest in their H capital stock, which is financed by collateralised riskless debt and new equity issuance. The new equity they issue is subject to the issuance premium given in (4).[15] These new firms then wait until period $t+1$ to commence their operations. When starting period $t+1$, these new entrants draw their initial productivity from a distribution denoted by $\Theta^T(\theta)$, which is related to the productivity process in (3). They then act as incumbent firms thereafter.

iii.2 Foreign Firms

F firms are taken to have a much simpler setup those in H. There is a single representative firm incorporated in F, which uses a constant returns to scale production function in F labour to produce goods for sale to the F market and H market through exports. They produce using the production function

$$Q_t^{F*} = N_t^{F*}$$

where Q_t^{F*} denotes their aggregate production and N_t^{F*} denotes the aggregate amount of labour they hire. Sale of F goods to the H household all take place through exporting, meaning that shipping of these goods comes with an iceberg transport cost, which recall was denoted by $d_{FH} \geq 1$. The owners of the F firm are all assumed to be the F household. The F firm's profit maximisation problem leads to the following relationships

$$P_t^F = d_{FH} W_t^*$$
$$P_t^{F*} = W_t^*$$

[15] I interpret this as the cost associated with the initial public offering (IPO) of the firm's equity on the stock exchange. This follows the approach of Corbae & D'Erasmo (2017).

where the price of F goods in H follows from the fact that the F firm exports its goods to H.

iv Government

iv.1 Home Government

The H Government collects taxes and distributes the proceeds to the H household in a lump sum fashion; its budget is balanced each period.[16] Following this approach is a straightforward way of internalising the effect of changes in aggregate H government tax revenues on the domestic economy and welfare. The tax rates levied are on corporate profits generated in H, dividends distributed to the H household, labour earnings made by the H household and repatriated overseas earnings generated by H multinationals, denoted by $\tau^{\Pi}, \tau^{D}, \tau^{W}$ and $\tau^{\Pi,U}$ respectively. Recall that the lump sum transfers to the household are denoted by G_t; its budget constraint is given by

$$G_t = \tau^{\Pi}\Pi_t + \tau^{W} + \tau^{D}\mathcal{D}_t^{+} + \tau^{\Pi,U}\mathcal{U}_t^{+}$$

where Π_t denotes aggregate profits generated in H net of firm tax deductions, $\mathcal{D}_t^{+}$ denotes dividend distributions to H households and $\mathcal{U}_t^{+}$ denotes repatriated overseas earnings of H multinationals.

iv.2 Foreign Government

The F Government collects taxes on corporate profits made in their jurisdiction, where the rate is denoted by $\tau^{\Pi *}$. In principle, they can levy taxes on other sources of income as well, but I abstract from them, keeping with the passive setup of F. I assume that the corporate tax collections are re-distributed to the F household using $G_t^{*} = \tau^{\Pi *}\Pi_t^{*}$ where G_t^{*} denotes the transfer and Π_t^{*} denotes profits made in F.

[16] Thinking about optimal tax rates is beyond the scope of this paper. I follow Corbae & D'Erasmo (2017) by being agnostic about the reasons for tax rates being in place in re-distributing in this way.

v Timing

Here I describe the timing of the decisions of H firms for an arbitrary time period t. See that

(1) Incumbents enter the period with state vector $(k_t^H, k_t^{H*}, b_t, \theta_{t-1}, s_{t-1})$ where $s_{t-1} \in \{T, D, X, M, MO\}$ denotes their status in period $t-1$.

(2) Incumbents draw their new productivity shock θ_t and exogenous death shock.

(3) Incumbent exits the industry if impacted by the death shock. If it survives, the firm makes its extensive margin decision $s_t \in \{E, D, X, M, MO\}$.

(4) Incumbents make their static decisions (how much labour to hire, how much to produce and what price to charge) and then their intensive-margin dynamic decisions.

(5) Entrants pay a fixed cost f^{HQ} to establish their headquarters and enter the industry.

(6) Entrants make their intensive margin decisions and act as incumbents from $t+1$ onwards.

III Model Equilibrium

i Households

i.1 Home Households

The H household makes optimal decisions regarding their inter-temporal variables — the number of shares to hold in each H firm and the number of riskless bonds, through which to save. Their optimisation behaviour yields Euler equations of the form

$$\begin{aligned} z_t(\omega) &= \tilde{\beta} \left(\frac{\mathscr{C}_{t+1}}{\mathscr{C}_t} \right)^{-\gamma} \left[z_{t+1}(\omega) + (1 - \tau^D) d_{t+1}(\omega) \right] \\ \frac{1}{1 + R_{t+1}} &= \tilde{\beta} \left(\frac{\mathscr{C}_{t+1}}{\mathscr{C}_t} \right)^{-\gamma} \end{aligned} \tag{5}$$

for shares and bonds respectively. Notice that in steady state, the Euler equation for bonds implies a relationship between the riskless rate and household discount factor of

$$\frac{1}{1+R} = \tilde{\beta}. \tag{6}$$

These equations are all consistent with the discount rate used by the H firms. In steady state, one can think of an H firm as discounting its future net dividends using a discount rate of R, while out of steady state, it uses a time-varying discount rate of R_{t+1}.

ii Firms

ii.1 Home Firms

Incumbent Recursive Formulation

Denote the state vector of an incumbent firm, (post productivity and death shock draw), by $\vec{\varphi}_t = (k_t^H, k_t^{H*}, b_t, \theta_t, s_{t-1})$. Then denote the value associated with the state by $v_t(\vec{\varphi}_t)$ to get

$$v_t(\vec{\varphi}_t) = \left(\max_{s_t \in \{E,D,X,M\}} v_t^{s_t}(\vec{\varphi}_t)\right) \mathbb{1}_{s_{t-1}\in\{T,D,X\}} + \left(\max_{s_t \in \{E,D,X,M,MO\}} v_t^{s_t}(\vec{\varphi}_t)\right) \mathbb{1}_{s_{t-1}\in\{M,MO\}}$$

where $v_t^{s_t}(\vec{\varphi}_t)$ denotes the value associated with discrete choice s_t in period t given the state vector. The two-part structure of the Bellman equation follows from the fact that only firms with multinational or offshorer status at $t-1$ have the option to be an offshorer in period t.

In what follows I avoid making the dependence of all variables, excepting value functions, on the firm's state vector explicit to economise on notation. The Bellman equations that follow will are written for the firm after having solved any static optimisation problems, (i.e. for set prices, employment levels and quantities). Post-optimised static variables will be denoted by hats, (e.g. $\widehat{p}_t^H$ for a variety/firm-level H price) and the derivation of such variables are deferred to appendix D. Note also that the iceberg costs of sending goods abroad feature in these static decisions.

When an H firm exits the model, it liquidates its capital stocks, repays its debts from the previous period, pays a final dividend to its shareholders and then ceases to exist. This gives exit value of

$$
\begin{aligned}
v_t^E(\vec{\varphi}_t) &= l_t^E - b_t \\
l_t^E &= \xi \Lambda_t \left(k_t^H + k_t^{H*} \right)
\end{aligned}
$$

which recall applies to both endogenous exit choices and firms that are hit with the exogenous death shock. A firm that chooses to be a domestic has value given by

$$
v_t^D(\vec{\varphi}_t) = \max_{\{k_{t+1}^H, b_{t+1}\}} e_t^D + \beta_1 \mathbb{E}_t[v_{t+1}(\vec{\varphi}_{t+1})]
$$

subject to

$$
\begin{aligned}
e_t^D =& d_t^D - (\mathbb{1}_{d_t^D < 0}) \zeta(d_t^D) \\
d_t^D =& (1-\tau^\Pi)\{\widehat{p}_t^H \widehat{q}_t^H - \widehat{n}_t^H\} - f_t^D - \Lambda_t i_t^H - \Lambda_t \Phi_t^H + l_t^D \\
& + \frac{b_{t+1}}{1+R_{t+1}} - b_t + b_t \left(1 - \frac{1}{1+R_t} \right) \tau^\Pi \\
f_t^D =& (1-\tau^\Pi) f^{HQ,C} \\
l_t^D =& (\mathbb{1}_{s_{t-1} \in \{M, MO\}}) \xi \Lambda_t k_t^{H*} \\
i_t^H =& k_{t+1}^H - (1-\delta) k_t^H \\
b_{t+1} \leq & \xi \Lambda_t k_{t+1}^H.
\end{aligned}
$$

The Bellman equation for a domestic firm is comprised of two parts — a net dividend to shareholders after any equity issuance premium is paid, e_t^D, in addition to the continuation value associated with its optimal controls $\beta_1 \mathbb{E}_t[V_{t+1}(\vec{\varphi}_{t+1})]$. If the dividend the firm pays its shareholders is negative, $d_t^D < 0$, then the firm also incurs the equity issuance premium of $\zeta(d_t^D)$.

The domestic firm's period dividend is comprised of its after-tax profits from its sales to the H household where $\widehat{p}_t^H$, $\widehat{q}_t^H$ and $\widehat{n}_t^H$ are the firm's optimal choices of price, quantity and labour input employed to service the H market. These variables are chosen in a static context to maximise the profits of the firm, (see appendix D). The period dividend involves cash outflows associated with paying fixed costs, variable investment and capital adjustment costs. The firm also re-balances its borrowing for the period, receives its debt tax shields and proceeds from liquidating its F capital stock if it came into the period with some. An exporting firm receives value given by

$$v_t^X(\vec{\varphi}_t) = \max_{\{k_{t+1}^H, b_{t+1}\}} e_t^X + \beta_1 \mathbb{E}_t[v_{t+1}(\vec{\varphi}_{t+1})]$$

subject to

$$\begin{aligned}
e_t^X =& d_t^X - (\mathbb{1}_{d_t^X<0})\zeta(d_t^X) \\
d_t^X =& (1-\tau^\Pi)\{\widehat{p}_t^H \widehat{q}_t^H + (\mathbb{1}_{s_{t-1}=X})\widehat{p}_t^{H*}\widehat{q}_t^{H*} - \widehat{n}_t^H\} - f_t^X - \Lambda_t i_t^H - \Lambda_t \Phi_t^H + l_t^X \\
&+ \frac{b_{t+1}}{1+R_{t+1}} - b_t + b_t\left(1 - \frac{1}{1+R_t}\right)\tau^\Pi \\
f_t^X =& (1-\tau^\Pi) f^{HQ,C} + (\mathbb{1}_{s_{t-1}=X})(1-\tau^\Pi) f^{X,C} + (\mathbb{1}_{s_{t-1}\neq X}) f^X \\
l_t^X =& (\mathbb{1}_{s_{t-1}\in\{M,MO\}})\xi\Lambda_t k_t^{H*} \\
i_t^H =& k_{t+1}^H - (1-\delta)k_t^H \\
b_{t+1} \leq& \xi\Lambda_t k_{t+1}^H.
\end{aligned}$$

where notice that the firm realises some sales revenue $\widehat{p}_t^{H*}\widehat{q}_t^{H*}$ associated with selling to the F household when its export segment is operational, (i.e. $s_{t-1} = X$). These variables are again chosen statically to maximise profits. The fixed cost function includes the export continuation fixed cost again when the segment is operational, otherwise the fixed establishment cost is incurred. A multinational firm has a Bellman equation given by

$$v_t^M(\vec{\varphi}_t) = \max_{\{k_{t+1}^H, k_{t+1}^{H*}, b_{t+1}\}} e_t^M + \beta_1 \mathbb{E}_t[v_{t+1}(\vec{\varphi}_{t+1})]$$

where

$$\begin{aligned}
e_t^M =& d_t^M - (\mathbb{1}_{d_t^M<0})\zeta(d_t^M) \\
d_t^M =& (1-\tau^\Pi)\{\widehat{p}_t^H \widehat{q}_t^H + \widehat{x}_t^M - \widehat{n}_t^H\} + \left\{\mathbb{1}_{u_t^M<0} + \mathbb{1}_{u_t^M\geq 0}\left(\frac{1-\tau^{\Pi,U}-\tau^{\Pi*}}{1-\tau^{\Pi*}}\right)\right\} u_t^M \\
&- f_t^M - \Lambda_t i_t^H - \Lambda_t \Phi_t^H + \frac{b_{t+1}}{1+R_{t+1}} - b_t + b_t\left(1 - \frac{1}{1+R_t}\right)\tau^\Pi \\
\widehat{x}_t^M =& (\mathbb{1}_{s_{t-1}=X}\mathbb{1}_{\widehat{o}_t=1})\widehat{p}_t^{H*}\widehat{q}_t^{H*} \\
u_t^M =& \mathbb{1}_{s_{t-1}\in\{M,MO\}}(1-\tau^{\Pi*})\{\widehat{p}_t^{H*}\widehat{q}_t^{H*} - W_t^*\widehat{n}_t^{H*}\} - \Lambda_t i_t^{H*} - \Lambda_t \Phi_t^{H*} \\
f_t^M =& (1-\tau^\Pi) f^{HQ,C} + \mathbb{1}_{s_{t-1}=M}(1-\tau^{\Pi,U}-\tau^{\Pi*})W_t^* f^{M*,C} + (\mathbb{1}_{s_{t-1}=X}\mathbb{1}_{\widehat{o}_t=1}) f^{X,C}
\end{aligned}$$

$$
\begin{aligned}
&+ (\mathbb{1}_{s_{t-1} \neq M}) f^M \\
i_t^H &= k_{t+1}^H - (1-\delta) k_t^H \\
i_t^{H*} &= k_{t+1}^{H*} - (1-\delta) k_t^{H*} \\
b_{t+1} &\leq \xi \Lambda_t (k_{t+1}^H + k_{t+1}^{H*}).
\end{aligned}
$$

The variable $\widehat{x}_t^M$ denotes any export income that the firm generates, should it be transitioning from export status last period. Specifically, a firm with $s_{t-1} = X$ makes an additional static choice — whether to continue exporting while it waits for its F subsidiary to become operational. The variable $\widehat{o}_t \in \{0, 1\}$ is an indicator function equal to one when such a firm elects to export in the transition. This decision is static and depends on the firm's current state. Further details are in appendix D.

The variable u_t^M is a net dividend, (can be positive or negative), from the F subsidiary back to the firm's headquarters in H; it denotes repatriations of overseas earnings. When these repatriations are positive, the firm pays the repatriation tax on its pretax earnings to the H Government (captured by the term $(1 - \tau^{\Pi,U} - \tau^{\Pi*})/(1 - \tau^{\Pi*})$: the denominator ensures that $\tau^{\Pi,U}$ is levied on the pretax F earnings). Negative repatriations, (the parent investing more funds into the subsidiary), are not tax deductible. The amount that a multinational repatriates is comprised of the earnings they generate if their F subsidiary is operational net of F taxes less what they re-invest in the F capital stock. That is — a subsidiary can defer repatriating their overseas earnings through re-investment in the capital stock.

Finally when studying the value of an offshoring multinational, notice that we must take account of the H capital stock downsizing decision of a firm transitioning from M to MO. In the interest of brevity, I show the value function for an offshorer with $s_{t-1} = MO$; that for an offshorer with $s_{t-1} = M$ is left to appendix E. When $s_t = s_{t-1} = MO$, the Bellman equation is

$$
v_t^{MO}(\varphi_t) = \max_{\{k_{t+1}^{H*}, b_{t+1}\}} e_t^{MO} + \beta_1 \mathbb{E}_t[v_{t+1}(\varphi_{t+1})] \tag{7}
$$

where

$$
e_t^{MO} = d_t^{MO} - \mathbb{1}_{d_t^{MO} < 0} \zeta(d_t^{MO})
$$

$$
\begin{aligned}
d_t^{MO} &= \left\{\mathbb{1}_{u_t^{MO}<0} + \mathbb{1}_{u_t^{MO}\geq 0}\left(\frac{1-\tau^{\Pi,U}-\tau^{\Pi*}}{1-\tau^{\Pi*}}\right)\right\} u_t^{MO} - f_t^{MO} + l_t^{MO} \\
&\quad + \frac{b_{t+1}}{1+R_{t+1}} - b_t + b_t\left(1-\frac{1}{1+R_t}\right)\tau^{\Pi} \\
u_t^{MO} &= (1-\tau^{\Pi*})\left\{\widehat{p}_t^H \widehat{q}_t^H + \widehat{p}_t^{H*}\widehat{q}_t^{H*} - W_t^* n_t^{H*}\right\} - \Lambda_t i_t^* - \Lambda_t \Phi_t^* \\
f_t^{MO} &= (1-\tau^{\Pi}) f^{HQ,C} + (1-\tau^{\Pi,U}-\tau^{\Pi*}) W_t^* \{f^{M*,C} + f^{MO*,C}\} \\
l_t^{MO} &= \xi \Lambda_t k_t^H \\
i_t^{H*} &= k_{t+1}^{H*} - (1-\delta) k_t^{H*} \\
b_{t+1} &\leq \xi^* \Lambda_t k_{t+1}^*.
\end{aligned}
$$

The salient difference of the offshorer's Bellman equation from that of a regular multinational is that the production for sale of goods to the H household takes place through the F subsidiary. Notice then, as a consequence, the profits generated from said production are then taxable by the F Government in the period they're earned. It's not until these earnings are repatriated back to headquarters in H that they are taxed by the H Government. Notice that a firm that was an offshorer at $t-1$ but was a regular multinational at $t-2$ that chose to continue producing in the transitional period will receive liquidation proceeds from its H capital stock.

Entrant Recursive Formulation

A new entrant pays its fixed establishment cost of f^{HQ}, thereby establishing its headquarters segment. It then decides on how much to invest in an H capital stock and how to finance it. Its Bellman equation is of the form

$$
v_t^T = \max_{\{k_{t+1}^H, b_{t+1}\}} e_t^T + \beta_1 \mathbb{E}^T[v_{t+1}(\vec{\varphi}_{t+1})]
$$

where

$$
\begin{aligned}
e_t^T &= d_t^T - \zeta(d_t^T) - f^{HQ} \\
d_t^T &= -i_t^H \\
b_{t+1} &\leq \xi \Lambda_t k_{t+1}^H.
\end{aligned}
$$

Notice that the value function for the entrant is not state dependent since all new entrants are ex-ante identical. Moreover the expectation over the future value function is with respect to the entrants' productivity distribution $\Theta^T(\theta)$ and the exogenous death shock.

iii Current Account

I follow the approach of Alvarez (2017), who assumes period-by-period balanced trade in a dynamic model of trade and capital accumulation. I rule-out international borrowing and lending between H and F, giving a balanced current account each period.[17] I make this assumption as it keeps the model's equilibrium computationally tractable. Moreover the primary focus of the model is on the effects of reforms on the H domestic economy; this current account assumption fits with the F price changes serving as a general equilibrium disciplining device. H imports both consumption and investment goods, while it generates income from exporting domestically-made consumption goods and from the activities of multinationals. The current account balance for H in period t is given by

$$CA_t = \mathcal{Y}_t^{H*} + \mathcal{EX}_t^{H*} - IM_t^F$$

where all the right-side variables are aggregates: $\mathcal{EX}_t^{H*}$ denotes the value of exported goods, $\mathcal{Y}_t^{H*}$ denotes net F income from the activities of multinationals and IM_t^F denotes the value of imported goods. The model's equilibrium is such that $CA_t = 0$. Note that this condition implicitly gives the equilibrium demand for H goods in F for a given price.

iv Recursive Equilibrium

The recursive equilibrium of the model is defined as having the following properties, (see appendix F for the full definition)

1. All optimising agents are optimising,

2. All world markets (global investment goods, H labour, F labour, H goods in H, H goods in F, F goods in H, F goods in F, H bonds and H shares) are clearing,

[17] Some recent papers studying dynamics in models of trade, (e.g. Alessandria, Choi, & Ruhl (2014) and Ravikumar, Santacreu, & Sposi (2019)) allow for bonds to be traded between countries with short-run trade imbalances. These papers typically find that the overall effects associated with trade reform tend to be larger in size than in a static context. Given the expansionary nature of removing the repatriation tax, it is likely that the quantitative results of the policy exercise that follow are a lower bound.

3. The ex-ante expected value of a new entering H firm is zero and
4. The current account for H balances each period.

IV Calibration

i Parameter Values

In this section, I detail choices of parameters used in the quantitative exercise. One period in the model is taken to be one year. There are two sets of parameters used in the quantitative exercises. The first is those that are selected outside of the model — this set exists to reduce the computational burden of the calibration. The second set of parameters are calibrated within the model to target moments in the data.

Name	**Symbol**	**Value**	**Source**
Steady state riskless rate	R	0.02	Hennessy & Whited (2007), Corbae & D'Erasmo (2017)
Household discount factor	$\tilde{\beta}$	0.98	$1/(1+R)$
Capital share production function	α	0.33	Standard
Labour share production function	$1-\alpha$	0.67	Constant returns
Depreciation rate	δ	0.15	Compustat
Household H consumption share	λ	0.85	National accounts
Elasticity of substitution	σ	4.00	Costantini & Melitz (2008)
Coefficient of relative risk aversion	γ	2.00	Alessandria, Choi, & Ruhl (2014)
Technology persistence	ρ_θ	0.87	OP (1996) regression
Technology volatility	σ_θ	0.32	OP (1996) regression
H corporate tax rate	τ^{Π}	0.35	Statutory rate
F corporate tax rate	$\tau^{\Pi*}$	0.23	Guvenen et al. (2017) and Hines & Rice (1994)
H repatriation tax rate	$\tau^{\Pi,U}$	0.12	Statutory rate $(\tau^{\Pi}-\tau^{\Pi*})$
H dividend tax rate	τ^{D}	0.15	Statutory rate
H labour income tax rate	τ^{W}	0.32	OECD (2018b)

Table 3: Parameters matched/selected outside the model

Table 3 shows the values of all the parameters chosen outside of the model. The steady state riskless rate is taken from other structural corporate finance studies with riskless bonds — namely Hennessy & Whited (2007) and Corbae & D'Erasmo (2017). Moreover this rate is broadly consistent with treasury real long term rates in the last couple of decades.[18] I take the capital share in the constant returns to scale production function to be one-third. The depreciation rate is taken to match the average rate in Compustat of 0.15.

The expenditure share for H households on H goods is set to 85% to match the complement of the share of imported goods in U.S. household consumption. I set the parameter $\rho = 0.75$, which implies an elasticity of substitution across varieties of goods of 4 as in Costantini & Melitz (2008). The coefficient of relative risk aversion is from Alessandria, Choi, & Ruhl (2014), but is also relatively standard in the macroeconomics literature. The persistence of productivity is set to a little under 0.9, while the standard deviation is set equal to 0.3, values that come from running Olley & Pakes (1992) regressions using Compustat data.

The final group of parameters selected outside the model are the tax rates. I set the H domestic corporate tax rate equal to the statutory U.S. rate, (pre-TCJA), of 35%. The F domestic corporate rate comes from averaging corporate rates across non-tax haven OECD countries, which gives 23%. Tax haven nations are taken to be those that are listed as such in two sources — Guvenen, Mataloni Jr, Rassier, & Ruhl (2017) and Hines & Rice (1994). The statutory repatriation tax rate is then 12%. The labour income tax rate in the U.S. comes from OECD (2018b), which states that the average single worker in the U.S. faced a tax wedge of around 32%. Finally the dividend tax rate is set to the 15% U.S. statutory rate.

Table 4 shows the parameter values that were calibrated inside the model and their corresponding targets in the data. Note that the moments in the model are all affected by parameters in a non-linear way, meaning that there is not a perfect mapping of each parameter to its target. The technicalities of the calibration procedure are deferred to appendix G.

The fixed costs for incumbent firms are identified by targeting the relevant transition probabilities in U.S. census data, (as reported in Boehm, Flaaen, & Pandalai-Nayar (2019)). The fixed establishment cost of a new firm is calibrated to the overall entry/exit rate. Given that there is no exact analogue of offshoring firms in the data, I choose the offshoring export segment continuation value to be the same as that for an exporter. The establishment cost for the offshorer's F export segment targets the aggregate employment intensity of U.S. multinationals abroad relative to domestically. The probabilities of ex-

[18]See `https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=reallongtermrateAll` for Treasury's estimates of historical real long term rates.

Name	Symbol	Value	Moment Targeted
Establishment cost of entry	f^{HQ}	0.56	Entry/exit rate
Continuation cost of D	$f^{HQ,C}$	0.08	Transition (D, D)
Establishment cost of X	f^{X}	0.07	Transition (D, X)
Continuation cost of X	$f^{X,C}$	0.06	Transition (X, X)
Establishment cost of M	f^{M}	1.25	Transition (D, M)
Continuation cost of M	$f^{M,C}$	0.32	Transition (M, M)
Establishment cost of MO	f^{MO}	0.10	F employment intensity
Continuation cost of MO	$f^{MO,C}$	0.06	$f^{X,C}$
Death probability for D	κ_D	0.00	Normalisation
Death probability for X	κ_X	0.05	Transition (X, E)
Death probability for M	κ_M	0.06	Transition (M, E)
Death probability for MO	κ_{MO}	0.06	κ_M
Entrant top productivity scaling	ν_{Θ}^{T}	0.20	Transition (T, M)
Iceberg cost H to F	d_{HF}	1.35	Mean export sales intensity
Iceberg cost F to H	d_{FH}	1.35	d_{HF}
F wage	W^*	0.95	Repatriations to F earnings
Adjustment cost	ϕ	0.20	Mean investment rate
Liquidation fraction	ξ	0.98	Mean leverage
Equity premium constant	ζ_0	0.05	Fraction of equity issuance
Equity premium proportional	ζ_1	0.10	Mean equity issuance to assets
Equity premium square	ζ_2	0.01	Standard deviation equity issuance to assets

Table 4: Parameters calibrated inside the model

ogenous death for firms with X and M statuses are identified by matching the exit rates from the corresponding status.

The productivity distribution for new entrants is a modified version of the ergodic distribution of that for incumbents in (3). Specifically, a parameter $\nu_{\Theta}^{T} \in [0, 1]$ is calibrated such that the average productivity of a new entrant is garnished relative to an incumbent to match the transition from new entrant to multinational, (details are in appendix G). This approach ensures that entry effects of tax reforms are not overstated, moreover it agrees with studies such as Foster, Haltiwanger, & Krizan (2001), who find that new entrants are less productive on average than incumbents.

The F wage is calibrated to match the aggregate level of repatriations to the aggregate level of overseas earnings by U.S. multinationals from the Bureau of Economic Analysis

Data Transition Probabilities				
t/t+1	Domestic	Exporter	Multinational	Exit
Domestic	84.62	5.41	0.03	9.93
Exporter	13.14	80.69	0.84	5.32
Multinational	0.27	1.86	91.75	6.13
Entrant	85.95	12.89	1.18	
Model Transition Probabilities				
t/t+1	Domestic	Exporter	Multinational	Exit
Domestic	86.19*	4.18*	0.01*	9.62
Exporter	11.08	78.15*	5.45	5.32*
Multinational	4.67	0.00	89.19*	6.14*
Entrant	82.30	16.40	1.30*	

Table 5: Transition probabilities (* denotes a targeted moment)

MNEs dataset. The moments for intensive margin investment and capital structure are constructed using Compustat. The adjustment cost parameter hits the average investment rate, while the liquidation fraction targets mean leverage of U.S. firms. The equity issuance cost parameters are calibrated to match the frequency, size and variance associated with equity issuances by U.S. firms.

ii Fit of Model to Data

Table 5 shows the fit of the model to the data transition probabilities across statuses.[19,20] The model under-predicts the transition from M to X. These firms downsize due to low productivity shocks; having to pay the sunk cost of exporting in the same period is unattractive. As such, these firms would downsize first to D status and up to X, should their productivity draws improve later in the future. The model also has some difficulty matching both the T to M and X to M probabilities simultaneously.

Table 6 shows the summary statistics for the remaining moments as well as additional data as an out of sample test. The model generally does well with regard to capital structure variables; it predicts a little too much variance and too few firms issuing new equity. The model does well in matching the level of aggregate repatriations to F earnings. Firms in

[19] Boehm, Flaaen, & Pandalai-Nayar (2019) also show the transitions for firms undertaking corporate inversions. I omit these firms from this analysis.

[20] I put regular and offshoring multinationals together since there is no clear distinction between the two in the data.

the model save through re-investment in their F capital stock. Savings are incentivised given the large upfront establishment cost versus lower continuation fixed cost setup. After paying their establishment cost, a firm with M status will tend to over-save in order to prevent future downsizing given the sunk cost associated with operating abroad.

Moment	**Data (%)**	**Model (%)**
Capital Structure		
Mean debt to book ratio	37.50	37.69*
Fraction of firms issuing equity	22.04	16.06*
Mean equity issuance to book ratio	5.60	5.51*
Std. dev. of equity issuance to book ratio	21.41	27.40*
Std. dev. of debt to book ratio	41.01	43.00
Firm size		
Mean investment to book ratio	5.80	4.11*
Mean export sales intensity	25.21	24.00*
Mean export output intensity	13.30	16.01
F employment intensity of M/MO	59.10	52.12*
Aggregate repatriations to F earnings	27.50	24.20*
Firm dynamics		
Exit rate	9.55	7.73*
Fraction of exporting firms	15.64	16.28
Fraction of multinational firms	5.60	10.34

Table 6: Summary statistics (* denotes a targeted moment)

V Policy Application: Removing the Repatriation Tax

This section studies the removal of the U.S. corporate repatriation tax in the context of the calibrated model. The quantification has two primary objectives: the first is to understand the impact of this major aspect of the TCJA on the U.S. economy in its own right. The second is to compare the model's implications with more standard quantitative trade models to gauge the usefulness its novel features, (specifically dynamics and financial frictions).

With these two objectives in mind, the analysis proceeds in four stages, each presented as a separate subsection. The first shows the quantitative results of the baseline tax removal exercise on the U.S. macroeconomy. The second subsection compares these results with the first year of U.S. data after the TCJA to understand the degree of data variation that that can be explained by the model and repatriation tax's removal. The third subsection compares the baseline results with a static (re-calibrated) version of the model to study the effect of dynamics and the final subsection shuts-down the equity issuance premium and re-calibrates to gauge the impact of financial frictions.

In light of the data calibration, H will be referred to as the U.S. hereafter. The baseline quantitative exercise is designed as follows.[21] At $t = 0$, the world economy rests in its initial pre-reform steady state. At $t = 1$, the U.S. Government announces and enacts the removal of the repatriation tax from that point onwards indefinitely. The exercise then follows the evolution from the pre-reform steady state to the post-reform steady state. Specifics regarding the computational algorithms are deferred to appendix H.

i Baseline Results

The cumulative quantitative effects on macroeconomic aggregates (top) and average productivities of each firm status (bottom) are presented in table 7. All of these results are discounted using the riskless rate corresponding to the relevant time period.[22] The welfare metric is consumption equivalent variation for the H household. More details regarding changes to the cross-section of U.S. firms across the two steady states are presented in appendix I.

Figure 1 depicts the reform's impact over time on both the cross-section and measures of U.S. firms. Removal of the repatriation tax re-shuffles the distribution of firms, which service the F market. In the impact period, the fraction of multinationals rises from around 10% to 13% while the fraction of exporters falls from 16% to 12%. The fractions then continue to gradually diverge before settling at their new steady state values of 8% and 16% for X and M status respectively after around 15 years. The compositional change promotes higher U.S. welfare given that its firms are more profitable. However the immediate impact is also production offshoring, which puts downward-pressure on domestic labour demand.

The reform also brings with it a surge in entry. Although U.S. startups all enter the model

[21] Additional exercises are run with one year of anticipation (results in appendix J), as well as simultaneously reducing the U.S. corporate rate to 21% as in the TCJA (results in appendix N).

[22] Recall that the inverse gross riskless rate is equal to the household's stochastic discount factor.

Aggregate Variables			
Variable	**Change (%)**	**Variable**	**Change (%)**
Consumption of U.S. goods in U.S.	0.10	Repatriations to U.S.	160.10
Consumption of F goods in U.S.	-1.57	Riskless bonds	9.76
Capital (domestic) of U.S. firms	0.20	Net dividends	-5.38
Capital (abroad) of U.S. firms	57.12	Tax collections by U.S.	0.00
Productivity U.S. firms	0.52	Price of U.S. goods in U.S.	-2.93
Measure of U.S. entrants	10.12	Price of U.S. goods in F	-2.64
Measure of U.S. firms	1.98	U.S. welfare	0.98

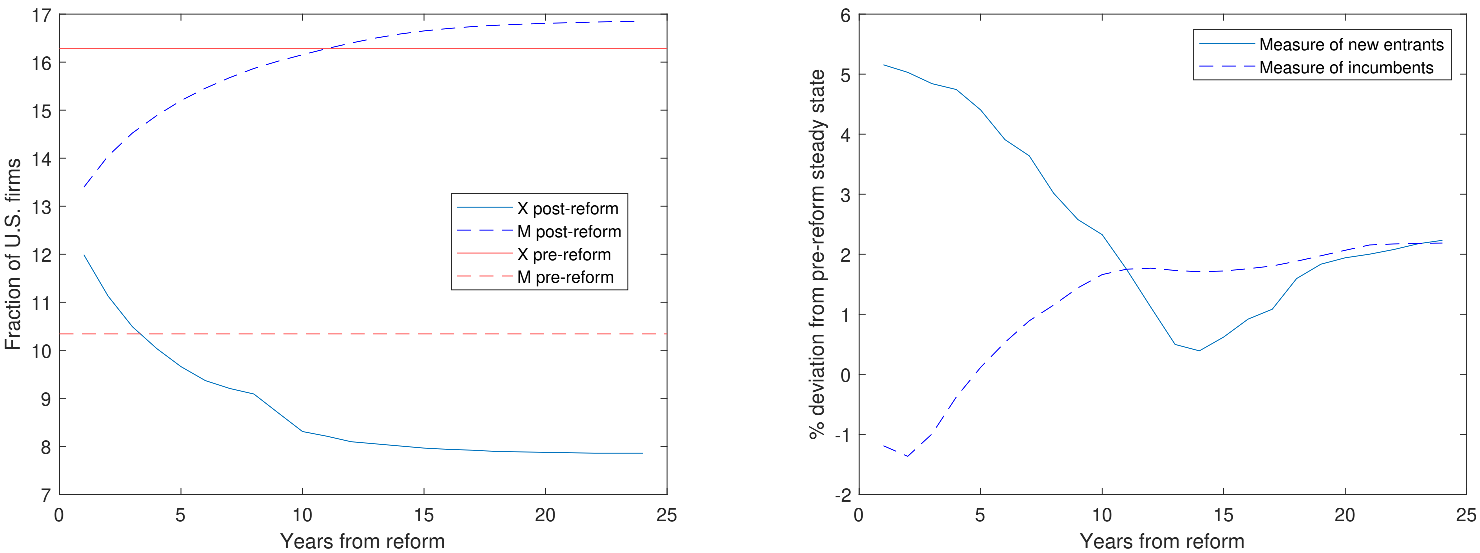
Average Productivities			
Firm Status	**Change (%)**	**Firm Status**	**Change (%)**
Exiting	1.01	Multinational	-0.09
Domestic	1.56	Offshoring multinational	-0.07
Exporter	0.51		

Table 7: Cumulative results (top: aggregates, bottom: average productivities)

as domestics, the potential for upgrading to multinational status in the future leads to a rise in the value of entry. The measure of new entrants rises on impact by 5% above its initial steady state value. Its subsequent time path is non-monotonic due to a deteriorating U.S. terms of trade, coming from the movement away from exporting and towards FDI. The rise in FDI causes the average productivities of regular and offshoring multinationals to fall cumulatively by around 0.1% each. Lower output prices domestically and abroad induce a rise in those for exiting, domestic and exporter firms of 1%, 1.5% and 0.5% respectively.

The rise in entry causes higher demand from firms for external financing. To facilitate their initial fixed establishment costs and capital investment, these new firms borrow more and issue new equity. The U.S. household is the source of this new financing; the reform drives an increase in the riskless rate to a little above 2.5% on impact to incentivise more saving through bonds and investment in U.S. firm shares. The evolution of the riskless rate is depicted in figure 2. Given that the persistence in the entry effect, the riskless rate remains above its steady state value until reaching the post-reform steady state after 25 years. Notice that the spike in financing costs on impact also leads to a slight drop in the measure of incumbent firms in the first few years after reform, as depicted in figure 1.

The policy change results in a cumulative increase in the savings of U.S. households. The overall effect on riskless bond holdings is an increase of around 10% in excess of the pre-reform steady state. Although the reform makes U.S. firms and multinationals more prof-



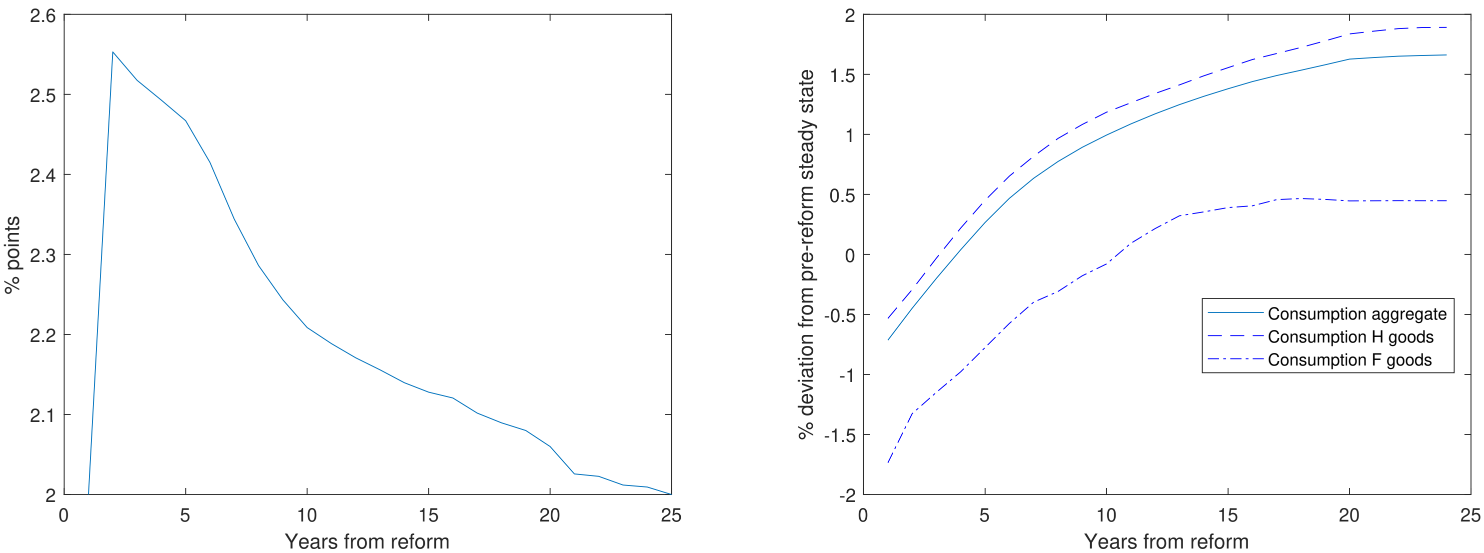
(a) Fractions of exporters and multinationals

(b) Measures of entrants and incumbents

Figure 1: Cross-sectional effects and U.S. firm measures

itable, increasing aggregate dividend distributions, the issuance of new equity immediately following the reform leads to a cumulative decrease in net dividends of 6%. Given the rise in household saving on impact, figure 2 shows that consumption immediately declines to around 0.5%. It remains below its original steady state value until around four years subsequent to the reform. In spite of lower short-term consumption, U.S. welfare rises by a little under 1% in consumption equivalents along the transition. These welfare gains are primarily driven by higher domestic real wages as household buying power rises given the overall drop in the price of U.S. consumption goods domestically of 3%.

The capital stocks associated with U.S. firms both increase along the transition; by 0.2% and 57% respectively. The quantitative impact on the domestic capital stock trades-off two separate effects. First, more U.S. firms means more demand for investment goods from the global market. In contrast, the presence of costly equity issuance induces U.S. firms to over-accumulate capital domestically as a buffer against new issuances; the reform pushes-down the demand for investment goods through this channel. Repatriated overseas earnings become a cheaper source of financing for U.S. firms, thereby mitigating the need for such savings. The overall impact indicates that the former effect dominates the latter.



(a) Riskless rate

(b) U.S. consumption

Figure 2: Interest rate and consumption of U.S. household

Similarly the F capital stock's overall effect results from two competing forces. Firms are no longer taxed on repatriations, meaning less need to hoard assets abroad. However more multinationals means a higher demand for capital abroad for FDI production. The reform is also exactly revenue neutral for the U.S. Government as the lost repatriation taxes are offset by those raised on these positive domestic effects.

ii Comparison of Baseline Results with U.S. Post-Reform Data

This subsection seeks to explore how much of the post-TCJA U.S. data can be explained by the removal of the repatriation tax. I seek to reconcile the first period of the transition in the quantitative exercise with U.S. data for the year 2018 — the first of the Act's effectiveness.[23] When evaluating the explanatory power of the model, one should bear in mind that that none of these 2018 data are targeted in the calibration due to numerous confounding factors around the time of the tax's removal.[24]

[23] Appendix K details the construction of the data numbers and figures.

[24] The U.S.' heightened trade protections around the same time of the TCJA, for instance, affect some key variables in the same direction as removing the repatriation tax. For example, exports would be expected

Table 8 contrasts the first period of the transition in the model with that in the data for aggregate variables; there are two panels in the table. The top panel contrasts the numbers for the ratio of the initial flow of repatriated earnings as a function of all accumulated overseas earnings of U.S. firms at the time of the reform. The bottom panel shows changes in aggregate variables, which are constructed by comparing the 2018 data with the data average over 2010–2017, which serves as a proxy for the pre-reform steady state.

Variable	**2018 Data Ratio (%)**	**2018 Model Ratio (%)**
Repatriations/ F savings	78	89
Variable	**2018 Data Change (%)**	**2018 Model Change (%)**
Repatriations	520	104
Consumption growth	0.2	-0.6
Household savings rate	0.5	2.0
Riskless rate	12	30

Table 8: Aggregate variables in the first year after TCJA

For the repatriations variables, the model closely reflects the fraction of accumulated overseas earnings at the time of the reform, which were remitted in the first year of its effectiveness. This ratio sits at around 90% in the model and 80% in the data. In terms of levels, the model is able to explain around one fifth of the rise in aggregate repatriations in the first year of the transition. A Federal Reserve study by Smolyansky, Suarez, & Tabova (2014) find that the vast amount of profit remittances that occurred in 2018 were from a small fraction (less than 0.15%) of exceptionally large U.S. multinationals. These numbers indicate that the model performs well when thinking about the behaviour of an average incumbent multinational, but has more difficulty with those at the very top of the size distribution. Difficulty matching the top of the savings distribution is a common feature of standard heterogeneous agent models, (see De Nardi (2015) for a survey). Better capturing this top firm savings behaviour could potentially be achieved by thinking more about earnings shifting by multinationals — an avenue I leave for future research. Instead the current focus of this paper surrounds the creation of new multinationals and new firms more generally.

to fall due to retaliation from China, confounding the offshoring effects of the tax's removal. To target the 2018 data in the calibration would require separating these two effects in an empirical context. This identification would be a challenging task in its own right — one that's outside the scope of this paper.

For U.S. households, the model qualitatively predicts the increase in the household savings rate, but under-predicts the growth rate in aggregate consumption. These differences are likely attributable to other aspects of the TCJA — in particular the large extent of personal tax cuts, which require much more richness in the context of a household problem. The model over-predicts the response of the riskless rate, but captures its qualitative movement.

Variable	**2018 Data Change (%)**	**2018 Model Change (%)**
Mean leverage	7.11	1.37
Mean equity issuance/assets	4.11	15.21
Fraction of equity issuance	-8.33	10.12
Mean export sales intensity	-5.56	-1.47

Table 9: Cross-sectional variables in the first year after TCJA

Table 9 shows the transitional effects on key cross-sectional variables in the data and compares with the quantitative exercise. For capital structure intensities, the model over predicts the increase in average equity issuance to assets and explains a quarter of the increase in the mean leverage ratio change in the data. The frequency of equity issuance goes the opposite way though qualitatively, perhaps being driven by higher U.S. policy uncertainty.

Finally, the model explains around one quarter of the decline in the mean export intensity of U.S. firms, with the remainder likely being driven by trade protectionism games that the U.S. played with China at the time. In the initial transition period of the model, firms reduce their export production in the U.S. before expanding their overseas operations. In summary, tables 8 and 9 show that the exercise in the model can predict a significant fraction of some data changes quantitatively and is generally consistent qualitatively with the first year of data after the TCJA.

iii The Role of Dynamics: Comparison with a Static Model

This subsection briefly compares the baseline exercise quantitative results with an entirely static re-calibrated version of the model to infer the significance of dynamics. The details regarding the static model are deferred to appendix L. The essential differences are that capital is no longer saved by firms and there are no financial frictions; the only dimension of heterogeneity is productivity and U.S. firms produce using constant returns in labour. Table 10 compares the percentage changes of variables across steady states for the static model and contrasts against the cumulative results of the baseline in the dynamic model.

	Change (%)			Change (%)	
Variable	**SM**	**BL**	**Variable**	**SM**	**BL**
Consumption of U.S. goods in U.S.	-1.85	0.10	Net dividends	8.85	-5.38
Consumption of F goods in U.S.	-3.97	-1.57	Tax collections in U.S.	-8.17	0.00
Productivity of U.S. firms	0.00	0.52	Price of U.S. goods in U.S.	-0.55	-2.93
Measure of U.S. entrants	8.96	10.12	Price of U.S. goods in F	-2.16	-2.64
Repatriations to U.S.	35.06	160.10	U.S. welfare	-0.95	0.98

Table 10: Steady state results for static model (SM) and cumulative results for baseline (BL)

The reform leads to welfare losses of around 1% in the static model, which contrasts against gains of the same magnitude in the baseline. Many of the aggregate variables move in a similar direction qualitatively for the two exercises, but the offshoring effect is gradual in the dynamic model. Firms wishing to upgrade to M status downsize domestically slowly to minimise capital adjustment costs. The static model misses this concept. The fraction of exporting firms falls from 20% to 13% across the static steady states while that for multinationals rises from 7% to 13%. The combination of lost repatriation taxes and drains from offshoring reduces U.S. tax collections by 8%, thereby reducing household income and welfare.

Due to the deferrability aspect of the repatriation tax, this particular reform's implications are inherently dynamic and its subtleties can only be captured by some notion of firm-level savings. In the static model, there is no concept of deferrability — all overseas earnings are repatriated at the end of the model horizon. The U.S. taxes on earnings made abroad are incurred immediately, making them a higher proportion of the Government's pre-reform budget. The static model does come with a strong entry effect of a 9% rise in the measure of firms. However, a lower calibrated fixed cost of M status in the static model, (see appendix L), means stronger offshoring effects that ultimately dominate. The broader implications of these results are clear: the use of static trade models can lead to considerable discrepancies in terms of evaluative inferences relative to dynamic models.

iv The Role of Financial Frictions: Costly Equity Issuance

This subsection seeks to quantify the impact of financial frictions in the model, in particular the role of the equity issuance premium.[25] Specifically, I set the parameters $\zeta_0 = \zeta_1 = \zeta_2 = 0$, thereby making equity issuance for U.S. firms costless. I then re-calibrate the model to target the transition probabilities of all the different firm statuses and then re-run the quantitative exercise of section V i. Details regarding the re-calibration procedure are left to appendix M.

	Change (%)			Change (%)	
Variable	**FL**	**BL**	**Variable**	**FL**	**BL**
Consumption of U.S. goods in U.S.	0.02	0.10	Repatriations to U.S.	10.15	160.10
Consumption of F goods in U.S.	-1.37	-1.57	Riskless bonds	1.83	9.76
Capital (domestic) of U.S. firms	0.09	0.20	Net dividends	4.88	-5.38
Capital (abroad) of U.S. firms	4.97	57.12	Tax collections by U.S.	-3.62	0.00
Productivity U.S. firms	0.17	0.52	Price of U.S. goods in U.S.	-1.78	-2.93
Measure of U.S. entrants	4.12	10.12	Price of U.S. goods in F	-0.15	-2.64
Measure of U.S. firms	3.58	1.98	U.S. welfare	0.23	0.98

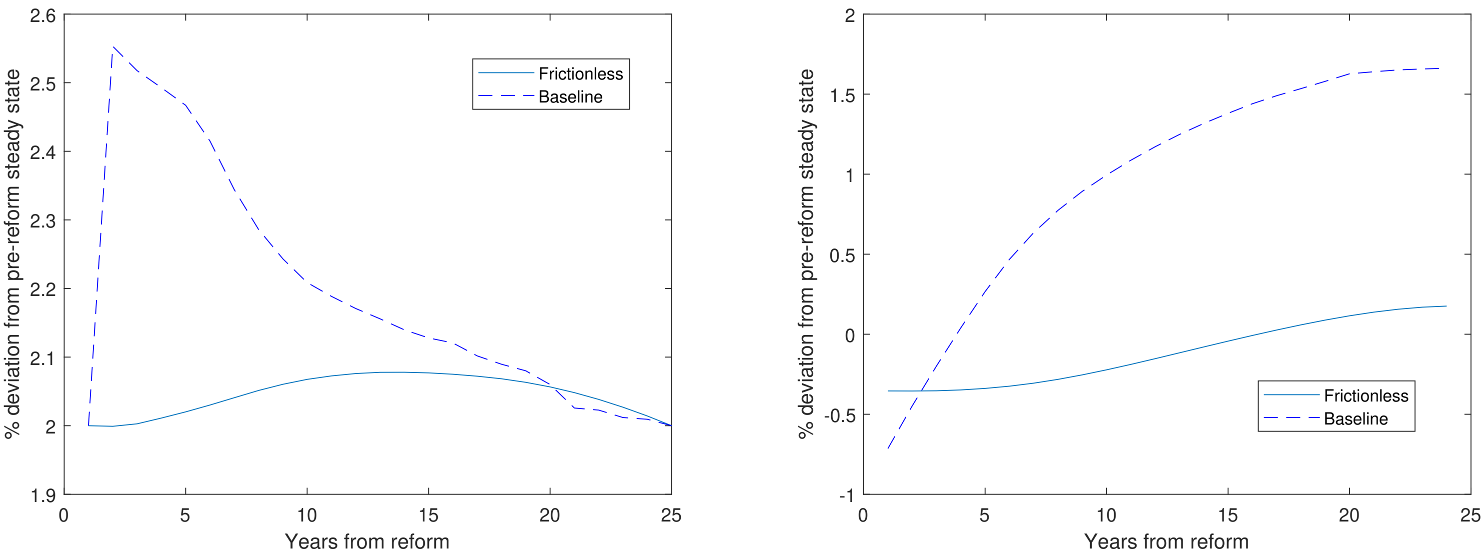
Table 11: Cumulative results for model without costly equity issuance (FL) and baseline (BL)

Table 11 presents the cumulative quantitative impact of the reform for the model without costly equity issuance (FL) and re-presents the results for the baseline (BL). The reform overall still appears to be favourable, but to a much smaller extent quantitatively. The key insight for understanding these results comes from the dampened entry effect of the reform.

Costless equity issuance makes it considerably cheaper for a firm to upgrade their status to being a multinational. These upgrading firms generally need to issue new equity in the period of their transition to cover their increased fixed and variable expenses. If the premium is shut-down without re-calibrating, the transition probability of newly-entered U.S. firms of moving to M status in their first period of incumbency increases to around five times that in the data. Recall that this moment is targeted in the calibration by garnishing the probability mass associated with the top productivity level for new entrants through parameter ν_{Θ}^{T}. Since entrants are less productive, the selection effects that ensue

[25]Note that I still leave the friction of interest tax deductions in the model when running this exercise. I do this since the ability for U.S. multinationals to borrow against their overseas earnings and to defer repatriation is important for not over-stating the quantitative results.

as a consequence of the removal of the tax tend to be less significant.[26]



(a) Riskless rate

(b) U.S. consumption

Figure 3: Interest rate and consumption of U.S. household without costly equity issuance

Figure 3 shows the time paths followed by the U.S. riskless rate and aggregate consumption level for the exercise without costly equity issuance and compares with those from the baseline. When new multinationals are established, a higher fraction of equity used in their issuance of external financing leads to a considerably mitigated effect on the U.S. riskless rate. Rather than spiking almost immediately to a value of 2.5%, the response is sluggish, with a peak below 2.1% being attained around 15 years after the reform. The cumulative effect on riskless bonds is around 2% rather than 10% in the baseline.

The dampened effects in the market for bonds spillover to affect real variables for the U.S. household. A dip in aggregate consumption still takes place immediately in the frictionless model, but with a smaller magnitude. Firms still draw-on higher savings of the household, but predominantly through the stock market. The initial drop of consumption is in the order of around 0.4% in contrast to around 0.8% in the baseline. The weaker entry effect

[26]Previous versions of the paper have also shut-down the premium and re-run the exercise without re-calibrating. This also leads to smaller quantitative effects of the reform through larger adverse terms of trade effects from more FDI. This follows since the average multinational is larger without frictions, (since external financing is cheaper), thereby leading to a larger increase in goods supply to the F country.

in the frictionless model also leads to a negative deviation of consumption that persists for a greater duration of time: around 15 years rather than five. The culmination of these effects is a considerably smaller increase in U.S. welfare: around 0.2% rather than 1%. The bottom-line from this exercise is that firm-level financial frictions have the power to significantly affect the impact of open economy reforms, both in the transition and in the long run.

VI Concluding Remarks

Tax reforms targeted at multinational firms have been pervasive in recent years. This paper studied the issue of how these reforms affect the domestic macroeconomy. My contributions are twofold. The first is methodological — I develop a dynamic general equilibrium model with firm-level open economy selection effects, capital accumulation and financial frictions. The framework developed is widely applicable and can be used to examine the impact of these targeted tax reforms across steady states and the transition path. The second is an applied policy contribution — parameters of the model are calibrated to the U.S. firm distribution and the impact of removing the corporate repatriation tax is quantified.

The key insight from the U.S. application is that this aspect of the TCJA appears to be positive from a domestic perspective — it leads to welfare gains and U.S. tax revenue neutrality. When reconciling the model's predictions with data, around one-quarter of the 2018 decrease in the average U.S. firm export intensity and increase in U.S. firm leverage can be explained by this aspect of the reform package. The takeaways from the paper from a methodological perspective are — dynamics and financial frictions greatly shape policy inferences relative to more standard trade models without these features.

This study lends itself to several avenues of future research. Why were some so concerned about the offshoring effects associated with this part of the TCJA? Added richness to the model in the form of labour market frictions might help to answer this question. A shortcoming of the model is that it has a hard time matching the behaviour of the pinnacle of the multinational hierarchy. More work in this dimension would help increase explanatory power and lead to potentially interesting interactions of selection effects with the richer responses large multinationals. Hopefully the implications of this new framework can be used to assist in future reform discussions, not just in the U.S., but by policymakers worldwide.

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Appendix A Analytical Partial Equilibrium Prologue Model

The purpose of this section is to illustrate two things in an entirely analytical framework. The first is the selection effects that result from the policy reform with regard to the exporter-multinational margin, in addition to the equilibrium effects that ensue and serve to affect the entire firm distribution. The second is how the equilibrium effects can be amplified in the presence of financial frictions.

Partial Equilibrium without Financial Frictions

This is a basic partial equilibrium version of Helpman, Melitz, & Yeaple (2004). There are two countries: Home (H) and Foreign (F) and this model is from the perspective of firms incorporated in the Home Country. The government in the Home Country taxes corporate earnings at a rate of τ^{Π} while that of the Foreign Government is denoted by $\tau^{\Pi*}$. I assume that $\tau^{\Pi*} < \tau^{\Pi}$ since the U.S. statutory rate was the highest in the OECD prior to the TCJA. The Home Government is also assumed to levy a repatriation tax rate denoted by $\tau^{\Pi,U} = \tau^{\Pi} - \tau^{\Pi*}$ prior to the reform.

The Home firms are price takers in each country. They receive idiosyncratic productivity shocks; conditional on their draw, they choose whether to exit the industry (E), operate as a pure domestic (D), an exporter (X) or a multinational (M)[27]. There is an exogenous demand for the goods made by these firms in Home and Foreign. The good sold in the Home Country is taken to be the numeraire, while there is an endogenously-determined price of goods in the Foreign Country denoted by P^{H*}.

Productivity shocks (denoted by θ) are idiosyncratic to the firms and are applied to a production function of the form $y = \theta$, where y denotes their output in a given market. That is — the output of a firm who chooses to produce is equal to their productivity — they need not hire any factor inputs. I assume that the production functions used in Home and Foreign, for a given firm, are identical. There is a fixed and exogenous unit mass of firms operating in the industry and their objective is standard: to maximise the present expected value of dividends to shareholders net of taxes.

Subsequent to their productivity draw at the start of the model, firms make a discrete choice with regard to their status. A firm that exits leaves the industry without operating. A domestic firm services only the Home market. Exporters and multinationals sell to both the Home and Foreign markets. Firms are required to pay a fixed cost along each extensive margin, in which they decide to operate. A purely domestic firm will pay fixed cost f^{HQ}, (to establish their headquarters in H), while exporters and multinationals pay additional costs f^X and f^M respectively.[28] The exporter-FDI trade-off is such that exporters incur a proportional iceberg cost associated with sending their goods abroad (denoted by $i \in [0, 1]$), while being a multinational involves a higher incremental fixed cost: $f^M > f^X$. The value to a firm's shareholders, conditional on their productivity draw, is given as

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

where $v^j(\theta)$ denotes the value of discrete choice $j \in \{E, D, X, M\}$ given the productivity

[27] I abstract from thinking about offshoring multinationals here for simplicity.

[28] I abstract from fixed costs of entry, prior to drawing θ here, as the model is partial equilibrium.

draw. The conditional values are given by

$$
\begin{aligned}
v^E(\theta) &= 0 \\
v^D(\theta) &= -f^{HQ} + (1-\tau^{\Pi})\theta \\
v^X(\theta) &= -f^{HQ} - f^X + (1-\tau^{\Pi})\theta + (1-\tau^{\Pi})(1-i)P^{H*}\theta \\
v^M(\theta) &= -f^{HQ} - f^M + (1-\tau^{\Pi})\theta + (1-\tau^{\Pi,U} - \tau^{\Pi*})P^{H*}\theta.
\end{aligned}
$$

Each of the non-exit choices yield value equal to the upfront cost of investment plus the after-tax revenues from their production. A couple of things to notice: an exporter's income from selling abroad is entirely taxable by the Home Government since all the production takes place in their jurisdiction. For a multinational, their overseas earnings are taxed at two rates — $\tau^{\Pi*}$ and $\tau^{\Pi,U}$ — they pay taxes to the Foreign Government at the time the earnings are generated, then the Home Government taxes at the rate $\tau^{\Pi,U}$ upon repatriation.[29] Definition 1 below gives the definition of an equilibrium in this model.

Definition 1. (Equilibrium). Partial equilibrium in this model is a cut-off rule for firms, contingent on their productivity draw, which defines their discrete choice. The price P^{H*} clears the market for goods made by the Home firms sold in the Foreign Country.

Assumption 1 below is used to ensure that, in the equilibrium of the model, there will exist non-zero regions for each discrete choice for the firms, as we observe in the data.

Assumption 1.

(a) The **incremental cost to benefit** ratio of being a multinational over an exporter is greater than that of being an exporter over a domestic, which is greater than that of being a domestic over an exiting firm. Formally, the following two inequalities hold

$$
\frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*}) - (1-i)(1-\tau^{\Pi})\}} > \frac{f^X}{P^{H*}(1-i)(1-\tau^{\Pi})} \tag{8}
$$

$$
\frac{f^X}{P^{H*}(1-\tau^{\Pi})(1-i)} > \frac{f^{HQ}}{(1-\tau^{\Pi})} \tag{9}
$$

(b) The **demand** for goods made by the Home firms in the Foreign Country, $Q^{D,H*}$, is perfectly inelastic — $Q^{D,H*} = a$ for some $a > 0$.

[29] Notice that all the earnings are repatriated at the end of the period by a multinational and paid-out as dividends since the model is static.

(c) The **distribution** for productivity is uniform — $\theta \sim U[\underline{\theta}, \bar{\theta}]$.

Assumption 1(a) states that it becomes progressively more costly to keep moving up a discrete choice in the hierarchy relative to the benefit. The first inequality in the assumption amounts to saying that the excess fixed cost of being a multinational over an exporter relative to the tax and iceberg cost savings, is larger than the additional fixed cost to revenue gains associated with being an exporter over a domestic. The second inequality says the same with regard to comparing the export-domestic decision to the domestic-exit decision. Notice that the first inequality imposes a restriction on the parameters of the problem, while the second inequality as written in terms of an endogenous object — P^{H*}. Assumptions 1(b) and (c) are made in the interest of ensuring an analytical solution for P^{H*} can be found. Proposition 1 characterises the equilibrium discrete choices of the firms.

Proposition 1. (Equilibrium discrete choices). Under assumption 1, the firm cut-off rules are such that a productivity hierarchy of firms materialises. Specifically, the least productive firms exit without producing, followed by domestic firms, exporters and finally multinationals. The cut-offs are such that

- $\theta \leq \frac{f^{HQ}}{(1-\tau^{\Pi})} \Rightarrow$ exit the industry,
- $\frac{f^{HQ}}{(1-\tau^{\Pi})} < \theta \leq \frac{f^X}{P^{H*}(1-\tau^{\Pi})(1-i)} \Rightarrow$ operate as a purely domestic firm,
- $\frac{f^X}{P^{H*}(1-\tau^{\Pi})(1-i)} < \theta \leq \frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}} \Rightarrow$ operate as an exporting firm,
- $\theta > \frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}} \Rightarrow$ operate as a multinational firm.

Proof. Recall that there are four potential choices — exit (E), domestic (D), exporter (X) and multinational (M). For a firm to choose to be an exiter, it must be the case that

$$
\begin{aligned}
&v^E(\theta) > v^D(\theta) \\
&\Rightarrow 0 > -f^{HQ} + (1-\tau^{\Pi})\theta \\
&\Rightarrow \theta < \frac{f^{HQ}}{(1-\tau^{\Pi})}
\end{aligned}
\tag{10}
$$

$$v^E(\theta) > v^X(\theta)$$

$$\begin{aligned} &\Rightarrow 0 > -f^{HQ} - f^X + (1-\tau^\Pi)\theta + (1-\tau^\Pi)(1-i)P^{H*}\theta \\ &\Rightarrow \theta < \frac{f^{HQ} + f^X}{(1-\tau^\Pi)\{1+(1-i)P^{H*}\}} \end{aligned} \tag{11}$$

$$\begin{aligned} &v^E(\theta) > v^M(\theta) \\ &\quad\Rightarrow 0 > -f^{HQ} - f^M + (1-\tau^\Pi)\theta + (1-\tau^{\Pi,U} - \tau^{\Pi*})P^{H*}\theta \\ &\quad\Rightarrow \theta < \frac{f^{HQ} + f^M}{(1-\tau^\Pi) + (1-\tau^{\Pi,U} - \tau^{\Pi*})P^{H*}} \end{aligned} \tag{12}$$

For the firm to be a domestic, the following three inequalities must be satisfied

$$\begin{aligned} &v^D(\theta) > v^E(\theta) \\ &\quad\Rightarrow - f^{HQ} + (1-\tau^\Pi)\theta > 0 \\ &\quad\Rightarrow \theta > \frac{f^{HQ}}{(1-\tau^\Pi)} \end{aligned} \tag{13}$$

$$\begin{aligned} &v^D(\theta) > v^X(\theta) \\ &\quad\Rightarrow - f^{HQ} + (1-\tau^\Pi)\theta > -f^{HQ} - f^X + (1-\tau^\Pi)\theta + (1-\tau^\Pi)(1-i)P^{H*}\theta \\ &\quad\Rightarrow \theta < \frac{f^X}{(1-\tau^\Pi)(1-i)P^{H*}} \end{aligned} \tag{14}$$

$$\begin{aligned} &v^D(\theta) > v^M(\theta) \\ &\quad\Rightarrow - f^{HQ} + (1-\tau^\Pi)\theta > -f^{HQ} - f^M + (1-\tau^\Pi)\theta + (1-\tau^{\Pi,U} - \tau^{\Pi*})P^{H*}\theta \\ &\quad\Rightarrow \theta < \frac{f^M}{(1-\tau^{\Pi,U} - \tau^{\Pi*})P^{H*}} \end{aligned} \tag{15}$$

For the firm to be an exporter, it must be that the following hold

$$\begin{aligned} &v^X(\theta) > v^E(\theta) \\ &\quad\Rightarrow - f^{HQ} - f^X + (1-\tau^\Pi)\theta + (1-\tau^\Pi)(1-i)P^{H*}\theta > 0 \\ &\quad\Rightarrow \theta > \frac{f^{HQ} + f^X}{(1-\tau^\Pi)\{1+(1-i)P^{H*}\}} \end{aligned} \tag{16}$$

$$\begin{aligned} &v^X(\theta) > v^D(\theta) \\ &\quad\Rightarrow - f^{HQ} - f^X + (1-\tau^\Pi)\theta + (1-\tau^\Pi)(1-i)P^{H*}\theta > -f^{HQ} + (1-\tau^\Pi)\theta \end{aligned}$$

$$
\begin{aligned}
&\Rightarrow \theta > \frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}} && (17)\\
&v^X(\theta) > v^M(\theta)\\
&\Rightarrow - f^{HQ} - f^X + (1-\tau^{\Pi})\theta + (1-\tau^{\Pi})(1-i)P^{H*}\theta\\
&\quad > -f^{HQ} - f^M + (1-\tau^{\Pi})\theta + (1-\tau^{\Pi,U} - \tau^{\Pi*})P^{H*}\theta\\
&\Rightarrow \theta < \frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*}) - (1-i)(1-\tau^{\Pi})\}} && (18)
\end{aligned}
$$

Finally to be a multinational, we must have

$$
\begin{aligned}
&v^M(\theta) > v^E(\theta)\\
&\Rightarrow - f^{HQ} - f^M + (1-\tau^{\Pi})\theta + (1-\tau^{\Pi,U} - \tau^{\Pi*})P^{H*}\theta > 0\\
&\Rightarrow \theta > \frac{f^{HQ} + f^M}{(1-\tau^{\Pi}) + (1-\tau^{\Pi,U}-\tau^{\Pi*})P^{H*}} && (19)\\
&v^M(\theta) > v^D(\theta)\\
&\Rightarrow - f^{HQ} - f^M + (1-\tau^{\Pi})\theta + (1-\tau^{\Pi,U} - \tau^{\Pi*})P^{H*}\theta > -f^{HQ} + (1-\tau^{\Pi})\theta\\
&\Rightarrow \theta > \frac{f^M}{(1-\tau^{\Pi,U}-\tau^{\Pi*})P^{H*}} && (20)\\
&v^M(\theta) > v^X(\theta)\\
&\Rightarrow - f^{HQ} - f^M + (1-\tau^{\Pi})\theta + (1-\tau^{\Pi,U} - \tau^{\Pi*})P^{H*}\theta\\
&\quad > -f^{HQ} - f^X + (1-\tau^{\Pi})\theta + (1-\tau^{\Pi})(1-i)P^{H*}\theta\\
&\Rightarrow \theta > \frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*}) - (1-i)(1-\tau^{\Pi})\}}. && (21)
\end{aligned}
$$

The objective now is to place sufficient conditions on all the parameters of the problem to give a strict ordering of the cut-offs such that there are non-zero regions for all of the discrete choices. See that (8) gives that

$$
\frac{f^M}{P^{H*}(1-\tau^{\Pi,U}-\tau^{\Pi*})} > \frac{f^X}{P^{H*}(1-\tau^{\Pi})(1-i)}, \tag{22}
$$

which when combined with (9) give the orderings

$$
\frac{f^{HQ}}{(1-\tau^{\Pi})} < \frac{f^{HQ}+f^X}{(1-\tau^{\Pi})\{1+(1-i)P^{H*}\}} < \frac{f^{HQ}+f^M}{(1-\tau^{\Pi}) + (1-\tau^{\Pi,U}-\tau^{\Pi*})P^{H*}}
$$

$$\frac{f^{HQ}}{(1-\tau^{\Pi})} < \frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}} < \frac{f^M}{(1-\tau^{\Pi,U}-\tau^{\Pi*})P^{H*}}$$

$$\begin{aligned}\frac{f^{HQ}+f^X}{(1-\tau^{\Pi})\{1+(1-i)P^{H*}\}} &< \frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}} \\ &< \frac{f^M-f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}}\end{aligned}$$

$$\begin{aligned}\frac{f^{HQ}+f^M}{(1-\tau^{\Pi})+(1-\tau^{\Pi,U}-\tau^{\Pi*})P^{H*}} &< \frac{f^M}{(1-\tau^{\Pi,U}-\tau^{\Pi*})P^{H*}} \\ &< \frac{f^M-f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}}\end{aligned}$$

where the first ordering gives that $\theta \leq \frac{f^{HQ}}{(1-\tau^{\Pi})}$ is sufficient for a firm to find it optimal to exit. The second ordering says $\frac{f^{HQ}}{(1-\tau^{\Pi})} < \theta \leq \frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}}$ is sufficient for a firm to be domestic, while the third says $\frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}} < \theta \leq \frac{f^M-f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}}$ gives an exporter and $\theta > \frac{f^M-f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}}$ gives a multinational.

□

Proposition 2 characterises the equilibrium price in the model.

Proposition 2. (Equilibrium price). Under assumption 1, the market-clearing price is given by

$$P^{H*} = \sqrt{\frac{\left(\frac{f^X}{(1-\tau^{\Pi})(1-i)}\right)^2 + i\left\{\left(\frac{f^M-f^X}{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-\tau^{\Pi})(1-i)}\right)^2 - \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)}\right)^2\right\}}{\bar{\theta}^2 - 2a(\bar{\theta}-\underline{\theta})}}.$$

Proof. The total supply from Home firms in the Foreign market (denoted $Q^{S,H*}$) can be found as the total output of firms above the exporter cut-off less the iceberg transport costs

$$Q^{S,H*} = \int_{\frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}}}^{\bar{\theta}} \frac{\theta}{\bar{\theta}-\underline{\theta}} d\theta - i\int_{\frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}}}^{\frac{f^M-f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}}} \frac{\theta}{\bar{\theta}-\underline{\theta}} d\theta$$

$$
\begin{aligned}
&= \frac{1}{2(\bar{\theta} - \underline{\theta})} \left\{ \bar{\theta}^2 - \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}} \right)^2 \right\} - \\
&\frac{i}{2(\bar{\theta} - \underline{\theta})} \left[\left(\frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U} - \tau^{\Pi*}) - (1-i)(1-\tau^{\Pi})\}} \right)^2 - \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}} \right)^2 \right].
\end{aligned}
$$

Equating this supply with demand, (which recall was supposed to be $Q^{D,H*} = a$ for $a > 0$), gives

$$
\begin{aligned}
a = &\frac{1}{2(\bar{\theta} - \underline{\theta})} \left\{ \bar{\theta}^2 - \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}} \right)^2 \right\} - \\
&\frac{i}{2(\bar{\theta} - \underline{\theta})} \left(\frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U} - \tau^{\Pi*}) - (1-i)(1-\tau^{\Pi})\}} \right)^2 - \\
&\frac{i}{2(\bar{\theta} - \underline{\theta})} \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}} \right)^2 \\
\Rightarrow 2a(\bar{\theta} - \underline{\theta}) - \bar{\theta}^2 = &- \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}} \right)^2 - \\
&i \left(\frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U} - \tau^{\Pi*}) - (1-i)(1-\tau^{\Pi})\}} \right)^2 - \\
&i \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)P^{H*}} \right)^2 \\
\Rightarrow P^{H*} = &\sqrt{\frac{\left(\frac{f^X}{(1-\tau^{\Pi})(1-i)} \right)^2 + i \left\{ \left(\frac{f^M - f^X}{(1-\tau^{\Pi,U} - \tau^{\Pi*}) - (1-\tau^{\Pi})(1-i)} \right)^2 - \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)} \right)^2 \right\}}{\bar{\theta}^2 - 2a(\bar{\theta} - \underline{\theta})}}.
\end{aligned}
$$

□

The equilibrium discrete choices under this model are depicted in figure 4. A hierachy of firms eventuates — the least productive of firms choose to exit the industry, followed by pure domestics, exporters and multinationals. Firms that are at the pinnacle of the productivity hierarchy seek to avoid incurring the iceberg transport cost: it's optimal for them to incur the higher fixed cost to undertake FDI. Notice that the cut-offs in the figure depend on the parameters of the problem. In particular, each cut-off moving up the hierarchy is equal to the incremental cost to benefit ratio of moving up another discrete choice. Of particular interest is the upper cut-off: it is defined by the productivity level such that the incremental fixed cost of FDI over exporting balances the incremental benefit. The incremental benefit is given by the earnings net of foreign corporate and repatriation taxes less the earnings net of taxes and iceberg costs.

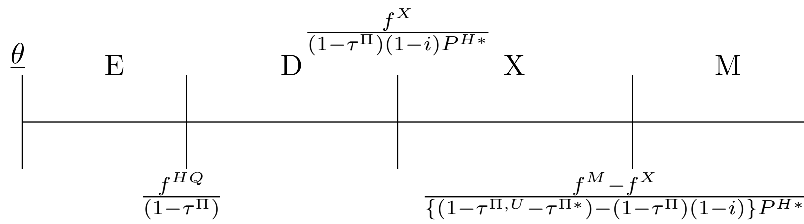

Figure 4: Equilibrium discrete choices

The equilibrium price clears the Home goods market in the Foreign Country. For the price to exist, the demand as captured by the a parameter, can't be too large. The iceberg cost is incurred by all firms who export; a larger fraction of such firms relative to multinationals implies a higher price given that this cost comes out of output, thereby restricting the supply to the foreign market. Most importantly though, notice that the price is increasing in the Home Country's repatriation tax rate. Intuitively, as this tax rate increases, the incentive for a firm to operate as a multinational is diminished, meaning more exporters, resulting in a lower output supply due to iceberg costs for a given productivity level. The next assumption ensures that the price effects associated with the reform will not be too extreme.

Assumption 2. The fixed cost of being a multinational relative to an exporter is "sufficiently large". More specifically, the following holds

$$(f^X)^2 i + (f^M - f^X)^2(1-i) - (1-\tau^{\Pi})^3(i)^3(1-i) > 0.$$

This assumption ensures that the fraction of multinational firms will not be too large prior to the reform. This assumption is needed to sign the movement in the cut-off between being an exporter and multinational in the reform. The fraction of multinationals has to be sufficiently small to ensure that an increase in the repatriation tax doesn't lead to an enormous price effect.

Combining the results of propositions 1 and 2 yields an intuition for the effect of removing the repatriation tax on the cross-section of U.S. firms. Proposition 3 summarises these effects on the Home firm cut-off rules for their discrete choices.

Proposition 3. (Removing the repatriation tax). Under assumptions 1 and 2, going from a scenario with $\tau^{\Pi,U} > 0$ to another with $\tau^{\Pi,U} = 0$ causes the productivity standard for being a multinational Home firm to decrease and that for exporting firms to increase.

Proof. To characterise how the cut-offs change, we need to first study the impact on the market clearing price. See that

$$\frac{dP^{H*}}{d\tau^{\Pi,U}} = \frac{i\left(\frac{f^M - f^X}{\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-\tau^{\Pi})(1-i)\}^2}\right)}{\bar{\theta}^2 - 2a(\bar{\theta} - \underline{\theta})}\frac{1}{P^{H*}}. \tag{23}$$

Denote the cut-off between being an exporter and a multinational by

$$\Gamma = \frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*}) - (1-i)(1-\tau^{\Pi})\}}.$$

See then that

$$\frac{\partial\Gamma}{\partial\tau^{\Pi,U}} = \frac{d\Gamma}{d\tau^{\Pi,U}} + \frac{\partial\Gamma}{\partial P^{H*}}\frac{dP^{H*}}{d\tau^{\Pi,U}} \tag{24}$$

where

$$\begin{aligned}\frac{d\Gamma}{d\tau^{\Pi,U}} &= \frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*}) - (1-\tau^{\Pi})(1-i)\}^2}\\ \frac{\partial\Gamma}{\partial P^{H*}} &= -\frac{f^M - f^X}{(P^{H*})^2\{(1-\tau^{\Pi,U}-\tau^{\Pi*}) - (1-\tau^{\Pi})(1-i)\}}.\end{aligned}$$

Hence we can express (24) as

$$\begin{aligned}\frac{\partial\Gamma}{\partial\tau^{\Pi,U}} =& \frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*}) - (1-\tau^{\Pi})(1-i)\}^2}\times\\ &\left\{1 - \frac{i\{(1-\tau^{\Pi,U}-\tau^{\Pi*}) - (1-\tau^{\Pi})(1-i)\}}{(P^{H*})^2[\bar{\theta}^2 - 2a(\bar{\theta}-\underline{\theta})]}\right\}\\ =& \frac{f^M - f^X}{P^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*}) - (1-\tau^{\Pi})(1-i)\}^2}\times\end{aligned}$$

$$\left\{1 - \frac{i\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-\tau^{\Pi})(1-i)\}}{\left(\frac{f^X}{(1-\tau^{\Pi})(1-i)}\right)^2 + i\left\{\left(\frac{f^M-f^X}{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-\tau^{\Pi})(1-i)}\right)^2 - \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)}\right)^2\right\}}\right\}$$

meaning that the change in the cut-off is positive provided that

$$1 - \frac{i\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-\tau^{\Pi})(1-i)\}}{\left(\frac{f^X}{(1-\tau^{\Pi})(1-i)}\right)^2 + i\left\{\left(\frac{f^M-f^X}{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-\tau^{\Pi})(1-i)}\right)^2 - \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)}\right)^2\right\}} > 0$$

Under the pre-reform U.S. system with the statutory rate equal to $\tau^{\Pi,U} = \tau^{\Pi} - \tau^{\Pi*}$, this simplifies to

$$1 - \frac{i(1-\tau^{\Pi})}{\left(\frac{f^X}{(1-\tau^{\Pi})(1-i)}\right)^2 + i\left\{\left(\frac{f^M-f^X}{i(1-\tau^{\Pi})}\right)^2 - \left(\frac{f^X}{(1-\tau^{\Pi})(1-i)}\right)^2\right\}} > 0$$
$$\Rightarrow (f^X)^2 i + (f^M - f^X)^2(1-i) - (1-\tau^{\Pi})^3(i)^3(1-i) > 0,$$

which is a necessary and sufficient condition to ensure that the cut-off increases. The case for the domestic-exporter cut-off follows simply from the fact that the price P^{H*} increases: thus a decline in the tax rate decrease the price, which causes said cut-off to shift upwards. $\square$

Figure 5 depicts the solutions pre-reform (top, with $\tau^{C,U} = \tau^C - \tau^{C*}$) and post-reform (bottom, with $\tau^{C,U} = 0$). Notice that the prices have subscripts $\tau^{C,U} = \tau^C - \tau^{C*}$ and $\tau^{C,U} = 0$ to denote that they are the clearing prices for the two respective cases. Each cut-off is equal to the incremental cost to benefit ratio of moving up another discrete choice in the hierarchy.

There are two effects associated with this policy change on the cross-section. The first is a direct effect, which changes the nature of the exporter-multinational choice trade-off. The second is an equilibrium effect, which comes about through changes in the endogenous price P^{H*}.

For the first effect, when the tax is removed, the incremental benefit to being a multinational increases with all else constant. In addition to saving on their iceberg costs, firms that undertake FDI will also save on their tax bill relative to an exporter, causing

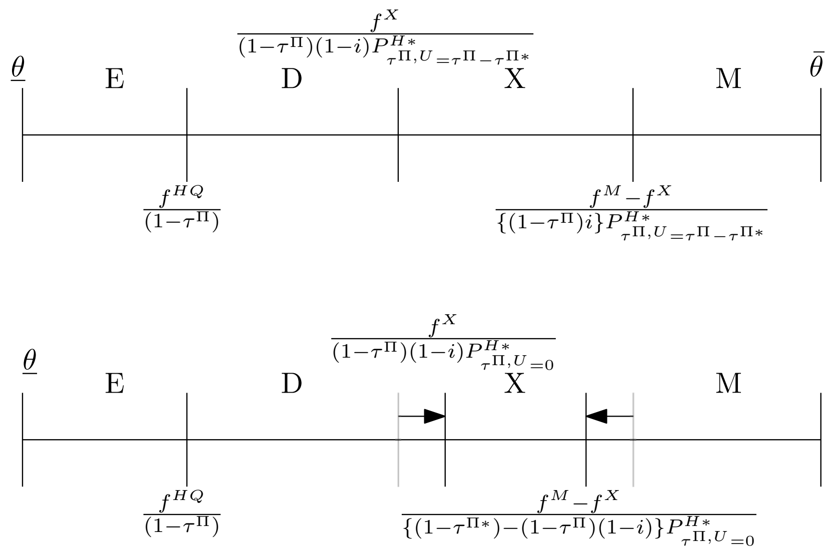

Figure 5: Removing the repatriation tax

a downward-movement of the corresponding productivity cut-off. When there are more multinationals, it means fewer firms incurring proportional iceberg costs — causing the supply of goods to the Foreign market to increase. This is the catalyst for the second effect — the price in the Foreign market decreases. This equilibrium effect dampens the rise in the multinational benefit, but also serves to affect firms on the margin between being domestics and exporters. A lower P^{H*} means a lower benefit to being an exporter over a domestic, shifting that cut-off upwards.

Prior to the reform, the repatriation tax was only borne by multinationals — the most productive of firms in this environment. Many critics of this aspect of the TCJA have focused primarily on the likely behavioural effects on incumbent U.S. multinationals and postulate that real effects are unlikely to eventuate.[30] This prologue model with selection effects has two things to say about such a focus — the first is that it overlooks the impact on firms that are just below the FDI productivity cut-off. The switching effect of these firms can have significant implications for their profitability, as they save on export costs, or

[30]For instance, see moss, who discusses the reforms in the context of Apple. The contention is that, since firms like Apple utilised aggressive tax-planning strategies prior to the reform, it's unlikely that removing the tax will spur domestic investment. Dharmapala, Foley, & Forbes (2011) empirically study the impact of temporary repatriation tax holidays and find little real effects when examining incumbent multinationals in an academic context.

more generally are able to take advantage of lower overseas factor prices in production.[31] This can be important for welfare, as their switching status will ultimately mean more value for U.S. shareholders.

The second comment is that focusing solely on incumbent multinationals totally misses the equilibrium effects on the cross-section. Those firms affected by this channel are much more grass-roots than Apple — in this prologue model they're less productive firms on the domestic-exporter margin — this reform has implications for their productivity. The next subsection briefly explores the role of financial frictions in the context of this prologue model and shows how they can serve to amplify equilibrium effects.

Partial Equilibrium Model with Financial Frictions

In this subsection, I assume that some fraction of Home firms (denoted $\omega \in [0,1]$) need to finance their fixed investment cost using costly external financing; firms draw this binary financing shock (need external financing or need not) at the same time as their productivity shock. The following assumption gives the form of the financing premium.

Assumption 3. The **external financing premium** (denoted $\zeta(d)$) is assumed to be proportional to the size of the firm's financing needs — their fixed costs. That is

$$\zeta(d) = \zeta_1 d$$

for some $\zeta_1 > 0$ where d denotes the size of the external financing issuance.

Firms that issue new financing will be referred to as *constrained firms* hereafter; the others will be referred to as *unconstrained firms*. In this augmented setup, constrained firms will have conditional value functions given by

$$\begin{aligned}
v_C^E(\theta) &= 0 \\
v_C^D(\theta) &= (-f^{HQ})(1+\zeta_1) + (1-\tau^{\Pi})\theta \\
v_C^X(\theta) &= (-f^{HQ} - f^X)(1+\zeta_1) + (1-\tau^{\Pi})\theta + (1-\tau^{\Pi})(1-i)\widehat{P}^{H*}\theta \\
v_C^M(\theta) &= (-f^{HQ} - f^M)(1+\zeta_1) + (1-\tau^{\Pi})\theta + (1-\tau^{\Pi,U} - \tau^{\Pi*})\widehat{P}^{H*}\theta
\end{aligned}$$

[31] This benefit of FDI is not modelled in this prologue model, but it is considered in the quantitative model later on.

where the C subscript denotes constrained firms and the price goods sold in the Foreign market is denoted by $\widehat{P}^{H*}$ to emphasise that it will be different to P^{H*} from the previous subsection. An unconstrained firm will have the same value functions as in the previous subsection, albeit with the alternative price. This external financing premium serves to increase the upfront cost borne by the constrained firms when they make non-exit discrete choices. The following proposition summarises the equilibrium discrete choices in the model with frictions.

Proposition 4. (Equilibrium discrete choices with financial frictions). Under assumptions 1 and 3, the firm cut-off rules are such that two separate hierarchies of firms materialise — one constrained firms and one for unconstrained firms. For both hierarchies, the least productive firms exit, followed by pure domestics, then exporters and multinationals. The cut-offs for unconstrained firms are the same as in proposition 1, except with the alternative price $\widehat{P}^{H*}$. The cut-offs for constrained firms are given by

- $\theta \leq \frac{f^{HQ}(1+\zeta_1)}{(1-\tau^{\Pi})} \Rightarrow$ exit the industry,
- $\frac{f^{HQ}(1+\zeta_1)}{(1-\tau^{\Pi})} < \theta \leq \frac{f^{X}(1+\zeta_1)}{\widehat{P}^{H*}(1-\tau^{\Pi})(1-i)} \Rightarrow$ operate as a purely domestic firm,
- $\frac{f^{X}(1+\zeta_1)}{\widehat{P}^{H*}(1-\tau^{\Pi})(1-i)} < \theta \leq \frac{(f^{M}-f^{X})(1+\zeta_1)}{\widehat{P}^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}} \Rightarrow$ operate as an exporting firm,
- $\theta > \frac{(f^{M}-f^{X})(1+\zeta_1)}{\widehat{P}^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}} \Rightarrow$ operate as a multinational firm.

Proof. This simply follows from the proof of proposition 1 with the fixed cost for the constrained firms adjusted to include the equity premium. □

Proposition 5 describes the equilibrium price in the model with financial frictions.

Proposition 5. (Equilibrium price with financial frictions). Under assumptions 1 and 2, the market-clearing price is given by

$$\widehat{P}^{H*} = P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}$$

Proof. The supply is augmented to account for the constrained and unconstrained firms. The supply from the unconstrained firms is the same as in the proof of proposition 2 above

— $Q^{S,H*}$ — except with the alternative price $\widehat{P}^{S,H*}$. Denote the supply by the constrained firms as $Q_c^{S,H*}$. See then that

$$\begin{aligned}
Q_c^{S,H*} &= \int_{\frac{f^X(1+\zeta_1)}{(1-\tau^{\Pi})(1-i)\widehat{P}^{H*}}}^{\bar{\theta}} \frac{\theta}{\bar{\theta}-\underline{\theta}} d\theta - i \int_{\frac{f^X(1+\zeta_1)}{(1-\tau^{\Pi})(1-i)\widehat{P}^{H*}}}^{\frac{(f^M-f^X)(1+\zeta_1)}{\widehat{P}^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}}} \frac{\theta}{\bar{\theta}-\underline{\theta}} d\theta \\
&= \frac{1}{2(\bar{\theta}-\underline{\theta})} \left\{ \bar{\theta}^2 - \left(\frac{f^X(1+\zeta_1)}{(1-\tau^{\Pi})(1-i)\widehat{P}^{H*}} \right)^2 \right\} - \\
& \frac{i}{2(\bar{\theta}-\underline{\theta})} \left[\left(\frac{(f^M-f^X)(1+\zeta_1)}{\widehat{P}^{H*}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}} \right)^2 - \left(\frac{f^X(1+\zeta_1)}{(1-\tau^{\Pi})(1-i)\widehat{P}^{H*}} \right)^2 \right].
\end{aligned}$$

It's clear then that the total supply is given by $\omega Q_c^{S,H*} + (1-\omega)Q^{S,H*}$, to which demand $Q^{D,H*} = a$ is equated: one can then re-arrange for $\widehat{P}^{H*}$ in the same way as for the proof of proposition 2. □

The equilibrium depicted in figure 6 is likely intuitive but the mechanics driving the differences in the equilibrium behaviour between constrained and unconstrained firms are quite deep. There is a striking asymmetry between the discrete choices made by the two firm types. Take for example firms that are on the margin between being a domestic and an exporter. The firms over the region

$$\left[\frac{f^X}{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}(1-\tau^{\Pi})(1-i)}, \frac{f^X(1+\zeta_1)}{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}(1-\tau^{\Pi})(1-i)} \right]$$

can justify operating as exporters when they are unconstrained, but not in the case that they are constrained. There is a re-allocation of resources away from firms that are relatively more productive yet constrained and towards firms that are less productive yet unconstrained. There is a larger degree of heterogeneity in discrete choices in the model with financial frictions than less; the heightened degree of dispersion is accounted for through the equilibrium price. Notice as two special cases: when $\omega = 0$ (all unconstrained) and $\omega = 1$ (all constrained). In both of these cases, the cross-section collapses down to the same scenario as for the case without financial frictions. Given that the firms are all the same in these two special cases, there is no re-allocation of resources away from one type to another. Proposition 6 describes the impact of the tax's removal in the context with

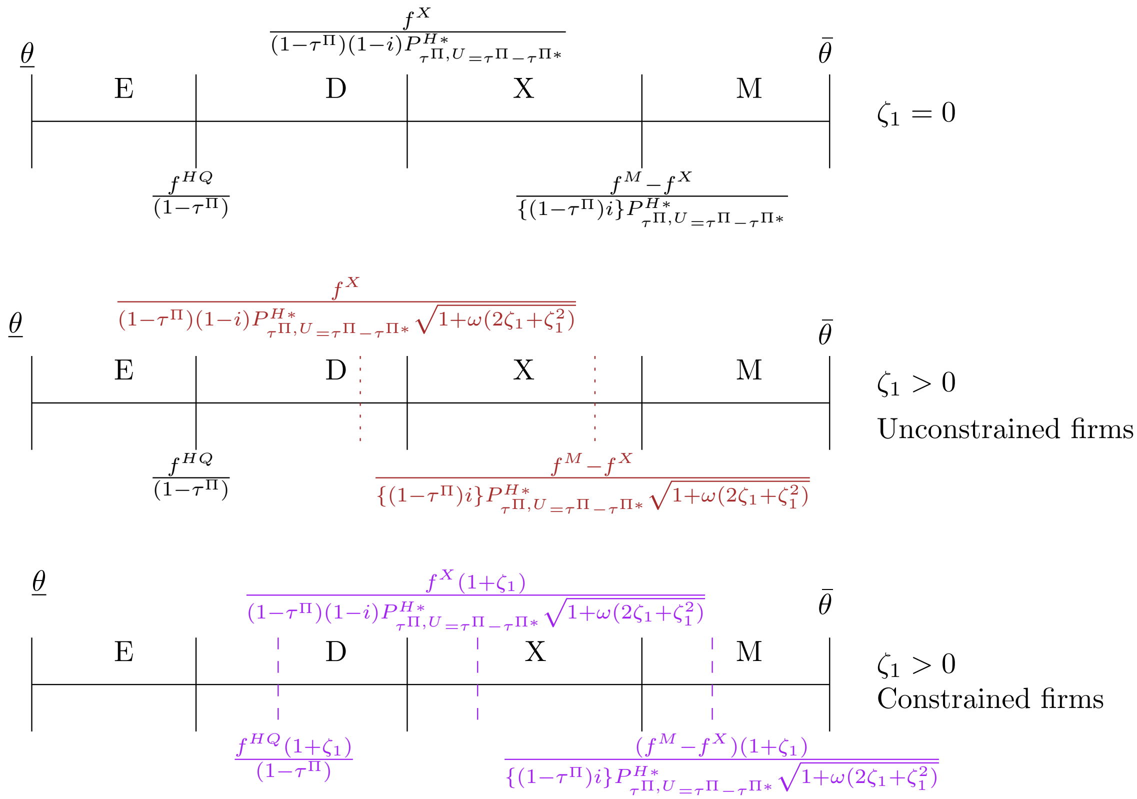

Figure 6: Equilibrium discrete choices with financial frictions

financial frictions.

Proposition 6. (Removing the repatriation tax with financial frictions). Under assumptions 1 and 2, going from a scenario with $\tau^{\Pi,U} > 0$ to another with $\tau^{\Pi,U} = 0$ has quantitatively differential effects on the equilibrium discrete choices of constrained and unconstrained firms. For both types of firms, the productivity standard for being a multinational decreases and that for an exporter increases. The movements in the cut-offs are both quantitatively larger for constrained firms.

Proof. Firstly notice that the change in the price with financial frictions is now given by

$$\begin{aligned}\frac{d\widehat{P}^{H*}}{d\tau^{\Pi,U}} &= \frac{d\{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}\}}{d\tau^{\Pi,U}} \\ &= \sqrt{1+\omega(2\zeta_1+\zeta_1^2)}\frac{dP^{H*}}{d\tau^{\Pi,U}}\end{aligned}$$

where the last line comes from the proof of proposition 3. This says that the change in price will be larger in the case with financial frictions that without. In particular, notice the special case that if $\omega = 1$, then $\frac{d\widehat{P}^{H*}}{d\tau^{\Pi,U}} = (1+\zeta_1)\frac{dP^{H*}}{d\tau^{\Pi,U}}$, meaning that if all firms are constrained, then the changes in the price are perfectly scaled by the issuance premium. Notice then that the expression $\frac{1+\zeta_1}{\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}} \geq 1$, with equality when $\omega = 1$. Notice then that we can re-write the expressions for the cut-offs for an unconstrained firm as

- $\theta \leq \frac{f^{HQ}}{(1-\tau^{\Pi})} \Rightarrow$ exit the industry,
- $\frac{f^{HQ}}{(1-\tau^{\Pi})} < \theta \leq \frac{f^X}{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}(1-\tau^{\Pi})(1-i)} \Rightarrow$ operate as a purely domestic firm,
- $\frac{f^X}{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}(1-\tau^{\Pi})(1-i)} < \theta \leq \frac{f^M-f^X}{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}} \Rightarrow$ operate as an exporting firm,
- $\theta > \frac{f^M-f^X}{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}} \Rightarrow$ operate as a multinational firm.

and those for a constrained firm as

- $\theta \leq \frac{f^{HQ}(1+\zeta_1)}{(1-\tau^{\Pi})} \Rightarrow$ exit the industry,
- $\frac{f^{HQ}(1+\zeta_1)}{(1-\tau^{\Pi})} < \theta \leq \frac{f^X(1+\zeta_1)}{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}(1-\tau^{\Pi})(1-i)} \Rightarrow$ operate as a purely domestic firm,
- $\frac{f^X(1+\zeta_1)}{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}(1-\tau^{\Pi})(1-i)} < \theta \leq \frac{(f^M-f^X)(1+\zeta_1)}{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}} \Rightarrow$ operate as an exporting firm,
- $\theta > \frac{(f^M-f^X)(1+\zeta_1)}{P^{H*}\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}\{(1-\tau^{\Pi,U}-\tau^{\Pi*})-(1-i)(1-\tau^{\Pi})\}} \Rightarrow$ operate as a multinational firm.

As a consequence, we study changes due to removing the repatriation tax in light of scaled versions of the cut-offs without financial frictions. In particular, notice that because of the $\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}$ in the denominator of each cut-off for the unconstrained firms, the movement in the cut-off for the unconstrained firms will be smaller than that in the case without financial frictions. Conversely, the constrained firm cut-offs contain the scaling factor $\frac{1+\zeta_1}{\sqrt{1+\omega(2\zeta_1+\zeta_1^2)}}$, meaning that the change is larger than that of the case without financial frictions. That is — the cut-off movements for the case with financial frictions will be scaled versions of the movements, which take place in the cut-offs without financial frictions. They all move in qualitatively the same direction. □

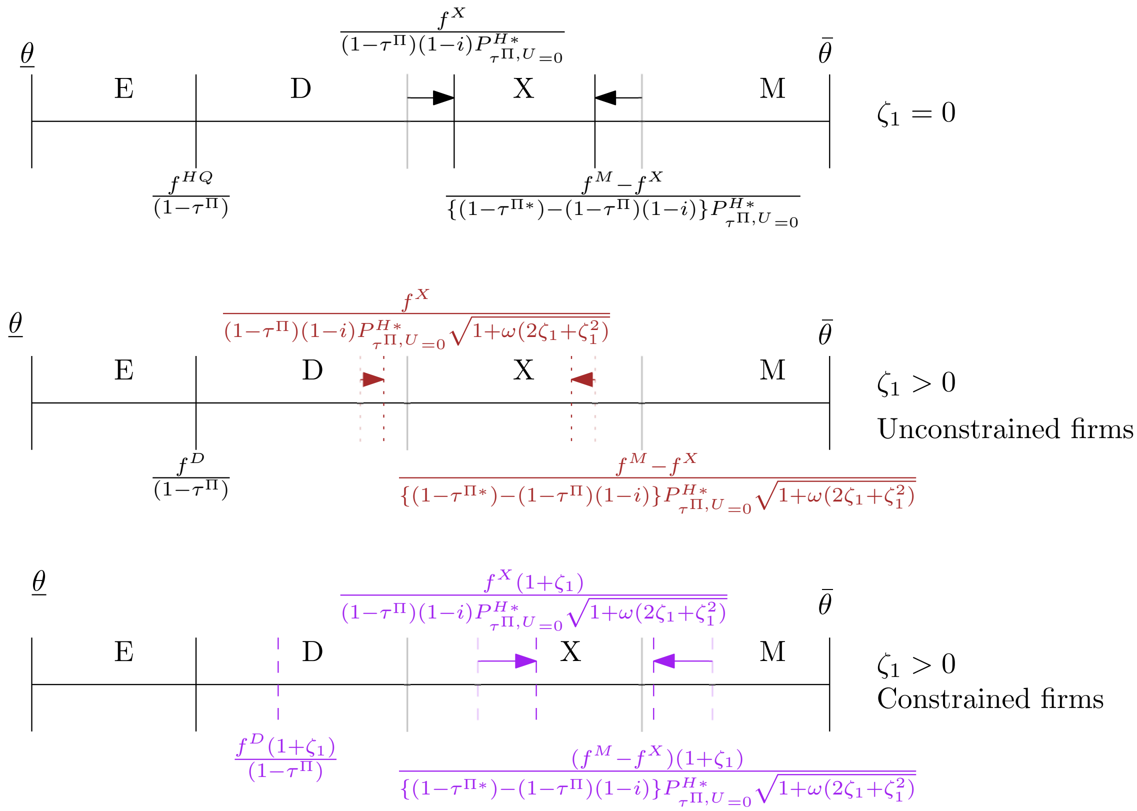

Figure 7: Removing the repatriation tax with financial frictions

Figure 7 shows the effect of the reform on the cross-section of firms in this model. The cut-offs move in the same direction for both types of firms with frictions as without, albeit with asymmetric magnitudes. Constrained firms reap the greatest benefits of the tax removal, resulting in larger movements in their cut-offs than those for unconstrained firms. The re-shuffling of the firm cross-section, in addition to the size of the equilibrium effect amplification, from the policy change ultimately depend on the parameters ω and ζ_1.

The main takeaways from this partial equilibrium prologue model are twofold. The first point to note is the importance of equilibrium and selection effects in evaluating this reform. A thorough evaluation of its effects requires the use of a model with several types of firms: not just large incumbent multinationals. The second takeaway is that financial frictions amplifies these equilibrium effects, thereby motivating their inclusion in the quantitative model.

Appendix B Full List of Fixed Cost Combinations

Table 12 displays the different combinations of fixed costs associated with all the possible statuses and transitions. The fixed establishment and continuation costs are reported separately for each transition.

Status $t-1$		**Status t** **D**	**X**	**M**	**MO**
T	*Continuation:*	$(1-\tau^{\Pi})f^{HQ,C}$	$(1-\tau^{\Pi})f^{HQ,C}$	$(1-\tau^{\Pi})f^{HQ,C}$	N/A
	Establishment:	–	f^{X}	f^{M}	N/A
D	*Continuation:*	$(1-\tau^{\Pi})f^{HQ,C}$	$(1-\tau^{\Pi})f^{HQ,C}$	$(1-\tau^{\Pi})f^{HQ,C}$	N/A
	Establishment:	–	f^{X}	f^{M}	N/A
X	*Continuation:*	$(1-\tau^{\Pi})f^{HQ,C}$	$(1-\tau^{\Pi})(f^{HQ,C}+f^{X,C})$	$(1-\tau^{\Pi})(f^{HQ,C}+f^{X,C})$ or $(1-\tau^{\Pi})(f^{HQ,C})$	N/A
	Establishment:	–	–	f^{M}	N/A
M	*Continuation:*	$(1-\tau^{\Pi})f^{HQ,C}$	$(1-\tau^{\Pi})f^{HQ,C}$	$(1-\tau^{\Pi})f^{HQ,C}+(1-\tau^{\Pi*})W_t^{*}f^{M*,C}$	$(1-\tau^{\Pi})f^{HQ,C}+(1-\tau^{\Pi*})W_t^{*}f^{M*,C}$
	Establishment:	–	f^{X}	–	$W_t^{*}f^{MO*}$
MO	*Continuation:*	$(1-\tau^{\Pi})f^{HQ,C}$	$(1-\tau^{\Pi})f^{HQ,C}$	$(1-\tau^{\Pi})f^{HQ,C}+(1-\tau^{\Pi*})W_t^{*}f^{M*,C}$ or $(1-\tau^{\Pi})f^{HQ,C}+$ $(1-\tau^{\Pi*})W_t^{*}(f^{M*,C}+f^{MO*,C})$	$(1-\tau^{\Pi})f^{HQ,C}+(1-\tau^{\Pi*})W_t^{*}(f^{M*,C}+f^{MO*,C})$
	Establishment:	–	f^{X}	–	–

Table 12: Fixed costs for each status ($f_t^{s_t}(\vec{\varphi}_t)$).

Appendix C Allowing for Corporate Inversions

Earlier versions of this paper have allowed for an additional H firm status — a corporate inversion. Firms that undertake inversions must have $s_{t-1} \in \{M, MO\}$ — meaning they must already have a segment in F. When modelling this, more assumptions are required regarding the corporate tax system of F. One can simply assume that F has a so-called territorial tax system for its firms, meaning that the F Government levies no repatriation tax or other worldwide taxes on any earnings its firms generate in H.

I model inverting firms as establishing their "paper" headquarters in F, meaning that they become an F firm for taxation purposes. I refer to them as "paper" headquarters as the new overseas parent is typically established in a tax haven nation where the firm has little to no real operations. For example, places like Bermuda and Panama are typical popular destinations, (see Desai & Hines Jr (2002) for a comprehensive list).

I model inverting firms as continuing to use their H headquarters for overall coordination of the entity, with the interpretation of management remaining in the U.S. post-inversion. Inverting firms pay a fixed establishment cost through their subsidiary of f^{HQ*} and then a continuation fixed cost of $f^{HQ*,C}$ in each period thereafter. The benefit associated with an inversion is that the firm is now no longer a U.S. firm for tax purposes. As a consequence, it is no longer subject to the repatriation tax when bringing funds back to H. I assume that the firm's shareholders remain all based in the U.S. post-inversion.[32] Similarly to when a status is upgraded in the model, I assume that there is a one period delay before the firm is officially recognised as being from F for tax purposes.

There are two permissible types of firms post-inversion. Those that were of status M at the time of inversion and those that were of status MO at the time of inversion. The distinction dictates whether some of the firm's production takes place in H or whether all takes place in F. I denote the status of these two types of firms by $s_t \in \{IM, IMO\}$ for the two respective possible types. The firms' overall Bellman equation is augmented for

[32]There are complications from an investor's perspective with these transactions. For instance, the act of an inversion makes accumulated capital gains on holding their shares payable immediately. For a careful treatment of these considerations and quantitative analysis, see Babkin, Glover, & Levine (2017). I abstract from such considerations as they're beyond the scope of my research question.

the possibility of inversion as follows

$$
\begin{aligned}
v_t(\vec{\varphi}_t) = &\left(\max_{s_t \in \{E,D,X,M\}} v_t^{s_t}(\vec{\varphi}_t)\right) \mathbb{1}_{s_{t-1}\in\{T,D,X\}} \\
&+ \left(\max_{s_t \in \{E,D,X,M,MO,IM,IMO\}} v_t^{s_t}(\vec{\varphi}_t)\right) \mathbb{1}_{s_{t-1}\in\{M,MO,IM,IMO\}}
\end{aligned}
$$

The Bellman equation for a firm with status $s_t = IM$ is given by

$$
v_t^{IM}(\vec{\varphi}_t) = \max_{\{k_{t+1}^H, k_{t+1}^{H*}, b_{t+1}\}} e_t^{IM} + \beta_1 \mathbb{E}_t[v_{t+1}(\vec{\varphi}_{t+1})]
$$

where

$$
\begin{aligned}
e_t^{IM} =& d_t^{IM} - (\mathbb{1}_{d_t^{IM}<0})\zeta(d_t^{IM}) \\
d_t^{IM} =& (1-\tau^{\Pi})\{\widehat{p}_t^H \widehat{q}_t^H - \widehat{n}_t^H\} + \mathbb{1}_{s_{t-1}=IM} u_t^{IM} + \mathbb{1}_{s_{t-1}=M}\left\{\mathbb{1}_{u_t^{IM}<0} + \mathbb{1}_{u_t^{IM}\geq 0}\left(\frac{1-\tau^{\Pi,U}-\tau^{\Pi*}}{1-\tau^{\Pi*}}\right)\right\} u_t^{IM} \\
& - f_t^{IM} - \Lambda_t i_t^H - \Lambda_t \Phi_t^H + \frac{b_{t+1}}{1+R_{t+1}} - b_t + b_t\left(1 - \frac{1}{1+R_t}\right)\tau^{\Pi} \\
u_t^{IM} =& (1-\tau^{\Pi*})\{\widehat{p}_t^{H*}\widehat{q}_t^{H*} - W_t^* \widehat{n}_t^{H*}\} - \Lambda_t i_t^{H*} - \Lambda_t \Phi_t^{H*} \\
f_t^{IM} =& (1-\tau^{\Pi}) f^{HQ,C} + (1 - \tau^{\Pi*} - \mathbb{1}_{s_{t-1}=M}\tau^{\Pi,U}) W_t^* f^{M*,C} \\
& + (\mathbb{1}_{s_{t-1}\neq IM})(1-\tau^{\Pi*}) W_t^* f^{HQ*} + \mathbb{1}_{s_{t-1}=IM}(1-\tau^{\Pi*}) W_t^* f^{HQ*,C} \\
i_t^H =& k_{t+1}^H - (1-\delta)k_t^H \\
i_t^{H*} =& k_{t+1}^{H*} - (1-\delta)k_t^{H*} \\
b_{t+1} \leq& \xi \Lambda_t (k_{t+1}^H + k_{t+1}^{H*}).
\end{aligned}
$$

where notice that the tax term $(1-\tau_t^{\Pi,U}-\tau^{\Pi*})/(1-\tau^{\Pi*})$ is no longer multiplying the amount of earnings repatriated once the "paper" headquarters is operational. Moreover the repatriation tax is no longer a deduction from the firm's fixed costs of overseas operations. Note also that the static variables — $\widehat{p}_t^H$, $\widehat{q}_t^H$, $\widehat{n}_t^H$, $\widehat{p}_t^{H*}$, $\widehat{q}_t^{H*}$ and $\widehat{n}_t^{H*}$ are the same as for a regular M status firm in appendix D. In the interest of brevity, I won't display the Bellman equation for a firm with $s_t = IMO$, but note it would be similar to that of a regular offshoring firm but again with repatriation taxes removed.

The source paper for the transition probabilities in table 5, Boehm, Flaaen, & Pandalai-Nayar (2019), actually consider inverting firms in their study of the U.S. census data. The persistence in this status and switching transition probability can be used to calibrate the costs in the model f^{HQ*} and $f^{HQ*,C}$. When these firms were included in the calibration exercise, a productivity hierarchy emerged where the productivity of inverting firms where the highest of all statuses.

Notice that, since these firms do not pay repatriation taxes under the U.S. worldwide system, they are a drain on U.S. tax revenues. As a result, in removing the repatriation tax, the presence of inverters in the model actually serves to strengthen the tax revenue neutrality result. Given that the fraction of inverting firms is small ($< 0.1\%$ of U.S. firms), I omit this extra discrete choice from the main analysis as their inclusion has no significant impact on the results.

Appendix D Static Choices: Optimal Pricing, Quantity and Employment

This appendix shows the static price-setting problems for firms of each status. The arguments that solve the optimisation problems will be denoted with hats, (those that correspond to the optimal variables in the Bellman equations in section III ii.1). I'll focus on describing the optimal prices for each status; optimal quantities and labour hired simply follow from the constraints associated with the following static problems.

Domestic Pricing

A domestic firm faces the following static profit maximisation problem

$$\max_{\{p_t^H, q_t^H, n_t^H\}} \; p_t^H q_t^H - n_t^H$$

subject to

$$q_t^H = \left(\frac{p_t^H}{P_t^H}\right)^{-\sigma} C_t^H$$

$$\theta_t (k_t^H)^\alpha (n_t^H)^{1-\alpha} \geq q_t^H.$$

The demand curve pins-down the optimal quantity, while the output requirement pins-down the optimal level of employment. Taking the first order condition (FOC) with respect to the price yields the optimal price of

$$\widehat{p}_t^H = \left\{ \frac{\sigma}{\sigma-1} \frac{1}{1-\alpha} \left(\frac{1}{\theta_t \{k_t^H\}^\alpha} \right)^{\frac{1}{1-\alpha}} (C_t^H \{P_t^H\}^\sigma)^{\frac{\alpha}{1-\alpha}} \right\}^{\frac{1-\alpha}{1-\alpha(1-\sigma)}} . \tag{25}$$

Exporter Pricing

The profit-maximising choices of an exporting firm depend on its previous status, s_{t-1}. In the case where $s_{t-1} = X$, the firm produces goods for both markets and sends goods abroad through its export segment. In this case, their static problem is of the form

$$\max_{\{p_t^H, q_t^H, p_t^{H*}, q_t^{H*}, n_t^H\}} \quad p_t^H q_t^H + p_t^{H*} q_t^{H*} - n_t^H$$

subject to

$$\begin{aligned} q_t^H &= \left(\frac{p_t^H}{P_t^H} \right)^{-\sigma} C_t^H \\ q_t^{H*} &= \left(\frac{p_t^{H*}}{P_t^{H*}} \right)^{-\sigma} C_t^{H*} \\ \theta_t (k_t^H)^\alpha (n_t^H)^{1-\alpha} &\geq q_t^H + d_{HF} q_t^{H*}. \end{aligned}$$

The demand curves for the two countries pin-down the optimal quantities while the optimal labour hiring comes from the output requirement constraint. Notice that the iceberg cost $d_{HF} \geq 1$ features in the production function requirement constraint. Two FOCs then pin-down the optimal prices in each market as

$$\widehat{p}_t^H = \frac{1}{d_{HF}} \widehat{p}_t^{H*} \tag{26}$$

$$\widehat{p}_t^H = \left\{ \frac{\sigma}{\sigma-1} \frac{1}{1-\alpha} \left(\frac{1}{\theta_t \{k_t^H\}^\alpha} \right)^{\frac{1}{1-\alpha}} \left[\{P_t^H\}^\sigma C_t^H + \{d_{HF}\}^{1-\sigma} \{P_t^{H*}\}^\sigma C_t^{H*} \right]^{\frac{\alpha}{1-\alpha}} \right\}^{\frac{1-\alpha}{1-\alpha(1-\sigma)}} . \tag{27}$$

In contrast, a firm that had status of $s_{t-1} \neq X$ is only choosing to establish its export segment in t, meaning that their production for export has not yet commenced. These firms choose the optimal price of a domestic firm given in (25).

Multinational Pricing

A firm that was a multinational last period $s_{t-1} = M$ solves two separate static profit maximisation problems. The first is with respect to domestic profits

$$\max_{\{p_t^H, q_t^H, n_t^H\}} \quad p_t^H q_t^H - n_t^H$$

with the same solution as for a domestic firm given in (25). The second is with respect to its overseas profits

$$\max_{\{p_t^{H*}, q_t^{H*}, n_t^{H*}\}} \quad p_t^{H*} q_t^{H*} - W_t^* n_t^{H*}$$

subject to

$$q_t^{H*} = \left(\frac{p_t^{H*}}{P_t^{H*}}\right)^{-\sigma} C_t^{H*}$$
$$\theta_t (k_t^{H*})^{\alpha} (n_t^{H*})^{1-\alpha} \geq q_t^{H*},$$

which yields an optimal pricing solution of the form

$$\widehat{p}_t^{H*} = \left\{ \frac{\sigma}{\sigma - 1} \frac{1}{1-\alpha} \left(\frac{1}{\theta_t \{k_t^{H*}\}^{\alpha}} \right)^{\frac{1}{1-\alpha}} \left(C_t^{H*} \{P_t^{H*}\}^{\sigma} \right)^{\frac{\alpha}{1-\alpha}} \right\}^{\frac{1-\alpha}{1-\alpha(1-\sigma)}}. \tag{28}$$

Firms with $s_{t-1} = D$ must wait a period to commence operations through their F subsidiary and thus set their H pricing in accordance with (25). A firm with $s_{t-1} = X$ has the option of whether to continue exporting in period t or to cease operations through its export segment. As in the main body of the text, such a firm receives earnings of $\widehat{x}_t^M$ during its transition and the policy function denoting this choice is the binary indicator of $\widehat{o}_t$. Should it continue to export in t, it's optimal pricing is given by equations (26) and (27), otherwise it only sets the H price through (25). Finally a firm with $s_{t-1} = MO$ has the option of whether or not to continue exporting from its F export segment or not. If it chooses not to do so, it's only sales take place to the F household, which have the solution given in (28). If it chooses to continue exporting to H in the transition period, then their static profit maximisation problem is given by

$$\max_{\{p_t^H, q_t^H, p_t^{H*}, q_t^{H*}, n_t^{H*}\}} \quad p_t^H q_t^H + p_t^{H*} q_t^{H*} - W_t^* n_t^{H*}$$

subject to

$$\begin{aligned} q_t^H &= \left(\frac{p_t^H}{P_t^H}\right)^{-\sigma} C_t^H \\ q_t^{H*} &= \left(\frac{p_t^{H*}}{P_t^{H*}}\right)^{-\sigma} C_t^{H*} \\ \theta_t (k_t^{H*})^\alpha (n_t^{H*})^{1-\alpha} &\geq d_{FH} q_t^H + q_t^{H*}, \end{aligned}$$

which gives optimal pricing solutions of the form

$$\widehat{p}_t^{H*} = \frac{1}{d_{FH}} \widehat{p}_t^H \tag{29}$$

$$\widehat{p}_t^{H*} = \left\{ \frac{\sigma}{\sigma - 1} \frac{1}{1-\alpha} W_t^* \left(\frac{1}{\theta_t \{k_t^*\}^\alpha}\right)^{\frac{1}{1-\alpha}} \left[(d_{FH})^{1-\sigma} \{P_t^H\}^\sigma C_t^H + \{P_t^{H*}\}^\sigma C_t^{H*}\right]^{\frac{\alpha}{1-\alpha}} \right\}^{\frac{1-\alpha}{1-\alpha(1-\sigma)}}. \tag{30}$$

Offshoring Multinational Pricing

A firm with $s_{t-1} = MO$ solves the problem of a downsizing offshorer, (who continues to export), to multinational in the previous subsection. Their optimal pricing solutions are given by (29) and (30). A firm such that $s_{t-1} = M$ must wait a period before it can use its F export segment to service the H market. As such it can either continue producing through headquarters at H, in which case its pricing decisions are given by (25) and (28). If it chooses not to produce at H while transitioning, it's only pricing decision is given by (28).

Appendix E Offshoring Multinational Bellman Equation

The value to the choice of $s_t = MO$ depends on whether the firm was already an offshorer or just a regular multinational at $t-1$

$$v_t^{MO}(\varphi_t) = (\mathbb{1}_{s_{t-1}=M}) \left(\max_{m\in\{0,1\}} \tilde{v}_t^{MO,m}(\vec{\varphi}_t) \right) + (\mathbb{1}_{s_{t-1}=MO}) \left(\bar{v}_t^{MO}(\vec{\varphi}_t) \right)$$

where $\bar{v}_t^{MO}(\vec{\varphi}_t)$ is the Bellman equation for a firm that was an offshorer in the previous period; this is the same as (7) in the main body of the text, (i.e. when $s_t = s_{t-1}$). The variable $m \in \{0,1\}$ is a control of the firm (which depends on its state $\vec{\varphi}_t$) that equals one when the firm chooses to keep producing through its headquarters in H during the transition period from M to MO and equals zero otherwise. The value function $\tilde{v}_t^{MO,m}(\vec{\varphi}_t)$ denotes the value of the firm's state in period t when choosing to be an offshorer when making choice m when transitioning from M. Specifically when $m = 1$ and the firm continues to produce through headquarters

$$\tilde{v}_t^{MO,m=1}(\varphi_t) = \max_{\{k_{t+1}^H, k_{t+1}^{H*}, b_{t+1}\}} e_t^{MO,m=1} + \beta_1 \mathbb{E}_t[v_{t+1}(\varphi_{t+1})]$$

where

$$\begin{aligned}
e_t^{MO,m=1} &= d_t^{MO,m=1} - \mathbb{1}_{d_t^{MO,m=1}<0}\zeta(d_t^{MO,m=1}) \\
d_t^{MO,m=1} &= (1-\tau^{\Pi})\{\widehat{p}_t^H \widehat{q}_t^H - \widehat{n}_t^H\} - \Lambda_t i_t^H - \Lambda_t \Phi_t^H - f_t^{MO,m=1} \\
&\quad + \left\{ \mathbb{1}_{u_t^{M,m=1}<0} + \mathbb{1}_{u_t^{M,m=1}\geq 0} \left(\frac{1-\tau^{\Pi,U}-\tau^{\Pi*}}{1-\tau^{\Pi*}} \right) \right\} u_t^{MO,m=1} \\
&\quad + \frac{b_{t+1}}{1+R_{t+1}} - b_t + b_t \left(1 - \frac{1}{1+R_t}\right)\tau^{\Pi} \\
u_t^{M,m=1} &= (1-\tau^{\Pi*})\{\widehat{p}_t^{H*}\widehat{q}_t^{H*} - W_t^* \widehat{n}_t^{H*}\} - \Lambda_t i_t^{H*} - \Lambda_t \Phi_t^{H*} \\
f_t^{MO,m=1} &= (1-\tau^{\Pi}) f^{HQ,C} + (1-\tau^{\Pi,U}-\tau^{\Pi*}) W_t^* f^{M*,C} + W_t^* f^{MO*} \\
i_t^{H*} &= k_{t+1}^{H*} - (1-\delta) k_t^{H*} \\
b_{t+1} &\leq \xi \Lambda_t (k_{t+1}^H + k_{t+1}^{H*}).
\end{aligned}$$

The key departure of this Bellman equation from that in (7) is that the firm receives some operating income from its servicing of the H household through production in H. When the firm instead chooses to downsize immediately, their Bellman equation is of the form

$$\tilde{v}_t^{MO,m=0}(\varphi_t) = \max_{\{k_{t+1}^H, k_{t+1}^{H*}, b_{t+1}\}} e_t^{MO,m=0} + \beta_1 \mathbb{E}_t[v_{t+1}(\varphi_{t+1})]$$

where

$$\begin{aligned}
e_t^{MO,m=0} &= d_t^{MO,m=0} - \mathbb{1}_{d_t^{MO,m=0}<0} \zeta(d_t^{MO,m=0}) \\
d_t^{MO,m=0} &= l_t^{MO,m=0} - f_t^{MO,m=0} \\
&\quad + \left\{ \mathbb{1}_{u_t^{M,m=1}<0} + \mathbb{1}_{u_t^{M,m=0}\geq 0} \left(\frac{1-\tau^{\Pi,U} - \tau^{\Pi*}}{1-\tau^{\Pi*}} \right) \right\} u_t^{MO,m=0} \\
&\quad + \frac{b_{t+1}}{1+R_{t+1}} - b_t + b_t \left(1 - \frac{1}{1+R_t}\right) \tau^{\Pi} \\
u_t^{M,m=0} &= (1-\tau^{\Pi*}) \{ \widehat{p}_t^{H*} \widehat{q}_t^{H*} - W_t^* \widehat{n}_t^{H*} \} - \Lambda_t i_t^{H*} - \Lambda_t \Phi_t^{H*} \\
f_t^{MO,m=0} &= (1-\tau^{\Pi}) f^{HQ,C} + (1-\tau^{\Pi,U} - \tau^{\Pi*}) W_t^* f^{M*,C} + W_t^* f^{MO*} \\
l_t^{MO,m=0} &= \xi \Lambda_t k_t^H \\
i_t^H &= k_{t+1}^H - (1-\delta) k_t^H \\
i_t^{H*} &= k_{t+1}^{H*} - (1-\delta) k_t^{H*} \\
b_{t+1} &\leq \xi \Lambda_t (k_{t+1}^{H*})
\end{aligned}$$

where the firm receives proceeds of the liquidation in the form of $l_t^{MO,m=0}$.

Appendix F Extended Recursive Equilibrium Definition

Cross-Sectional Measure of Home Firms

The cross-sectional measure of firms over the state space is denoted by $\mu_t(\vec{\varphi}_t)$ where recall that

$$\vec{\varphi}_t = (k_t^H, k_t^{H*}, b_t, \theta_t, s_{t-1}).$$

Denote the policy functions for an incumbent firm, for choices made at time t by $k_{t+1}^H(\vec{\varphi}_t)$, $k_{t+1}^{H*}(\vec{\varphi}_t)$, $b_{t+1}(\vec{\varphi}_t)$ and $s_t(\vec{\varphi}_t)$, which are all functions of the current period state. Then denote the policy functions for a new entrant by $k_t^{H,T}$ and $b_t^{H,T}$ (where the T superscript is for their status shorthand of T), which are scalars given that new entrants have no state at the time of their initial choices. Notice that all these policy functions have time subscripts given that the quantitative exercise aims to study transitional effects. See then that the cross-sectional measure evolves according to the law of motion given by

$$\mu_{t+1}(\vec{\varphi}_{t+1}) = \sum_{s\in\{D,X,M,MO\}} \sum_{\theta_t} \int_{b,k^{H*},k} \Gamma[\vec{\varphi}_{t+1}, \vec{\varphi}_t]\mu_t(dk^H, dk^{H*}, db, \theta_t, s) + M_t^T \sum_{\theta_t} \Gamma^T \quad (31)$$

where recall that M_t^T is the measure of new entrants that come into the economy at t, (which are incumbents from $t+1$ onwards). The $\Gamma[\vec{\varphi}_{t+1}, \vec{\varphi}_t]$ and Γ^T functions are endogenous transition functions for incumbents and new entrants respectively, which have form given by

$$\begin{aligned}
\Gamma[\vec{\varphi}_{t+1}, \vec{\varphi}_t] &= \mathbb{1}_{[k^H = k^H_{t+1}(\vec{\varphi}_t)]\wedge[k^{H*} = k^{H*}_{t+1}(\vec{\varphi}_t)]\wedge[b=b_{t+1}(\vec{\varphi}_t)]}\Theta(\theta_{t+1}|\theta_t)(1-\kappa_{s_t}) \\
\Gamma^T &= \mathbb{1}_{[k^H = k^{H,T}_t]\wedge[b=b^{H,T}_t]}\Theta^T(\theta_t)(1-\kappa_D)
\end{aligned}$$

where $\wedge$ is the logical conjunction operator and $\Theta(\theta_{t+1}|\theta_t)$ denotes the conditional discretised version of the productivity process for incumbents in equation (3). Recall that κ_{s_t} denotes the exogenous death probability associated with status s_t. These transition functions are indicators, which are equal to one when a part of the state space that corresponds with firms' endogenous choices is considered.

Recursive Equilibrium

A recursive equilibrium in this model is defined as a set of sequences

$$\{P_t^H, P_t^{H*}, P_t^F, P_t^{F*}, W_t^*, \Lambda_t, R_t, z_t, M_t^T, \mu_t\}_{t=0}^{\infty} \quad (32)$$

such that the following conditions hold for any arbitrary time period t, (with the above sequences taken as given by agents)

1. H household optimises over consumption and savings.
2. H incumbent firms optimise.
3. H entrant firms optimise and the free entry condition $V_t^T = 0$ holds.

4. μ_t is the measure of H firms across their entire state space.

5. M_t^T is the measure of entering H firms.

6. P_t^H is the equilibrium price (endogenous) of H goods in H with market clearing

$$\mathcal{Q}_t^H = C_t^H$$

where $\mathcal{Q}_t^H$ denotes supply of H goods made by H firms and C_t^H is aggregate consumption of H goods by the H household.

7. P_t^{H*} is the equilibrium price (endogenous) of H goods in F with market clearing

$$\mathcal{Q}_t^{H*} + \mathcal{X}_t^{H*} = C_t^{H*}$$

where $\mathcal{Q}_t^{H*}$ is aggregate supply of H goods by H multinationals abroad, $\mathcal{X}_t^{H*}$ is aggregate exports of H goods to F and C_t^{H*} is aggregate demand for H goods in F.

8. P_t^F is the equilibrium price (exogenous) of F goods in F with market clearing

$$X_t^F = C_t^F$$

where X_t^F is the exports of F goods to H and C_t^F is aggregate demand for F goods by H households.

9. P_t^{F*} is the equilibrium price (exogenous) of F goods in F with market clearing

$$Q_t^{F*} = C_t^{F*}$$

where Q_t^{F*} is aggregate supply of F goods and C_t^{F*} is aggregate demand for F goods by F households.

10. The H labour market clears with condition

$$1 = \mathcal{N}_t^H + \mathcal{Z}_t + \mathcal{F}_t^{HQ} + \mathcal{F}_t^{HQ,C} + \mathcal{F}_t^X + \mathcal{F}_t^{X,C} + \mathcal{F}_t^M$$

where the labour supply on the left-side of the equation equals one, (from a normalisation in section II). The total labour demand is made-up of total variable labour demand $\mathcal{N}_t^H$, aggregate equity issuance costs $\mathcal{Z}_t$, aggregate entry fixed establishment costs, $\mathcal{F}_t^{HQ}$, aggregate fixed headquarters continuation costs $\mathcal{F}_t^{HQ,C}$, aggregate exporting fixed establishment costs $\mathcal{F}_t^{X}$, aggregate exporting fixed continuation costs $\mathcal{F}_t^{X,C}$ and aggregate multinational fixed establishment costs $\mathcal{F}_t^{M}$.

11. W_t^* is the equilibrium wage (exogenous) in F with market clearing condition

$$L_t^* = \mathcal{N}_t^{H*} + N_t^{F*} + \mathcal{F}_t^{M*,C} + \mathcal{F}_t^{MO*} + \mathcal{F}_t^{MO*,C}$$

where L_t^* is the F labour supply, $\mathcal{N}_t^{H*}$ is aggregate variable labour demand in F from H firms, N_t^{F*} is aggregate variable labour demand in F by F firms, $\mathcal{F}_t^{M*,C}$ is the aggregate multinational fixed continuation cost of H firms, $\mathcal{F}_t^{MO*}$ is the aggregate offshoring fixed establishment cost for H firms and $\mathcal{F}_t^{MO*,C}$ is aggregate fixed continuation cost for H offshoring firms.

12. Λ_t is the equilibrium price (exogenous) of investment goods, which clears the global investment good market

$$S_t^* = \mathcal{I}_t^{H} + \mathcal{I}_t^{H*} + \mathcal{AC}_t^{H} + \mathcal{AC}_t^{H*}$$

where S_t^* is aggregate supply of investment goods from F, $\mathcal{I}_t^{H}$ is aggregate demand for variable investment goods in H by H firms, $\mathcal{I}_t^{H*}$ is aggregate demand for variable investment goods in F by H firms and $\mathcal{AC}_t^{H}$ and $\mathcal{AC}_t^{H*}$ are aggregate adjustment costs incurred by H firms in H and F respectively.

13. R_t is the equilibrium riskless rate (endogenous) for bonds in H, which clears the market with

$$B_t = \mathcal{B}_t$$

where B_t is savings through riskless bonds by the H household and $\mathcal{B}_t$ is aggregate borrowing through bonds by H firms.

14. The stock markets for H firms in H clear at prices (endogenous) z_t with

$$a_t = 1$$

where 1 is the normalised number of shares per firm and a_t is the number of shares in a given firm that a household optimally chooses to hold.

15. The H Government budget constraint is

$$G_t = \tau^{\Pi}\Pi_t + \tau^W + \tau^D \mathcal{D}_t^+ + \tau^{\Pi,U}\mathcal{U}_t^+,$$

where recall G_t is redistributed lump-sum to the H household and τ^W multiplies one given that the wage is the numeraire and labour supply is normalised to unity.

16. The F Government budget constraint is

$$G_t^* = \tau^{\Pi*}\Pi_t^*$$

where again the proceeds are distributed lump-sum to the F household.

Notice that in the case of a steady state, the sequences in (32) will be invariant across time, (despite changes at the idiosyncratic level). An economy in transition as a result of a policy change will have these objects all changing over time until converging to a new steady state.

Appendix G Calibration Technical Details

The productivity process for H firms is discretised into a Markov process with 15 gridpoints using the process of Adda & Cooper (2003). The distribution of productivity draws for the new entrants, $\Theta^T(\theta)$ is taken to be an adjusted version of the ergodic distribution of that for incumbents in (3). I take the discretised ergodic distribution of (3) and scale the probability mass associated with the top value by a factor denoted by $\nu_{\Theta}^T \in [0,1]$. The mass removed is redistributed amongst the remaining values. There are a total of 21 parameters to be calibrated inside of the model, (all listed in table 4). Denote the vector of parameters to be calibrated as $\vec{\Xi}$. The calibration procedure is executed in accordance with the following objective function

$$J(\vec{\Xi}) = \left[\Psi^{\text{Data}} - \Psi^{\text{Model}}(\vec{\Xi})\right]' W \left[\Psi^{\text{Data}} - \Psi^{\text{Model}}(\vec{\Xi})\right]$$

where Ψ^{Data} are the target moments in the data, (fixed numbers), $\Psi^{\text{Model}}(\vec{\Xi})$ are the set of moments in the model (aa function of the parameters) and W is a positive definite weighting matrix. I set the weighting matrix to be the identity, meaning that all moments are weighted equally and the objective simplifies down to the sum of squared deviations. I consider this to be a reasonable objective specification from the perspective that all the moments that are being targeted are rates or fractions, (i.e. all percentages).

Appendix H Computational Algorithms

In what follows I describe the algorithms for solving for the steady state and transition paths in turn.

Stationary Recursive Equilibrium

1. Discretise: set grids for the continuous state variables k^H, k^{H*}, b, θ.
2. Guess initial values for the aggregate variables required for incumbent H firm optimisation: $C^{H,0}, C^{H*,0}, P^{H,0}, P^{H*,0}$. Note that the 0 superscripts denote the initial guess.
3. Solve the optimisation for an incumbent H firm: gives value functions and policy functions.
4. Solve the optimisation problem for an H entrant: gives the value to entry and associated policy functions.
5. Find the stationary distribution of H firms across their state space: the stationary measure corresponding to a unit measure of firms.
6. Find aggregate variables corresponding to the stationary distribution.
7. Find the stationary measure of firms using linearity of the stationary measure in addition to the market clearing condition for H labour, (given the unit labour supply). Notice that this step imposes that the labour market at H clears; it yields M^T.
8. Find aggregate variables using the equilibrium measure of firms found in step 7.
9. Find the steady state levels of consumption and savings for the H household.
10. Construct metrics of distance from each equilibrium condition:

- $\Delta^{v^T} = v^T$ is the value to entry for H firms (from step 4),
- Δ^{ED^H} is the excess demand for H goods in H (where demand comes from step 9 and supply comes from step 8),
- Δ^{CA} is the current account balance for H, (using aggregates from step 8 and F good imports from step 9).

If

$$\max(|\Delta^{v^T}|, |\Delta^{ED^H}|, |\Delta^{CA}|) \tag{33}$$

is sufficiently close to zero, then stop. Otherwise construct new guesses for the aggregate objects using

$$\begin{aligned}
C^{H,1} &= C^{H,0} + \epsilon^{C^H} \Delta^{ED^H} \\
C^{H*,1} &= C^{H*,0} + \epsilon^{C^{H*}} \Delta^{CA} \\
P^{H,1} &= P^{H,0} + \epsilon^{P^H} \Delta^{VT} \\
P^{H*,1} &= P^{H*,0} + \epsilon^{P^{H*}} \Delta^{CA}
\end{aligned}$$

where $\epsilon^j \in \mathbb{R}$ for $j \in \{C^H, C^{H*}, P^H, P^{H*}\}$ are small parameters chosen for updating of each of the equilibrium objects. Then set

$$\begin{aligned}
C^{H,0} &= C^{H,1} \\
C^{H*,0} &= C^{H*,1} \\
P^{H,0} &= P^{H,1} \\
P^{H*,0} &= P^{H*,1}.
\end{aligned}$$

Then return to step 2 and repeat until convergence, (when the object (33) is sufficiently close to zero).

Transition Recursive Equilibrium

The algorithm below describes how to find the transition path between two steady states after a policy change. The policy change is assumed to be announced in period $t = 1$ and be effective thereafter. The initial condition for the model is the pre-reform steady state at time $t = 0$.

A. Conjecture the number of time periods required to converge to the post-reform steady state: call this number $\mathcal{T} \in \mathbb{N}$.

B. Find the pre and post reform steady states using the algorithm described in the previous subsection. This step yields two lists of steady state equilibrium objects

$$\Upsilon_0 = (P_0^H, P_0^{H*}, P_0^F, P_0^{F*}, W_0^*, \Lambda_0, R_0, z_0, M_0^T, \mu_0, v_0, \mathscr{C}_0, B_1)$$
$$\Upsilon_{\mathcal{T}} = (P_{\mathcal{T}}^H, P_{\mathcal{T}}^{H*}, P_{\mathcal{T}}^F, P_{\mathcal{T}}^{F*}, W_{\mathcal{T}}^*, \Lambda_{\mathcal{T}}, R_{\mathcal{T}}, z_{\mathcal{T}}, M_{\mathcal{T}}^T, \mu_{\mathcal{T}}, v_{\mathcal{T}}, \mathscr{C}_{\mathcal{T}}, B_{\mathcal{T}+1})$$

where Υ_0 denotes the set of equilibrium objects for the pre-reform steady state and $\Upsilon_{\mathcal{T}}$ denotes that for the post-reform new steady state. The variables $\mathscr{C}_0$ and $\mathscr{C}_{\mathcal{T}}$ denote the aggregate consumption level of the H household pre and post-reform. Variables B_1 and $B_{\mathcal{T}+1}$ are the optimal H household savings in each steady state and v_0 and $v_{\mathcal{T}}$ are the value functions for incumbent H firms in the pre and post-reform steady states respectively. Notice that $W_0^* = W_{\mathcal{T}}^*$, $P_0^F = P_{\mathcal{T}}^F$, $P_0^{F*} = P_{\mathcal{T}}^{F*}$ and $\Lambda_0 = \Lambda_{\mathcal{T}}$ given that these prices are exogenous. Moreover note that $R_0 = R_{\mathcal{T}}$ given the steady state relationship between the riskless rate and discount factor in equation (6).

C. Conjecture sequences of time paths for aggregate variables

$$\{C_t^{H,0}, C_t^{H*,0}, P_t^{H,0}, P_t^{H*,0}, R_{t+1}^0, M_t^{T,0}, \mathcal{E}_t^0\}_{t=1}^{\mathcal{T}-1} \tag{34}$$

where the 0 superscript denotes that these are the first guess of the transitional paths of the equilibrium objects. Note that $\mathcal{E}_t^0$ denotes aggregate net dividends from the firms to the households, (used for share market clearing).

D. Take $v_{\mathcal{T}}$ to be the endpoint value for the H incumbent firms' value function. Iterate backwards from $t = \mathcal{T} - 1$ to $t = 1$ on the incumbent firms' optimisation problem. Note that the firm one period ahead discount factor at each point in time is $\beta_1 = 1/(1 + R_{t+1}^0)$, (which is time-varying). This step gives a sequence of value functions, $\{v_t\}_{t=1}^{\mathcal{T}-1}$ and policy functions for the H incumbent firms.

E. Using the incumbent firm value functions $\{v_t\}_{t=1}^{\mathcal{T}-1}$ found in the previous step, iterate backwards on the sequence of problems for an H entering firm. This yields a sequence of entrant policy functions and values to entry $\{v_t^T\}_{t=1}^{\mathcal{T}-1}$. Again notice that the discount factor for the entrant is given by a time-varying $\beta_1 = 1/(1 + R_{t+1}^0)$.

F. Iterate forwards on the measure of H firms using μ_0 as the starting point and the law of motion in (31). Notice that these forward iterations make use of the sequence of conjectured entering firm measures, $\{M_t^{T,0}\}_{t=1}^{\mathcal{T}-1}$. This yields a sequence of measures $\{\mu_t\}_{t=1}^{\mathcal{T}-1}$. These measures can then be used to find aggregate variables corresponding to H firms at any given t.

G. Iterate forwards on the H household's problem until convergence using the following procedure:

   i. Use the household's pre-reform level of steady state savings B_1 as an initial condition. Make an initial guess of their consumption in the period of the reform denoted $\mathscr{C}_1^{hh,0}$. Note that the 1 subscript denotes period $t = 1$ and the $hh, 0$ superscript denotes the initial guess for this household (hh) object. For an arbitrary $t > 1$, denote the resulting level of aggregate H consumption and savings by $\mathscr{C}_t^{hh,0}$ and $B_{t+1}^{hh,0}$ respectively.

   ii. Find the time t chosen level of borrowing $B_{t+1}^{hh,0}$ from the household's budget constraint (2) using the conjectured aggregate net dividends from the firms $\mathcal{E}_t^0$.

   iii. Find the time $t + 1$ level of aggregate consumption using the household's Euler equation (5).

   iv. Repeat steps ii.–iii. until reaching the conjectured period of convergence $\mathcal{T}$. Compare the distance of the implied convergence period consumption and savings from the iterative procedure with those found in step B. of the overall procedure. Specifically compute metrics of distance from the endpoints as

$$\Delta^{hh,\mathscr{C}} = \mathscr{C}_{\mathcal{T}}^{hh,0} - \mathscr{C}_{\mathcal{T}}$$
$$\Delta^{hh,B} = B_{\mathcal{T}+1}^{hh,0} - B_{\mathcal{T}+1}$$

   where $\Delta^{hh,\mathscr{C}}$ and $\Delta^{hh,B}$ denote differences of the iterative household variables in the conjectured period of convergence with the values in the post-reform steady state. If

$$\max\left(|\Delta^{hh,\mathscr{C}}|, |\Delta^{hh,B}|\right) \tag{35}$$

is sufficiently small then stop. Otherwise update the reform period guess for aggregate consumption using

$$\mathscr{C}_1^{hh,1} = \mathscr{C}_1^{hh,0} + \epsilon^{\mathscr{C}} \Delta^{hh,B}$$

for $\epsilon^{\mathscr{C}} \in \mathbb{R}$ as a sufficiently small updating parameter. Set $\mathscr{C}_1^{hh,0} = \mathscr{C}_1^{hh,1}$ and return to step ii. and repeat the procedure until the object in (35) is sufficiently close to zero. The final outcome of this household forward-shooting procedure is sequences of optimal household savings, denoted by $\{B_{t+1}^0\}_{t=1}^{\mathcal{T}}$ and consumption of H goods, F goods and aggregate consumption, denoted respectively by $\{C_t^{H,0}\}_{t=0}^{\mathcal{T}-1}$, $\{C_t^{F,0}\}_{t=0}^{\mathcal{T}-1}$ and $\{\mathscr{C}_t^0\}_{t=0}^{\mathcal{T}-1}$

H. Compute metrics of distance from each of the equilibrium objects for each time period t over the transition. Specifically

- $\Delta_t^{v^T} = v_t^T$ is the value to entry for H firms (found in step E.),
- $\Delta_t^{ED^H}$ is the excess demand for H goods in H (where demand comes from step G. and aggregate supply comes from step F.),
- Δ_t^{CA} is the current account balance for H, (using aggregates from step F. and F good imports from step G.),
- $\Delta_t^{ED^L}$ is the excess demand for H labour, (where supply is unity for each period and demand for labour comes from step F.),
- $\Delta_t^{ED^B}$ is the excess demand for H riskless bonds, (where supply of bonds are the savings from the household problem in step G. and aggregate demand comes from aggregate firm borrowing in step F.),
- $\Delta_t^{\mathcal{E}}$ is the difference of the actual aggregate level of net dividends from firms to households and those conjectured, (where actual level comes from step F.).

If

$$\max\left(\{|\Delta_t^{v^T}|, |\Delta_t^{ED^H}|, |\Delta_t^{CA}|, |\Delta_t^{ED^L}|, |\Delta_t^{ED^B}|, |\Delta_t^{\mathcal{E}}|\}_{t=1}^{\mathcal{T}-1}\right)$$

is sufficiently close to zero, then stop and proceed to step I. Otherwise construct new guesses for the aggregate objects using

$$C_t^{H,1} = C_t^{H,0} + \varrho^{C^H} \Delta_t^{ED^H}$$

$$C_t^{H*,1} = C_t^{H*,0} + \varrho^{C^{H*}} \Delta_t^{CA}$$
$$P_t^{H,1} = P_t^{H,0} + \varrho^{P^H} \Delta_t^{v^T}$$
$$P_t^{H*,1} = P_t^{H*,0} + \varrho^{P^{H*}} \Delta_t^{CA}$$
$$R_t^1 = R_t^0 + \varrho^B \Delta_t^{ED^B}$$
$$M_t^{T,1} = M_t^{T,0} + \varrho^{M^T} \Delta_t^{v^T}$$
$$\mathcal{E}_t^1 = \varrho E_t^0 + \upsilon^{\mathcal{E}_t} \Delta_t^{\mathcal{E}}$$

where ϱ^j for $j \in \{C^H, C^{H*}, P^H.P^{H*}, B, M^T, \mathcal{E}\}$ are very small, appropriately-chosen updating parameters for the aggregate variables that agents take as given when optimising. Set $C_t^{H,0} = C_t^{H,1}, C_t^{H*,0} = C_t^{H*,1}, P_t^{H,0} = P_t^{H,1}$, $P_t^{H*,0} = P_t^{H*,1}$, $R_t^0 = R_t^1$, $M_t^{T,0} = M_t^{T,1}$ and $\mathcal{E}_t^0 = \mathcal{E}_t^1$. Return to step D. and repeat.

I. Check to see if the aggregate variables, (including the overall measure of H firms), have converged continuously to the post-reform steady state by period $\mathcal{T}$. If not, update your guess of how long the convergence takes, $\mathcal{T}$ and return to step C.

Appendix I Baseline Results: Steady State Comparison

This appendix compares the cross-sectional summary statistics across the steady states associated with the quantitative exercise of section V i. Table 13 shows the difference in transition probabilities between the pre and post reform steady states while table 14 shows the summary statistics and how they change.

Data Transition Probabilities				
t/t+1	Domestic	Exporter	Multinational	Exit
Domestic	84.62	5.41	0.03	9.93
Exporter	13.14	80.69	0.84	5.32
Multinational	0.27	1.86	91.75	6.13
Entrant	85.95	12.89	1.18	
Model Pre-Reform Transition Probabilities				
t/t+1	Domestic	Exporter	Multinational	Exit
Domestic	86.19*	4.18*	0.01*	9.62
Exporter	11.08	78.15*	5.45	5.32*
Multinational	4.67	0.00	89.19*	6.14*
Entrant	82.30	16.40	1.30*	
Model Post-Reform Transition Probabilities				
t/t+1	Domestic	Exporter	Multinational	Exit
Domestic	86.50	3.84	1.12	8.54
Exporter	13.72	75.25	3.12	7.91
Multinational	4.35	0.00	89.25	6.40
Entrant	82.40	12.10	5.50	

Table 13: Steady state transition probabilities (* denotes a targeted moment)

Moment	**Data (%)**	**Pre-Reform (%)**	**Post-Reform (%)**
Capital Structure			
Mean debt to book ratio	37.50	37.69*	37.20
Fraction of firms issuing equity	22.04	16.06*	18.34
Mean equity issuance to book ratio	5.60	5.51*	7.42
Std. dev. of equity issuance to book ratio	21.41	27.40*	35.10
Std. dev. of debt to book ratio	41.01	43.00	51.10
Firm size			
Mean investment to book ratio	5.80	4.11*	6.01
Mean export sales intensity	25.21	24.00*	21.00
Mean export output intensity	13.30	16.01	15.34
Foreign employment intensity of M/MO	59.10	52.12*	52.41
Aggregate repatriations to F earnings	27.50	24.20*	24.35
Firm dynamics			
Exit rate	9.55	7.73*	7.93
Fraction of exporting firms	15.64	16.28	7.98
Fraction of multinational firms	5.60	10.34	16.85

Table 14: Steady state summary statistics (* denotes a targeted moment)

Appendix J Baseline Exercise with Anticipation

In this appendix I allow for a one year anticipation of the removal of the repatriation tax. The exercise is the same as the baseline in section V i in every other respect. A one year window of anticipation is an appropriate length given that the TCJA was passed in 2017, after lengthy discussion in the media and by politicians, becoming effective in 2018. The exercise is designed such that the world economy is in steady state at time $t = 0$ and at $t = 1$ the agents become aware that the repatriation tax will be removed from $t = 2$ onwards. Thereafter the tax is removed and the economy converges to the new post-reform steady state. Table 15 shows the cumulative changes in aggregate variables, where the exercise labelled AP corresponds to the one year anticipation, while BL is for the baseline.

	Change (%)			**Change (%)**	
Variable	**AP**	**BL**	**Variable**	**AP**	**BL**
Consumption of U.S. goods in U.S.	0.08	0.10	Repatriations to U.S.	120.23	160.10
Consumption of F goods in U.S.	-0.06	-1.57	Riskless bonds	9.56	9.76
Capital (domestic) of U.S. firms	1.52	0.20	Net dividends	-5.33	-5.38
Capital (abroad) of U.S. firms	58.10	57.12	Tax collections by U.S.	0.00	0.00
Productivity U.S. firms	0.49	0.52	Price of U.S. goods in U.S.	-2.01	-2.93
Measure of U.S. entrants	10.10	10.12	Price of U.S. goods in F	-1.69	-2.64
Measure of U.S. firms	2.10	1.98	U.S. welfare	0.91	0.98

Table 15: Cumulative results for one year anticipation (AP) and basline (BL)

The results are generally similar to those of the baseline quantitative exercise, albeit with the magnitudes dampened. The reform becomes effective two periods in the future from the initial steady state; this has little bearing on the incentives of new entrants at $t = 1$. Their continuation value of entry is unchanged, (in the absence of general equilibrium effects), given that they must wait a period before moving to multinational status anyway. However, incumbent multinationals don't receive any tax savings until time $t = 2$. Recall that in the baseline exercise, incumbent multinationals repatriated a lot of their overseas savings and paid dividends to households; these effects are delayed in the case with anticipation. This reduces the cumulative change in net dividend distributions and dampens the welfare result relative to the baseline exercise.

Appendix K Details for U.S. Post-Reform Data

This appendix details the sources of data in tables 8 and 9. In relation to table 8:

1. Repatriations and overseas savings: Federal Reserve Bank report on the impact of removing the repatriation tax, (Smolyansky, Suarez, & Tabova (2014)). Their data are reported on a quarterly basis. I sum the repatriation totals across the four quarters of each year to get yearly aggregates.

2. Riskless rate: from the U.S. Treasury's website at `https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=reallongtermrateAll`. Their real interest rates are reported on a daily basis. I average rates across those in a year to get yearly estimates.

3. Consumption (real) growth: Federal Reserve Bank of St. Louis Economic Data (FRED), series DPCERO1Q156NBEA. Real personal consumption expenditures, percent change from quarter one year ago. I take the percentage change from the first quarter of the year.

4. Household savings rate: FRED series PSAVERT. These data are reported monthly. I average the rates for months across the year to get the yearly estimates.

Then for table 9, the data are all sourced from Compustat.

1. Leverage: comes from data transformation (dlc + dltt)/at: roughly long-term plus short term debt over total assets. I drop the top and bottom 5% of observations to ensure no outliers.

2. Equity issuance: an equity issuance takes place for a firm when the object sstk - prstkc - dv is positive. When constructing the measures of equity issuance frequency and equity issuance to assets, I drop the top and bottom 5% of observations again to ensure no outliers.

3. Export sales: comes from combining export data from Compustat's segment information. It's merged with the annual fundamentals part of the dataset, merging using the Global Company Key and the Data Date variables.

Appendix L Static Model Environment, Equilibrium and Calibration

This appendix details the static variant of the model whose results are discussed in section V iii. All variables are defined in the same way as in the dynamic model, (but without time dependence), unless otherwise stated.

Home Household

The Home household maximises the objective

$$\max_{C^H, C^F} \mathscr{C} = (C^H)^\lambda (C^F)^{1-\lambda}$$

subject to the constraint

$$P^H C^H + P^F C^F = (1 - \tau^D) D^+ - D^- + G + (1 - \tau^W)$$

where the preferences across the two varieties are the same as in the dynamic model. The new variables in the budget constraint are D^+, which are positive profit distributions from the H firms to the household and D^- are cashflows from the household to the firms, (the fixed costs of entry). The aggregators for the varieties of goods are given by

$$C^H = \left(\int_{\omega \in \Omega} c^H(\omega)^\rho d\omega \right)^{\frac{1}{\rho}}$$
$$P^H = \left(\int_{\omega \in \Omega} p^H(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}}$$

where the parameters are still defined in the same ways as in the dynamic model. Given that this model is static, I abstract from thinking about an explicit stock market, but rather assume that the H household is endowed with all of the shares in the H firms.

Foreign Household

The F household still simply has aggregators across the H varieties given by

$$C^{H*} = \left(\int_{\omega\in\Omega} c^{H*}(\omega)^{\rho} d\omega\right)^{\frac{1}{\rho}}$$
$$P^{H*} = \left(\int_{\omega\in\Omega} p^{H*}(\omega)^{1-\sigma} d\omega\right)^{\frac{1}{1-\sigma}}$$

Home Firms

Home firms are all ex-ante identical at the start of the static model. They pay their fixed establishment cost of entry f^{HQ} to enter the industry. A mass of M^T of firms enter the industry, after which they then all draw their idiosyncratic productivity shocks θ. Conditional on their shock, they then decide what status to take: exit (E) domestic (D), exporter (X) and multinational (M).[33] After making their status choice, they then choose their optimal prices, quantities and employment subject to their demand curves for each country. Their initial value to entry is given by

$$v^T = -f^{HQ} + \mathbb{E}^{\Theta}[v(\theta)]$$

where the conditional value function is given by

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

The conditional value of exit is $v^E(\theta) = 0$ while that for being a domestic is

$$v^D(\theta) = \max_{\{p^H(\theta), q^H(\theta), n^H(\theta)\}} (1-\tau^{\Pi})(p^H(\theta)q^H(\theta) - n^H(\theta) - f^{HQ,C})$$

subject to

$$\theta n^H(\theta) \geq q^H(\theta)$$
$$q^H(\theta) = \left(\frac{p^H(\theta)}{P^H}\right)^{-\sigma} C^H.$$

[33] I abstract from offshoring multinationals here since there's no clear analogue in the status fractions in the data.

That for an exporter is

$$v^X(\theta) = \max_{\{p^H(\theta), q^H(\theta), p^{H*}(\theta), q^{H*}(\theta), n^H(\theta)\}} (1-\tau^\Pi)(p^H(\theta)q^H(\theta) + p^{H*}(\theta)q^{H*}(\theta) - n^H(\theta) - f^{HQ,C} - f^{X,C})$$

subject to

$$\begin{aligned}
\theta n^H(\theta) &\geq q^H(\theta) + d_{HF}q^{H*}(\theta) \\
q^H(\theta) &= \left(\frac{p^H(\theta)}{P^H}\right)^{-\sigma} C^H \\
q^{H*}(\theta) &= \left(\frac{p^{H*}(\theta)}{P^{H*}}\right)^{-\sigma} C^{H*}.
\end{aligned}$$

Then conditional value for a multinational is

$$\begin{aligned}
v^M(\theta) = & \max_{\{p^H(\theta), q^H(\theta), p^{H*}(\theta), q^{H*}(\theta), n^H(\theta), n^{H*}(\theta)\}} (1-\tau^\Pi)(p^H(\theta)q^H(\theta) - n^H(\theta) - f^{HQ,C}) + \\
& (1-\tau^{\Pi,U} - \tau^{\Pi*})(p^{H*}(\theta)q^{H*}(\theta) - W^* n^{H*}(\theta) - W^* f^{M*,C})
\end{aligned}$$

subject to

$$\begin{aligned}
\theta n^H(\theta) &\geq q^H(\theta) \\
\theta n^{H*}(\theta) &\geq q^{H*}(\theta) \\
q^H(\theta) &= \left(\frac{p^H(\theta)}{P^H}\right)^{-\sigma} C^H \\
q^{H*}(\theta) &= \left(\frac{p^{H*}(\theta)}{P^{H*}}\right)^{-\sigma} C^{H*}.
\end{aligned}$$

Foreign Firms

Foreign firms just produce with the constant returns to scale production function $Q^{F*} = N^{F*}$. Their pricing for goods sold in H is such that $P^F = d_{FH}W^*$.

Home Government

The H Government collects taxes on profit distributions to the H household, corporate earnings, repatriated overseas earnings and labour income.

$$G = \tau^{\Pi}\Pi + \tau^{W} + \tau^{D}D^{+} + \tau^{\Pi,U}U^{+}$$

They collect these taxes and then distribute them to the H household lump-sum.

Foreign Government

The F Government collects taxes on corporate earnings and labour income.

$$G^{*} = \tau^{\Pi*}\Pi^{*} + \tau^{W*}W^{*}N^{*}$$

They collect these taxes and then distribute them to the H household lump-sum.

Equilibrium Definition

The equilibrium in this static context is defined as a scenario where

1. All optimising agents are optimising,
2. All markets (H goods in H, F goods in H, H goods in F, F goods in F, labour in H, labour in F) are clearing,
3. The ex-ante expected value to entering hte industry is zero for an H firm,
4. The current account balances.

Calibration

The productivity process is kept identical to the dynamic model. The fixed establishment cost for entering the industry is calibrated to keep $P^{H} = 1$. The remaining fixed costs are chosen to hit the fractions of firms in each status in the data. The parameter configuration is given in table 16. The fractions of firms in each status in the model and data are in table 17.

Parameter	Symbol	Value
Fixed establishment cost of entry	f^{HQ}	0.42
Continuation cost of D	$f^{HQ,C}$	0.01
Continuation cost of X	$f^{X,C}$	0.09
Continuation cost of M	$f^{M,C}$	0.80

Table 16: Static model calibrated parameters

Moment	Data	Model
Fraction of exiting firms	9.55	6.67
Fraction of domestics	69.21	66.67
Fraction of exporters	15.64	20.00
Fraction of multinationals	5.60	6.67

Table 17: Static model moments (all targeted)

Appendix M Re-Calibration without Costly Equity Issuance

Table 18 presents the transition probabilities for the re-calibrated model without financial frictions (bottom panel) and compares those against the data and baseline model transitions (top and middle panels respectively).

Data Transition Probabilities				
t/t+1	Domestic	Exporter	Multinational	Exit
Domestic	84.62	5.41	0.03	9.93
Exporter	13.14	80.69	0.84	5.32
Multinational	0.27	1.86	91.75	6.13
Entrant	85.95	12.89	1.18	
Baseline Calibration Transition Probabilities				
t/t+1	Domestic	Exporter	Multinational	Exit
Domestic	86.19*	4.18*	0.01*	9.62
Exporter	11.08	78.15*	5.45	5.32*
Multinational	4.67	0.00	89.19*	6.14*
Entrant	82.30	16.40	1.30*	
Costless Equity Issuance Calibration Transition Probabilities				
t/t+1	Domestic	Exporter	Multinational	Exit
Domestic	86.71*	3.92*	0.05*	8.87
Exporter	10.91	77.15*	5.36	5.37*
Multinational	2.70	0.00	90.71*	6.58*
Entrant	88.59	10.12	1.29*	

Table 18: Data and baseline and frictionless model transitions (* denotes a targeted moment)

Appendix N Reducing the Domestic Corporate Tax Rate

This appendix outlines the results associated with both removing the repatriation tax and reducing the U.S. domestic corporate tax rate from 35% to 21% as per the TCJA. Table 19 gives the cumulative impact of this exercise (denoted by TCJA) and compares against the results of the baseline exercise (denoted by BL) from section V i.

The TCJA exercise yields considerably stronger entry effects domestically. In addition to future multinationals being more profitable, newly-entered firms will also be more profitable based-on their domestic operations. The cumulative change in the measure of entrants is 12.5% in the TCJA exercise relative to 10.1% in the baseline. These stronger entry effects also induce a much stronger impact on the U.S. real wage, with the price of domestically-sold goods falling by 9%. This brings a much larger increase in U.S. welfare of 2%. The effect on the domestic U.S. capital stock is stronger in the TCJA, with a 6% rise in contrast with around a 0.2% increase in the baseline. Moreover since the drop in the domestic rate greatly boosts the value of being an exporter, the rise in the overseas capital stock is smaller under the TCJA exercise: 11% in contrast with 57% in the baseline. The reform is also very far from being revenue neutral, with a loss of U.S. Government tax collections of around 9%.

	Change (%)			Change (%)	
Variable	**TCJA**	**BL**	**Variable**	**TCJA**	**BL**
Consumption of U.S. goods in U.S.	2.82	0.10	Repatriations to U.S.	11.21	160.10
Consumption of F goods in U.S.	-4.93	-1.57	Riskless bonds	-0.20	9.76
Capital (domestic) of U.S. firms	6.24	0.20	Net dividends	-3.05	-5.38
Capital (abroad) of U.S. firms	11.44	57.12	Tax collections by U.S.	-8.92	0.00
Productivity U.S. firms	0.95	0.52	Price of U.S. goods in U.S.	-9.21	-2.93
Measure of U.S. entrants	12.53	10.12	Price of U.S. goods in F	-5.03	-2.64
Measure of U.S. firms	1.46	1.98	U.S. welfare	2.15	0.98

Table 19: Cumulative results for drop in the corporate rate (TJCA) and basline (BL)