Repatriation Taxes*

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Abstract

We present a model of a multinational firm to quantify the effects of policy changes in repatriation tax rates. The framework captures the dynamic responses of the firm from the time a policy change is anticipated through its enactment, including its long-run effects. We find that failing to account for anticipatory behavior surrounding a reduction in repatriation tax rates overstates the amount of profits repatriated from abroad and underestimates tax revenue losses. We further show that policy changes have a relatively small impact on hiring and investment decisions if firms have relatively easy access to credit markets – as is the case for most multinational firms. Finally, by altering the relative price of holding assets abroad, news of a future reduction in repatriation tax rates acts as an implicit tax on repatriating funds today. We capture and quantify this "shadow tax."

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1 Introduction

Prior to 2018, the U.S. government collected taxes on the worldwide profits of U.S. based corporations. In addition to paying foreign taxes on profits earned abroad, corporations were often also subject to U.S. taxes once these profits were repatriated to the U.S. This is known as the repatriation tax. Many firms argued that these additional repatriation taxes deterred them from repatriating foreign sourced income. Leading up to the enactment of U.S. tax reforms in 2018, these foreign profits, not yet taxed by the U.S. government, stood at over $2 trillion. This large accumulation of assets abroad pushed changing repatriation tax policies high on the legislative agenda. Motivated by long and ongoing policy discussions, as well as past and recent repatriation tax policy reforms, we build a dynamic model to quantify the effects of repatriation tax policy changes on firm-level variables and to understand the mechanisms driving those responses. Can tax reforms lead to an increase in repatriated assets? Do these reforms stimulate employment and investment? What are the associated tax revenue costs? How are the costs and benefits of a reform influenced by protracted legislative deliberations and policy uncertainty? The goal of this paper is to shed light on these questions.

While the economic and tax revenue consequences of reforming repatriation tax policy are potentially large and involve a non-trivial dynamic aspect, the literature, for the most part, has abstracted from studying the dynamic behavior of the firm that accounts for expectations of changes in repatriation tax policy. To the best of our knowledge, this paper presents the first quantitative framework capturing the dynamic impacts of repatriation tax changes that includes the anticipation effects of such reforms.

We find that accounting for the anticipatory behavior of a firm, along with the responses after the policy change, is essential to fully understand the effects of repatriation tax policy changes. In our model, firms respond to news of a repatriation tax policy change in advance of the actual policy change. Conceptually, we consider news as any information that alters the likelihood of future repatriation tax changes such as a policy proposal, the deliberation of a policy, or the legislative lag. Receiving news of a potential future reduction in repatriation tax rates leads to a reduction of repatriated income from abroad, an accumulation of foreign assets untaxed by the U.S. government, and a fall in U.S. government tax revenue. At the enactment of a repatriation tax policy change, firms repatriate back the assets withheld during this *news period* – the period between the arrival of news and the policy change. As in our baseline experiment, modeled after the temporary repatriation tax reduction in 2004-2005, firms additionally bring forward the repatriation of assets that were planned to be remitted at a future date to the time of the policy change, causing repatriations to once again fall after the implementation of the policy. As a result, policy evaluations that do not account for a firm's anticipation of lower future repatriation tax rates overstate the amount of income repatriated from abroad and the effects on labor and capital, while they understate the losses in tax revenue.

One of the primary motivations for reforming repatriation tax policy is to incentivize firms to repatriate assets to the U.S., thereby stimulating domestic employment and investment. We find that the effects of a reduction in the repatriation tax rate on U.S. employment and investment crucially depend on the firm's ability to access external credit markets. When the cost of accessing credit is high, the firm is more dependent on internal funds to support production activities. For such a firm, a contraction in repatriations during the news period corresponds with a large contraction in its U.S. production, and the influx of foreign income at the time of the policy change leads to a sizable expansion of domestic activity. Since most multinational firms are large and relatively unconstrained in their access to credit, our analysis indicates that a repatriation tax rate reduction has a relatively minor impact on domestic employment and investment. Firms that are not credit constrained are able to operate close to their optimal scale independent of whether or not they access their foreign assets. Thus, while a policy change may result in a large inflow of foreign assets, this change in asset flows does not affect production but primarily affects the firm's debt position and shareholder payouts.

Our model consists of a firm that is incorporated in the U.S., but operates and holds assets both domestically and abroad, with the objective of maximizing dividend streams paid to U.S. shareholders. Within each country, the firm decides on the levels of capital and labor required for production, its holdings of liquid financial assets, and the amount of debt to carry in the U.S. Across geographies, profits originating from abroad and repatriated back to its U.S. parent are subject to a repatriation tax levied by the U.S. government. Thus, repatriation taxes play a key role in the across-geography allocation decision. We use this framework to quantify the impact of repatriation tax changes on the firm's decisions within and across geographies.

Our baseline experiment studies the effects of a temporary repatriation tax rate reduction that is anticipated a year in advance of its implementation. While we consider a range of repatriation tax policies, this experiment is motivated and disciplined by the American Jobs Creation Act of 2004 (AJCA), which granted a one-time "tax holiday" on repatriated assets in 2005. In our model, during the news period the firm reduces the rate of repatriations from abroad and accumulates foreign assets to maximize its tax savings from the tax holiday. This reduced flow of assets into the U.S. leads to a small contraction in domestic production and to losses in U.S. tax revenue. At the enactment of the policy, the accumulated foreign assets flow into the U.S.; the firm then uses the additional inflow of assets to primarily pay U.S. shareholders, and reduce its debt.

We show that during the period between when a proposal is presented and its (potential) approval, there is a change in the relative cost of repatriating funds. The period of deliberation can be thought of as a wedge that distorts the firm's decision relative to the status quo without these announcements. We capture and quantify this wedge, generated by the news itself, which we refer to as a "shadow tax." By altering the intertemporal cost of repatriating foreign assets, news of a future tax reduction has both an income effect – higher expected future disposable income induces the firm to repatriate income for dividend payments today – and a substitution effect – repatriating funds today is relatively more expensive than in the future.

Prior to 2018, repatriation rates were set as the larger of zero and the difference between U.S. and foreign tax rates, and by 2017 the top marginal U.S. corporate income tax was the highest among OECD countries. U.S. repatriation taxes were recently eliminated from legislation under the *Tax Cut and Jobs Act of 2017*. However, calls for repatriation tax reform preceded these reforms by many years. Following the enactment of the AJCA, bills were introduced to congress nearly every year requesting temporary and/or permanent reductions in repatriation tax rates. To study the effects of changes in expectations about repatriation tax reforms that such protracted discussions may introduce, we additionally model news with uncertainty surrounding *when* and *if* a repatriation tax change will occur. We show that uncertainty in the timing of the policy change generates a 'wait-and-see' effect. If the firm deems that future repatriation tax reform is likely but they are unsure *when* it will occur, they steadily accumulate foreign asset holdings, which can persist over a long time horizon. Even though the intent of the many proposals was to attract offshore assets held by U.S. firms, the discussions of such proposals arguably had the opposite effect of inducing firms to further accumulate assets abroad while they await a resolution of policy.

An innovation of our dynamic analysis is the inclusion of the anticipation, or new effects, of repatriation tax reform. In this regard, we complement models analyzing the impacts of repatriation taxes such as the static analysis of repatriation/investment decisions from an uncertain arrival of a tax holiday of De Waegenaere and Sansing (2008), Altshuler and Grubert (2003)'s theory of tradeoffs between investment and repatriation decisions of multinational corporations, and the structural model of the relationship between firm-level cash holding and repatriation tax rates in Gu (2017). In an influential paper, Hartman (1985) argues that if tax rates on multinational firms were constant across time, the level of repatriation tax rates would have no impact on the repatriation decisions of mature firms because these taxes would be unavoidable. In our model, in the absence of an actual policy change, a reduction in repatriations and an increase in the stock of foreign asset holdings only occurs if firms expect a future repatriation tax reduction.

The partial equilibrium nature of our model allows for tractability and enables us to focus on the portfolio allocation – cross and within country – and study the mechanisms and adjustments occurring at the firm level. However, the partial equilibrium model abstract from both indirect price adjustments that could dampen the firm-level responses and from long-run efficiency gains from the reduction of a distortionary tax. In this sense, our paper is most suitable for understanding news and the periods around a repatriation tax change rather than its long-term effects. Incorporating general equilibrium effects, Spencer (2017) investigates the aggregate implications of a permanent repatriation tax reform. We believe both papers to be complements. His equilibrium environment can draw conclusions on the welfare consequences of permanent repatriation tax changes, whereas our paper focuses on the dynamics surrounding reforms – and discussions changing the probability of future tax rates, – including firm level responses to news of a reform. Further, we abstract from corporate inversions and model multinational firms with headquarters in the U.S. which are subject to U.S. repatriation tax policy. We focus on the dynamic effects of repatriation tax changes rather than long-term decisions of corporate headquarter relocation (or even the choice to become a multinational) that, arguably, may arise from repatriation tax policy or uncertainty in future repatriation tax policy changes.[1,2]

Our contribution can also be viewed as a counterpart to the empirical literature looking at the effects of repatriation tax policy change from the AJCA such as Dharmapala, Foley, and Forbes (2011), Blouin and Krull (2009) and Faulkender and Petersen (2012). As external validation of our model, we find that our policy experiments of a one-time repatriation tax reduction capture the salient features found in these empirical studies.[3]

Our paper follows the large literature on fiscal policy news shocks such as House and Shapiro (2006), Yang (2005), Leeper, Richter, and Walker (2012), and Beaudry and Portier (2007). We investigate a specific fiscal policy shock – repatriation tax changes – and evaluate the tax revenue consequences and firm-level responses to the shock across a set of variables. In this regard, our analysis is closest to the news and uncertainty of future tax policy studied in Mertens and Ravn (2011) and Stokey (2016). Stokey presents a model with tax uncertainty that can generate an investment boom after the resolution of the policy. In that environment,

[1]See Gu (2017) for a model analyzing tax revenue estimates from U.S. inversion law changes.

[2]For instance, expectations of future higher (lower) repatriation taxes may discourage (encourage) marginal firms from (to) becoming multinationals.

[3]Further, to support our modeling strategy of accounting for policy news, we provide empirical and narrative evidence suggesting that firms received and responded to information on the passage of the AJCA prior to its introduction in Congress.

firms reduce investment in new projects and accumulate liquid assets as a 'wait-and-see' policy until the uncertainty is settled. We differ from Stokey in two ways. First, ours is a quantitative study. This allows us to map some objects in our framework to the data. Second, we allow for firms to access financial markets. Our framework generates similar dynamics to Stokey but that behavior crucially depends on the firm's ability to access credit markets. In our model, allowing the firm to access external and internal financing dampens the investment effects of news of a policy change. Specifically, in the news period, the firm finances domestic operations with external financing while simultaneously accumulating liquid assets abroad.

In the DSGE model of Mertens and Ravn (2011), the economy experiences a contraction of output and investment in anticipation of a tax cut and then an expansion of these variables once the tax cut is implemented, regardless of whether it was anticipated or not. Whereas firms in Mertens and Ravn (2011) adjust domestic inputs in response to a tax cut, our focus on international firms provides an additional margin of adjustment. In our benchmark model, responses to output and investment to either an anticipated or unanticipated reduction in the repatriation tax rate are small due to the firm's ability to borrow and alter asset flows between domestic and foreign operations. This is consistent with the investment dynamics found in the empirical literature of the most recent U.S. repatriation tax change under the AJCA (Dharmapala, Foley, and Forbes, 2011; Faulkender and Petersen, 2012).

2 Model Economy

In this section, we present a dynamic, partial equilibrium model to capture the effects of changes in repatriation tax policy. The model economy consists of a multinational firm that is owned by households and a government that levies taxes on various income sources. The multinational firm is incorporated in the U.S. but operates and holds assets both in the U.S. and overseas. The firm faces corporate income taxes in both jurisdictions and repatriation taxes on any income earned by its foreign operations that are remitted back to the U.S. Thus, a key decision for the firm consists of a portfolio choice problem of optimally allocating assets between its U.S. and foreign subsidiary. Since our focus is primarily on how a firm internally reallocates its assets in response to repatriation tax changes, we do not model the debt vs. equity choice for external financing. Instead, we assume that the firm only has direct access to one type of external financing – debt. Furthermore, we focus on firms that already operate across geographies and focus instead on changes in the scale of cross-border production activities.

2.1 Firm

The multinational firm's objective is to maximize the present discounted value of the stream of utility from dividend payments, d_t, to its infinitely lived shareholders. The firm's objective function is

$$\mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t U((1-\tau_d)d_t)\right]$$

where τ_d is the capital gains tax on dividends, $U(\cdot)$ is the flow utility derived from the after-tax dividend payments with $U'(\cdot) > 0$, $U''(\cdot) \leq 0$, and β is the subjective discount factor.[4]

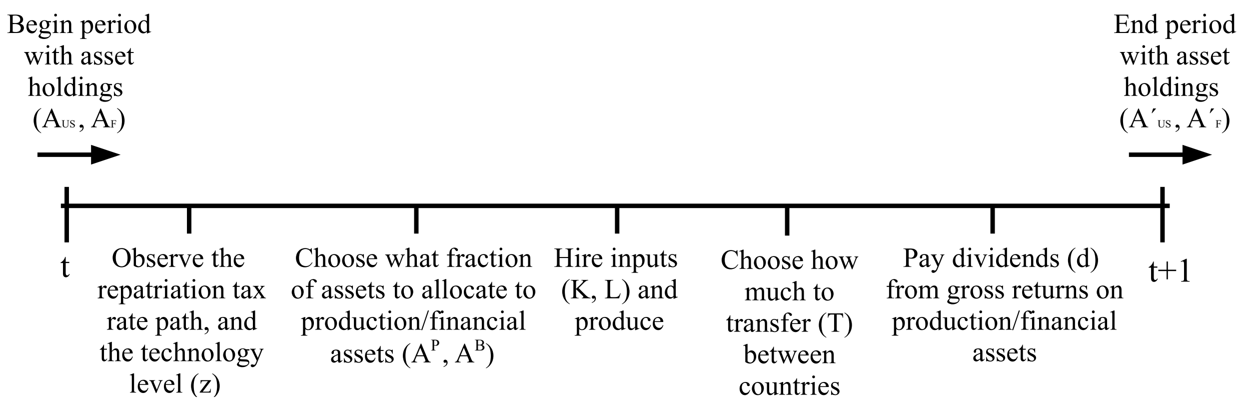

Figure 1: Timeline of Events

The firm enters each period with assets held in the U.S., A_{US}, and abroad, A_F. A firm observes the current and expected time path of repatriation tax rates as well as the exogenous total factor productivity level on its U.S. and the foreign subsidiary, z_{US} and z_F, respectively. Within each period, the firm sequentially makes the following decisions illustrated in Figure 1. *i*) First, the firm chooses how to allocate assets between production and financial assets within each geographical location and decides its debt position. *ii*) Next, using assets allocated to production, it hires labor, rents capital, and produces. *iii*) Finally, the firm decides how many assets, T, to transfer between its U.S. and foreign operations and pays dividends. Assets, A'_{US} and A'_F, are carried over into the next period. We continue by formally introducing these decisions.

Within-Geography Asset Allocation Decision

Within each geography, the firm enters the period with internally held assets carried over

[4]The curvature in the utility function is important as it generates a motive to smooth dividend payments over time rather than an erratic stream of payments. We could alternatively generate smooth dividends by having risk-neutral investors who are subject to dividend adjustment costs.

from the previous period and decides how to allocate its assets between productive activities and holding them as interest bearing financial assets. In the U.S., firms can hold financial assets ($A^B_{US} > 0$) or supplement its assets by taking on debt ($A^B_{US} < 0$). The firm faces a portfolio allocation problem with the aims of maximizing after tax returns. Formally, the firm's intra-period decision for its U.S. based operations is

$$\Pi_{US} = \max_{A^P_{US}, A^B_{US}} \left\{ R^P_{US} + \left[1 + (1 - \tau_{US}) r^B\right] A^B_{US} \right\} \tag{1}$$

subject to

$$A^P_{US} + A^B_{US} \leq A_{US} \tag{2}$$

$$A^P_{US} \geq 0 \tag{3}$$

$$A^B_{US} \in (\infty, -\infty) \tag{4}$$

The first term in Equation (1), R^P_{US}, gives the post-tax returns from assets allocated to production; the second term is the after-tax returns to financial assets (if $A^B_{US} > 0$) or debt (if $A^B_{US} < 0$), with r^B as the interest rate and τ_{US} as the U.S. corporate income tax rate. We assume that the interest rate on borrowed funds, r^B, is a function of the firm's global debt-asset ratio. If, however, financial asset holdings are positive then the interest rate is given by r. Formally:

$$r^B = \begin{cases} r + \psi \left[\exp\left(\frac{|A^B_{US}|}{A_{US} + A_F}\right) - 1\right] & \text{if } A^B_{US} < 0 \\ r & \text{if } A^B_{US} \geq 0 \end{cases} \tag{5}$$

where $\psi > 0$ is the elasticity parameter of debt. This debt-elastic interest rate allows the firm to leverage its total (U.S. plus foreign) asset holdings to reduce domestic debt costs. Including a debt-elastic interest rate serves two purposes. First, it ensures there is no arbitrage opportunity as the firm always faces a debt-elastic interest rate of borrowing that is higher than the returns it gets on financial assets. Second, it induces stationarity in this type of model when interest rates are exogenous. Without this, the model's steady state depends on the initial debt position and the dynamics feature a random walk component.[5]

The firm's foreign subsidiary faces a nearly identical problem of allocating assets to maximize gross returns net of the corporate taxes abroad. The only difference is, for clarity in the analysis, we assume the foreign subsidiary cannot take on debt, i.e. the debt decision of our model firm is confined to the U.S.[6]

[5] See, for instance, Schmitt-Grohé and Uribe (2003).

[6] In the Online Appendix, we relax this assumption and show that results are robust to relaxing this

The foreign intra-period decision is

$$\Pi_F = \max_{A_F^P, A_F^B} \left\{ R_F^P + \left[1 + (1-\tau_F)r\right] A_F^B \right\} \tag{6}$$

subject to

$$\begin{aligned} A_F^P + A_F^B &\leq A_F & (7) \\ A_F^P &\geq 0 & (8) \\ A_F^B &\geq 0 & (9) \end{aligned}$$

where the variables are defined similarly as before, but with F subscripts denoting the decision of the foreign subsidiary.

Production Decisions

Within each geographical location, the firm uses the assets it allocates to production to hire labor, L, and rent capital, K. The firm's aim is to maximize the profits of its production units:

$$R_i^P = \max_{K_i, L_i} \left\{ (1-\tau_i) \left[Y_i - wL_i - r^K K_i \right] + A_i^P \right\} \tag{10}$$

subject to:

$$\begin{aligned} Y_i &= e^{z_i} K_i^{\alpha} L_i^{\eta} & (11) \\ A_i^P &\geq wL_i + r^K K_i & (12) \\ z_i' &= (1-\rho_i^z)\bar{z}_i + \rho_i^z z_i + \epsilon_i^z & (13) \\ \epsilon_i^z &\sim \mathcal{N}\left(0, (\sigma_i^z)^2\right) & (14) \end{aligned}$$

where $i = \{US, F\}$, τ_i is the country-specific corporate income tax rate, and Y_i denotes output. The parameters z_i, α, and η represent the level of technology, capital share in production, and labor share in production, respectively. Finally, w is the constant wage rate and $r^K = r + \delta$ is the capital rental rate with depreciation rate δ.[7]

Repatriation and Dividend Decisions

At the end of the period, the firm simultaneously chooses how many assets to transfer between foreign and U.S. operations, T, the amount of dividends paid to shareholders, and

assumption.

[7]The assumption of constant input prices greatly simplifies our analysis. Including positively-sloped labor supply curves as in Bloom (2009) would dampen the labor responses which would not significantly change our main results.

the amount of assets to carry over to the next period. Consistent with U.S. regulations, all dividend payments by domestically based corporations must be paid through the U.S. parent company.

The repatriation tax rate, τ_R, consists of two components and it is given by

$$\tau_R = \tau + \epsilon_R \tag{15}$$

where τ is the repatriation tax rate set by the U.S. government and ϵ_R is a stochastic component measuring firm-level idiosyncrasies that may impact the tax rate. Consistent with the legal environment of U.S. corporations, the repatriation tax rate set by the U.S. government, τ, is the greater of 0 and the U.S. corporate income tax rate less tax credits for taxes paid to the foreign country on overseas earnings, $\tau = \max\{0, \tau_{US} - \tau_F\}$. The firm-level idiosyncratic component encompasses many firm-specific idiosyncrasies with respect to the repatriation tax rate that we do not model, including special tax deductions, earnings stripping, transfer pricing, R&D credits, income loss deductions, etc.[8]

If the firm transfers assets from overseas to the U.S. ($T > 0$), it must pay repatriation taxes which results in a net transfer of $(1 - \tau_R)T$. However, if the transfer is from the U.S. to overseas ($T < 0$), then there are no repatriation taxes due and the full amount T is transferred abroad. This one-sided repatriation tax friction is consistent with: *i*) prior to 2018, on average U.S. corporate tax rates were higher than those abroad, and thus tax credits overseas left transfers from the U.S. untaxed, and *ii*) many countries have a territorial tax system whereby income earned abroad by domestic firms are not subject to domestic taxes.[9]

Given the asymmetry of taxation on transferring assets across geographies, the stock of assets carried over to the next period are

$$A'_{US} = \Pi_{US} - d + \widetilde{T} \tag{16}$$

$$A'_F = \Pi_F - T \tag{17}$$

where

$$\widetilde{T} = \begin{cases} (1 - \tau_R)T & \text{if } T \geq 0 \\ T & \text{if } T < 0 \end{cases} \tag{18}$$

While the production-side profit maximization problem is a static one, the dividend

[8] The sources of heterogeneity are thus generated by idiosyncratic shocks ϵ^R, ϵ^z_{US}, and ϵ^z_F rather than, say, industry competition.

[9] For instance, leading up to 2018 the top U.S. marginal corporate income tax was the highest among OECD countries, and in 2011, over 75 percent of OECD countries had a territorial tax system (Matheson, Perry, and Veung, 2013).

decision is dynamic. The multinational firm's ultimate objective is to maximize the present value of the stream of utility derived from dividend payments to its shareholders. The problem can be written recursively:

$$V\left(A_{US}, A_F, \tau, z_{US}, z_F\right) = \max_{A'_{US}, A'_F, T, d} U((1-\tau_d)d) + \beta \mathbb{E}\left[V\left(A'_{US}, A'_F, \tau', z'_{US}, z'_F, \epsilon'_R\right) | \tau, z_{US}, z_F, \epsilon_R\right] \tag{19}$$

subject to (1)–(18).

3 Calibration and the Stochastic Steady State

This section first explains how we discipline the model's parameters. It then describes some of the model's primary mechanisms by highlighting its properties in the stochastic steady state.

3.1 Calibration

We parameterize the model so it matches moments of economic aggregates, country-specific tax rates, and firm-level data for U.S.-based multinationals. The calibration characterizes the model in the stochastic steady state where the time period is one quarter. We specify values for 19 parameters. We begin by assigning preference parameters, common technological parameters, and parameter values informed by U.S. aggregates. Of the remaining values, 5 are tax parameters and 8 are jointly calibrated.

We assume preferences are logarithmic[10] and the subjective discount factor is $\beta = 0.993$.[11] For simplicity, we set the common firm-level parameters to be the same across the two countries. Since the ratio of labor to capital share in U.S. data is approximately 2, the labor share, η, is set at 0.5, while the capital share, α, is set at 0.25. This gives an average marginal cost markup of 33 percent.

The real interest rate on financial assets is set to match the quarterly real interest rate on the 10 year U.S. T-bond for the period 2000Q1–2014Q4, $r = 0.0045$ (0.018 annually). We calculate this as $r = \frac{1+i^{T-bond}}{1+\mathbb{E}[\pi]} - 1$ where the expected inflation rate, $\mathbb{E}[\pi]$, is the average inflation in the previous 4 quarters based on the PCE core price index. The capital rental rate is set as the real interest rate plus depreciation. Letting depreciation $\delta = 0.02$, $r^K = r + \delta = 0.0245$.

[10] In the Online Appendix we perform sensitivity analysis on σ, including the case with linear utility ($\sigma = 0$).

[11] This implies a steady state interest rate on debt of 2.06 percent per year in our model.

Table 1: Parameter Values

Moments	Data	Model	Parameter
Tax parameters			
U.S. marginal corporate income tax rate	0.302	0.302	$\tau_{US} = 0.302$
Ave. foreign corporate income tax rate	0.171	0.171	$\tau_F = 0.171$
U.S. capital gains/dividends tax rate	0.15	0.15	$\tau_D = 0.15$
Ave. U.S. repatriation tax rate	0.131	0.131	$\tau = \tau_{US} - \tau_F = 0.131$
Across period variation in firm-level repatriation tax rates	± 0.032	± 0.032	$\epsilon_R \sim \mathcal{U}(-0.032, 0.032)$
Jointly calibrated to firm-level multinational data			
Debt to net asset ratio	0.32	0.32	$\psi = 0.0009$
Ave. number of employees (thousands)	10.22	10.22	$w = 0.588$
Foreign generated share of total income	0.41	0.41	$\bar{z}_F = -0.095$ ($\bar{z}_{US} = 0$)
Persistence of U.S. real income	0.76	0.76	$\rho^z_{US} = 0.889$
Persistence of Foreign real income	0.66	0.66	$\rho^z_F = 0.705$
Standard deviation of real U.S. output	0.104	0.104	$\sigma^z_{US} = 0.019$
Standard deviation of real Foreign output	0.105	0.105	$\sigma^z_F = 0.026$

We are then left with 13 parameters that are more specific to our model economy, which are set to match relevant moments in the data. These are shown in Table 1.

The values chosen for tax parameters in the model come from four sources: U.S. and foreign corporate income taxes, taxes paid by households on dividends, and repatriation taxes. The tax rate on dividends is set to $\tau_d = 0.15$. This is the U.S. capital gains tax on long-term assets of the highest 4 tax income brackets in the 2010s (post 2003).

The remaining tax parameters are set to match firm-level data of U.S. multinationals. We construct firm-level data by matching firm and year specific U.S. marginal corporate income tax rates from Graham (1996) with corresponding observations in the *Compustat Industrial Database*.[12] We restrict our sample to the 2006–2013 period to avoid having the tax policy changes from the AJCA affecting our estimate of repatriation tax rates absent a temporary policy change. We further restrict our sample to firm-year entries with positive foreign and domestic sales and positive foreign taxes.

For a firm i at time t we calculate the repatriation tax rate in the firm-level data as the maximum of 0 and the difference between the marginal U.S. corporate income tax rate and the average foreign corporate income tax rate.[13] For firms that face a positive repatriation tax rate, that is

$$Repatriation\ Tax\ Rate_{i,t} = \left\{ US\ Marginal\ Tax_{i,t} - \frac{Foreign\ Income\ Tax_{i,t}}{Foreign\ Pretax\ Income_{i,t}} \right\}.$$

[12]The marginal tax rate data is updated through 2013. These tax rates are reported after accounting for interest deductions and accounts for the dynamics of the tax code such as net operating loss carry forwards and back, alternative minimum taxes, and investment tax credits.

[13]We argue this is an appropriate measure of the repatriation tax because the U.S. tax obligations are determined by the worldwide averaging of the foreign tax rate. It is also important to note that this may not necessarily be the repatriation tax rate firms effectively pay (they may choose to not repatriate any income, for example), but an estimate of the tax rate they would pay if they were to repatriate foreign income.

The average repatriation tax rate in our sample is $\tau = 0.131$. This value is similar to van't Riet and Lejour (2014) who estimate the U.S. repatriation tax rate to be between 14.6 and 16.7 percent. Further, splitting up the components of the repatriation tax rate, we have the average U.S. marginal tax as $\tau_{US} = 0.302$ and the mean foreign corporate income tax rate as $\tau_F = 0.171$.

Repatriation tax rates by firms in our sample are quite variable from one period to the next. This may be due to various idiosyncrasies such as tax deductions from losses, various tax credits, changes in a firm's marginal tax bracket, and other factors affecting tax rates. We capture such idiosyncrasies in our model with the stochastic variable ϵ_R. To parameterize the distribution of ϵ_R, we first assume it to be uniformly distributed. We then calculate the difference of the 2^{nd} highest and 2^{nd} lowest repatriation tax rate for the 2006–2013 period and divide it by each firm's average repatriation tax rate in this interval.[14] The median value across firms is 0.489. This gives the bounds on ϵ_R of ± 0.032 ($0.064/0.131 = 0.489$). Formally, $\tau_R = 0.131 + \epsilon_R$ with $\epsilon_R \sim \mathcal{U}(-0.032, 0.032)$.[15]

The remaining parameters are jointly calibrated to match firm-level cross-sectional and time-series moments. We again draw upon the firm-level data used in calculating the tax rate parameters above. Our approach is to discipline the technology shock processes at the firm level. This requires a longer time-series, so we expand the sample to include 1990–2013. To maintain consistency with the firms used in the sample to calculate tax rates, a firm again must have positive U.S. and foreign sales and have a calculated repatriation tax rate. After this selection, firms must have at least 15 observations. We then calculate real U.S. and foreign income by firm, deflating the observations by the GDP deflator. Finally, we restrict observations to have less than an absolute value of 25% change in real income from one-year to the next to avoid relatively large outliers in our estimation.

Unfortunately, the Compustat data does not separate use of labor and capital by location, so we infer the model technology processes in the U.S. and abroad by matching moments of foreign and domestic income. We normalize the technology level in the U.S. to $\overline{z}_{US} = 0$ ($e^{\overline{z}_{US}} = 1$) and $\overline{z}_F = -0.095$ is calibrated to match the median share of foreign to total income, 0.43. To find the persistence and standard deviation of the AR(1) shock processes, we first separately normalize the U.S. and foreign firm-year income observations by the average income in the sample. To remove the trend components and aggregate shocks from our income series, for each firm and location – U.S. and abroad – we regress a firm-specific time trend and a year dummy on (normalized) income. We then subtract the predicted from

[14] In this calculation, we require each firm to have 8 continuous observations. We do not use the highest and lowest observations to avoid potential outliers in our calculations.

[15] In the Online Appendix, we additionally consider ϵ_R as being normally distributed. This does not impact our main results.

the observed values to retrieve a stationary firm-level income series. Using this, $\rho^z_{US} = 0.889$ and $\rho^z_F = 0.705$ are calibrated to match the median of firm-specific autocorrelations in the model with the median firm-level income autocorrelations in the data, being 0.76 and 0.66 respectively. We then calibrate the standard deviations of the technology shock processes in the model as $\sigma^z_{US} = 0.019$ and $\sigma^z_F = 0.026$ which matches the corresponding median firm-specific moments the model with the median firm-level standard deviation of income in the data.[16]

Finally, the parameter regulating the elasticity of the interest rate with respect to debt, ψ, is calibrated to match the mean ratio of debt to net assets minus debt, 0.32. We finish by calibrating $w = 0.588$ which equates the median firm size in the model, defined as the number of employees, with that in the data – 10.22 (thousands in the data).

Because of the importance of capturing the non-linearities of the firm's problem, we rely on global solution methods. The Appendix discusses the solution method in detail.

3.2 Model in the Steady State

Many of the key insights emerging from our quantitative exercise are best understood by looking into the steady state properties of the model. Here, we first highlight the impact of repatriation taxes on asset allocation decisions. We show that foreign liquid asset holdings are growing in the level of the repatriation tax rate, quantitatively matching previous empirical findings. We then explore the role of asset holdings on firm-level production decisions which provides a basis for understanding our dynamic exercises.

3.2.1 Repatriation Tax Rates and Foreign Assets

Many policymakers voiced concern that high repatriation tax rates encouraged firms to hold onto foreign earnings – particularly liquid assets – as a vehicle for tax avoidance. Foley, Hartzell, Titman, and Twite (2007) (henceforth FHTT) empirically document this relationship and find that the amount of foreign liquid asset holdings by U.S. multinationals is growing in the level of repatriation tax rates faced by the subsidiaries. Here, we compare this empirical relationship in FHTT with the quantitative implications of our model.

FHTT use confidential firm-level BEA data on foreign subsidiaries of U.S. multinationals in 4 benchmark surveys from 1982–1999. Their measure of liquid asset holdings by foreign subsidiaries is the natural log of liquid assets (referred to as "cash") held abroad divided by the firm's net assets (total assets less foreign cash), $ln\left(\frac{Cash}{Net\ Assets}\right)$. They regress this on the

[16]The model is quarterly while the Compustat data is annual, so we convert the standard deviations to a quarterly frequency.

employment-weighted-effective repatriation tax rate and firm-level controls. This repatriation tax rate measure is calculated the same way we estimate it in our calibration, except it is additionally weighted by the share of employees in foreign subsidiaries to total employees of the firm. The coefficient estimate on the employment-weighted-effective repatriation tax rate in their specification is 6.83.[17]

To obtain the model counterpart of this empirical estimate, we simulate the model economy at its stochastic steady state at various repatriation tax rates between 0.05 and 0.35, i.e. $\tau \in \{0.05, 0.1, ..., 0.35\}$.[18] For each tax rate, we simulate 200,000 firms. Consistent with FHTT we calculate, for each firm, the *employment-weighted-effective repatriation tax rate.* We then regress $ln\left(\frac{Cash}{Net\ Assets}\right)$ on the this weighted repatriation tax rate and the firm-level controls used in FHTT.[19]

Using the regression estimates from our simulated data, we generate predicted values of $ln\left(\frac{Cash}{Net\ Assets}\right)$, holding the control variables at their conditional means. Figure 2 plots the predicted values of $ln\left(\frac{Cash}{Net\ Assets}\right)$ against the employment weighted repatriation tax rate at evenly spaced intervals. In the figure, the predicted values are centered around zero by subtracting the mean predicted value of $ln\left(\frac{Cash}{Net\ Assets}\right)$ from each estimate. For comparison, the dashed line follows the slope coefficient estimate in FHTT.

Given we did not target this empirical relationship, this exercise (in addition to exercises in forthcoming sections) provides confidence in the external validity of our framework. Moreover, it also highlights an important channel through which repatriation taxes in the model provide firms with a motive to hold financial assets abroad. In the model, the stochastic element in repatriation tax rates, ϵ_R, induces firms to accumulate foreign financial assets to await tax saving from a lower realization of ϵ_R (therefore a lower τ_R). Given positive borrowing costs, when the underlying repatriation tax rate τ is high, the marginal utility of shareholders from dividends is also relatively high. In this case, the marginal benefit of tax saving from a lower realization of ϵ_R is likewise high, leading firms to defer repatriations to await such a realization. Additionally, recall that in the model foreign asset holdings reduce domestic debt costs. Repatriation taxes thus induce firms to hold assets up to the point where the marginal returns on after-tax repatriations equals the marginal cost of debt.

[17]This coefficient is significant at the 5 percent level; see Table 5, Column 3 in Foley, Hartzell, Titman, and Twite (2007).

[18]0.35 is the highest repatriation tax rate a firm could face prior to the U.S. tax reforms in 2017.

[19]There are three control variables in FHTT for which our model does not have a counterpart: dividend dummy (due to concave utility, firms always pay dividends in our model), R&D expenditures, and investment. Details on this regression are in the Online Appendix.

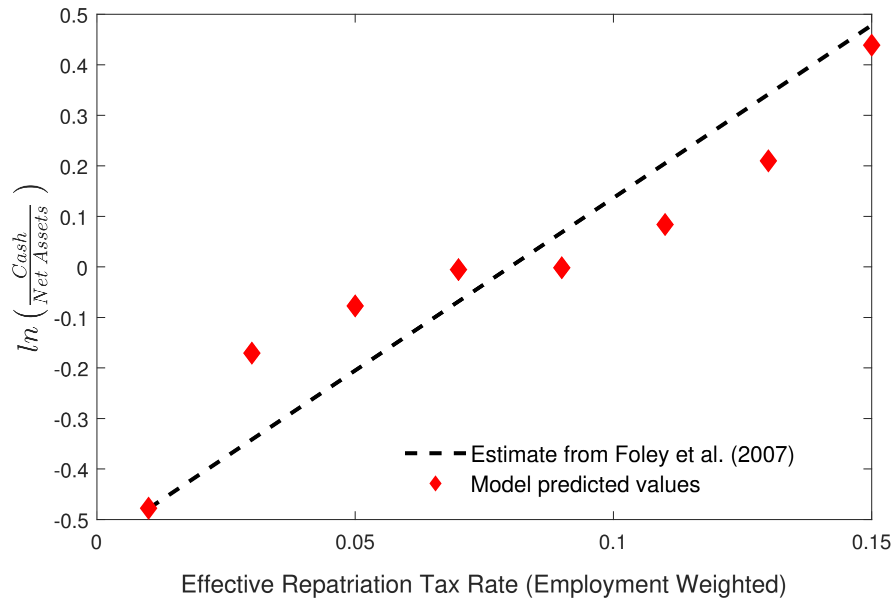

Figure 2: *Foreign Liquid Asset Holdings and Effective Repatriation Tax Rates (Employment Weighted)*

Notes: We follow the estimation in Foley, Hartzell, Titman, and Twite (2007), regressing foreign $ln\left(\frac{Cash}{Net\ Assets}\right)$ on the *employment-weighted-effective repatriation tax rate* and controls using our simulated model data at the firm-level. The predicted values are generated by holding the control variables at their conditional means. All values are centered at zero by subtracting the mean predicted value. The slope of the dashed line follows the corresponding coefficient estimate in Foley, Hartzell, Titman, and Twite (2007) (Table 5, Column 3).

3.2.2 Asset Allocation and Production

Next, we look at the policy functions to understand the production and debt decisions of the firm. We numerically solve for the policy functions for various levels of the debt-elastic interest rate parameter ψ, holding firm-level productivity parameters, z_{US} and z_F, and foreign asset holdings, A_F, at their mean levels. We interpret ψ as the ease of access to external credit markets. Figure 3 plots the policy functions for U.S. operations of internally held assets, A_{US}, against assets devoted to production, A^P_{US}, financial asset holdings, A^B_{US}, and U.S. profits. Here $A^B_{US} < 0$ indicates debt.

We let A^*_{US} denote the level of productive assets when the returns to production equal the interest rate offered by financial asset holdings.[20] When $A_{US} < A^*_{US}$ the firm allocates all of its internally held assets to production as these offer a relatively higher return. Once $A_{US} \geq A^*_{US}$, production is at its maximum scale and, because of diminishing returns to scale in production, all assets $A_{US} > A^*_{US}$ are held in interest bearing financial assets.

Looking first at the baseline parameterization of ψ, the total amount of assets devoted

[20] See Equation (20) in the Appendix for the solution to A^*_{US}.

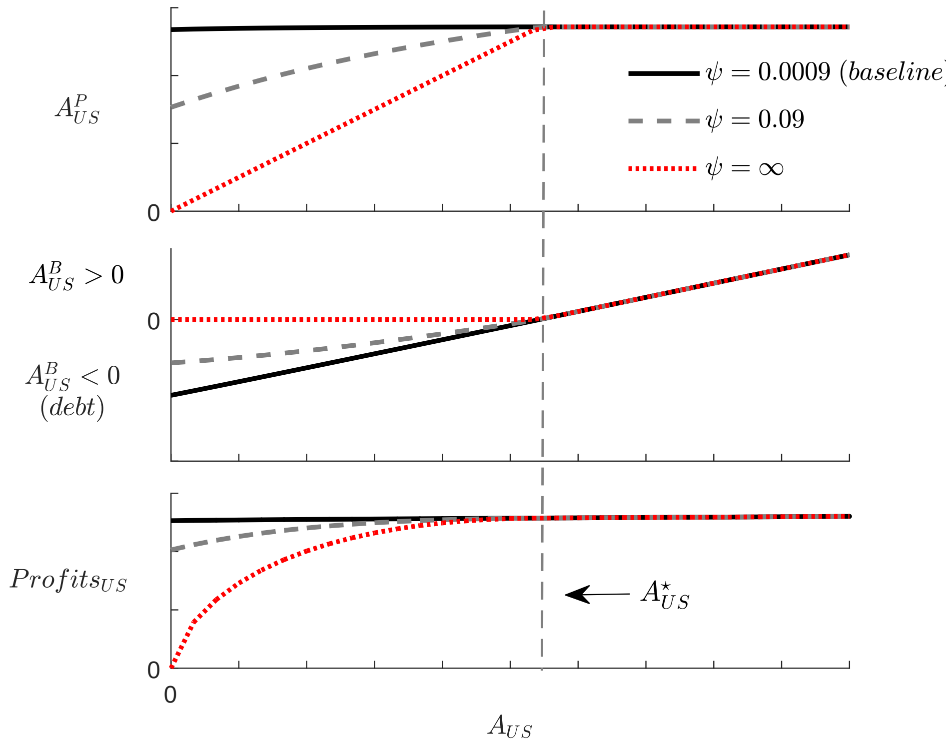

Figure 3: *Policy Functions and Access to External Credit*

to production is *relatively* unaffected by the amount of internally held assets A_{US}. This is because the firm may borrow to supplement its productive assets when the returns to production exceed its borrowing costs (i.e. $A^B_{US} < 0$ when $A_{US} < A^*_{US}$). Profits, although growing in A_{US}, are not substantially impacted by the level of internally held assets due to the firm's ability to access debt. Contrast this to the cases when it is more costly to access external credit (or impossible when $\psi = \infty$).[21] When internally held assets $A_{US} < A^*_{US}$ the amount of assets devoted to production – and thus profits – are lower than the baseline case. This is because it is more costly to supplement the shortfall in assets devoted to production with debt.

These policy functions are instructive when understanding the model exercises of a reduction in repatriation tax rates, which, we will see, lend to an influx of foreign assets and hence an increase in A_{US}. As our policy functions illustrate, even large changes in A_{US} in our baseline case will have relatively small impacts on assets devoted to U.S. production and, by extension, use of capital and labor.

[21] We note that the policy functions of foreign operations mirror the policy functions shown here when $\psi = \infty$.

4 Quantitative analysis

This section presents our model dynamics from a temporary repatriation tax rate reduction – a tax holiday – where the firm receives news of the policy change in advance. We then compare our model predictions with the empirical findings on the effects of the tax holiday around the *American Jobs Creation Act of 2004*. We show that the model is consistent with this empirical literature and that it can account for a substantial share of the observed repatriated assets before, during, and after the policy change. Following this, we examine the importance of news, uncertainty, and access to external credit markets on firm-level behavior stemming from a repatriation tax policy change.

4.1 Baseline Exercise

Our baseline experiment considers a tax holiday that reduces the repatriation tax rate faced by multinational firms for one period from a steady state level of τ^H to τ^L. We further assume that firms receive news of the tax holiday J periods in advance of its enactment. This choice for the baseline tax policy is motivated by the *American Jobs Creation Act of 2004* (AJCA), the only repatriation tax holiday in U.S. history. The AJCA contained several tax incentives, including a one-time allowance for firms to bring back assets from abroad at a reduced repatriation tax rate. For our baseline exercise, consistent with the AJCA, we reduce repatriation tax rates for one-period from $\tau^H = 0.131$ to $\tau^L = 0.0643$.[22]

In this exercise, the firm knows with certainty that a tax holiday will occur 4 periods in advance of the actual tax holiday occurring, i.e. $J = 4$. Such policy lags are typical for fiscal policy changes and are crucial to quantifying the full effects of a tax holiday. In our subsequent discussion, we refer to these policy lags – the periods between when the firm begins anticipating a future tax holiday and when it is implemented – as the news periods.

Figure 4 presents the responses to news of, and implementation of, a tax holiday per our baseline policy. The plots are the average responses of the multinational firms that we model, and there is not economy-wide aggregation. Throughout, panels and results labeled as "U.S." refer to the average responses to U.S. variables. Panel A gives the firm-level responses and panel B gives the responses for the U.S. government's tax revenue collected from these firms. The units are percentage deviations from the original stochastic steady

[22]Under the AJCA, firms were allowed a maximum tax rate on overseas earnings of 5.25 percent on 85 percent of repatriated funds. The remaining 15 percent of funds faced their 'normal' repatriation tax rate, 0.131. The average repatriation tax rate on our model firms in the tax holiday is thus $0.85 \times 0.0525 + 0.15 \times 0.131 = 0.0643$. Kleinbard and Driessen (2008) note that additional tax credits toward the effective tax rate on funds receiving tax breaks under the AJCA was 3.65 percent rather than 5.25 percent. Since we do not explicitly model additional foreign tax credits, we use the 5.25 percent rate in our calculation.

state with the exception of the repatriation tax rate graph, which shows the actual time-path for the repatriation tax rate. The tax holiday is implemented at period 0 and the firm receives news of it 4 quarters in advance (period -4).

It is most instructive to discuss our results by dividing the effects of our baseline repatriation tax holiday into three separate sub-intervals: the news period (from periods -4 to -1), the period of the tax holiday (at-realization, period 0), and the periods thereafter (post-realization, period 1 onwards). On receiving news about an imminent future tax holiday, during the news period the firm cuts back on repatriations from their foreign subsidiary as they await more favorable repatriation tax rates. This leads to an accumulation of financial assets abroad. In the U.S., the firm compensates for this reduction in transfers by issuing debt. However, since borrowing is not costless, the U.S. operations are unable to fully make up for the entire fall in assets and thus have to cut back on dividend payments and assets devoted to production. The fall in U.S. capital and labor is quite small at approximately 3/10 of 1 percent.

In the period of implementation, the firm takes advantage of the one-time tax holiday and repatriates a large amount of foreign assets to the U.S. The amount of repatriated assets contains not only the financial assets the firm accumulated abroad during the news period, but to take maximum benefit of the tax holiday the firm also brings forward planned future transfers to the period of implementation. The U.S. operations then use this large inflow of funds from abroad to pay higher dividends, reduce debt, and increase production.

After the tax holiday period, the firm reduces transfers and reaccumulates assets abroad toward returning to their steady state level. In the U.S., the firm uses the large influx of assets from the tax holiday period to temporarily sustain higher dividend payments, higher production, and debt reduction.

Next, with respect to share value and dividend payments, the announcement of a tax holiday signals a lower tax obligation in the future, which causes an instant increase in the firm's value at the time of the news. The value of the firm continues to rise within the news period up to the realization period, after which it slowly returns to steady state as the tax-savings from the tax holiday are eventually paid out as dividends. Further, during the news period, even though dividends are cut back they are still positive. When the firm foresees a future tax reduction, they accumulate foreign financial assets while simultaneously issuing domestic debt to smooth out dividend payments. This behavior is consistent with the observation that several companies (Apple Inc., Ford Motor Co., Caterpillar Inc., for instance) have relied on bond issuance to finance dividend payments while simultaneously amassing large sums of untaxed assets abroad.

On the U.S. government side, in Panel B, the collection of tax revenues on repatriated

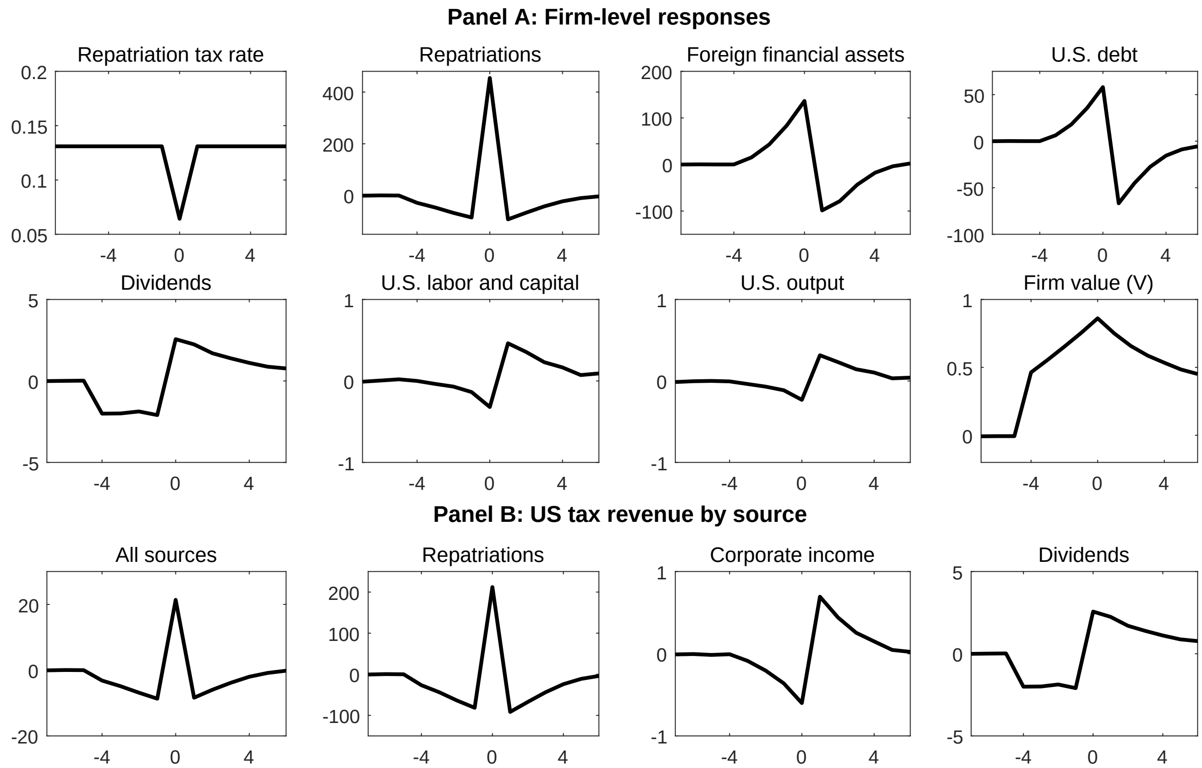

Figure 4: *Responses to an Announced Temporary Reduction in Repatriation Taxes*

Notes: News of tax reduction is received 4 quarters in advance. Except for the repatriation tax rate, units are in percent deviation from initial steady state.

assets, corporate income, and dividends mirror the transition path of their respective tax sources.[23] The responses of tax revenues from corporate income and dividends are small relative to that of transfers. Since the firm uses debt to smooth out U.S. production and dividend payments, the magnitude of the impact from transfers is the primary force governing the changes in tax revenues from all sources.

4.2 The American Jobs Creation Act of 2004

Our baseline calibration was informed by the actual tax rate reduction from the AJCA, leading to a natural benchmark from which to judge the validity of our framework. Here we compare our baseline results directly with the main findings from the empirical literature that evaluates the impact of the AJCA.[24] Our model is able to explain key empirical findings

[23]Our model does not incorporate profit shifting – attributing U.S. value added to foreign affiliates – for tax purposes (see Guvenen, Mataloni Jr, Rassier, and Ruhl (2017)). If our model included opportunities for profit shifting, profit shifting could increase if firms anticipate a repatriation tax rate reduction. While this would not affect real variables, it may amplify the responses to tax revenues.

[24]A summary of this literature is in the Online Appendix. This literature, surprisingly, generally does not consider the anticipatory effects of repatriation tax policy changes.

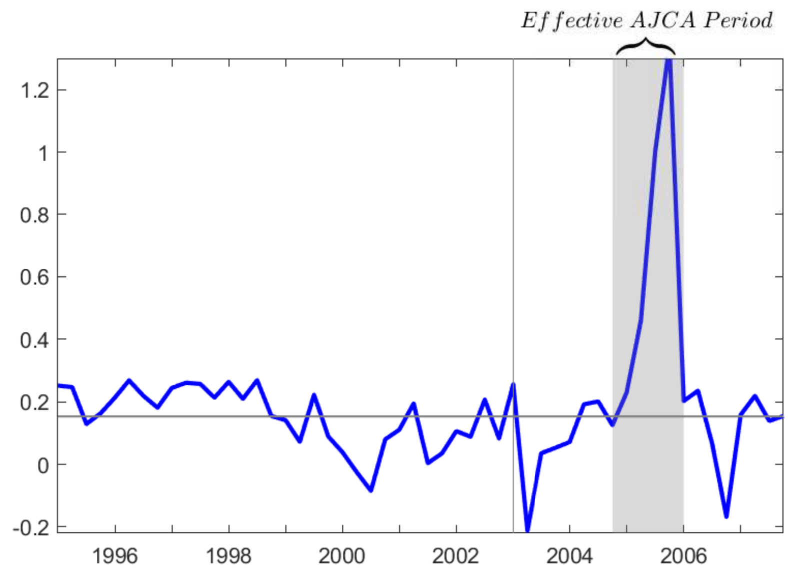

Figure 5: *Transfers: Net Repatriations of U.S. Incorporated Companies as a Share of Foreign Profits*

Notes: The shaded area is time of repatriation tax breaks under the *American Jobs Creation Act of 2004*. The vertical line is the introduction of the *Homeland Investment Act of 2003* to Congress. Constructed using Balance of Payments data from the U.S. Bureau of Economic Analysis

surrounding the AJCA. We also present suggestive evidence that firms both anticipated and reacted to the tax holiday provision in the AJCA well before it was signed into law. Furthermore, the effects of policy lasted for several quarters after the end of the tax holiday. This evidence lends support to the importance of accounting for the full dynamics in any analysis of repatriation tax policy reform.

It is estimated that under the AJCA tax holiday approximately $312 billion of qualified earnings were repatriated to the U.S. (Redmiles, 2008). Figure 5 shows net repatriated dividends from foreign subsidiaries to U.S. based parent companies as a share of foreign corporate profits in the years around the AJCA. The shaded area is the effective period of the tax holiday[25] and the horizontal line - at 15% – is the average from 1995-2003. Net repatriated dividends as a share of corporate profits had never exceeded 26% prior to the enactment of the law, but reached 130% in the final quarter of the tax holiday before sharply falling below its average level just following the repatriation tax holiday. The fall in repatriations after the tax holiday was anticipated by policy makers. The Joint Committee on Taxation predicted firms would shift repatriated earnings they would otherwise have repatriated in future years to the tax-holiday period to get more favorable rates (Kleinbard and Driessen, 2008). This is the same mechanism that causes repatriations to fall after the tax holiday in our model.

[25]Due to misalignment of fiscal to calendar years, some firms were allowed tax breaks on repatriated income extending into 2006Q1.

Despite the influx of liquidity during the tax holiday, the general consensus in the literature is that the AJCA's objective of stimulating employment and investment were not met. Dharmapala, Foley, and Forbes (2011) find that repatriations had no significant impact on U.S. investment or employment, as did Clemons and Kinney (2008) with regards to investment.[26] Faulkender and Petersen (2012) echo these findings and show that financially unconstrained firms, which repatriated 73% of all qualified funds, did not alter domestic employment or investment.[27]

Additionally, under the AJCA, funds receiving tax breaks were prohibited from being used for shareholder payouts (dividends and share buybacks). However, in an evaluation of the proposed tax holiday released a year prior to the AJCA, a Congressional Research Service report noted that due to the fungibility of internal funds, firms could channel the repatriated funds from a tax holiday to investment while switching domestic funds to shareholder payouts (Brumbaugh, 2003). Studies on the AJCA have, in fact, found that the tax holiday was associated with an increase in payments to shareholders (Blouin and Krull, 2009; Clemons and Kinney, 2008). Dharmapala, Foley, and Forbes (2011) estimate that a \$1 increase in repatriation during the AJCA tax holiday corresponded with a \$0.60–\$0.92 increase in shareholder payouts. In our model we can do a similar calculation. Relative to the steady state, in the five-year window around the tax holiday (including the news period) in our model, a \$1 increase in after tax repatriations corresponds with a \$0.74 increase in dividend payouts. This is in the middle of the range found by Dharmapala, Foley, and Forbes (2011).

Studies on the impacts of the AJCA have primarily focused on its impact only at and after its enactment. However, we argue that to correctly quantify the effects of the AJCA, one must also account for any anticipatory effects that may have occurred, i.e. the impacts during the news period. In the case of the AJCA, there were a series of earlier bills beginning in February 2003 that did not pass through congress but contained the tax holiday provisions that were later incorporated in the AJCA.[28]

In the time leading up to the AJCA, there is evidence that these earlier bills did lead to anticipation of the tax holiday. For example, in 2003 Lehman Brothers' tax accounting

[26] Further, of the top 15 repatriating corporations, 10 actually reported a decrease in U.S. jobs from 2004-2007 (Permanent Subcommittee on Investigations, 2011).

[27] However, Faulkender and Petersen (2012) also document that financially constrained firms did increase investment, but still not employment, in response to the act. We return to this point in Section 4.5.

[28] Lobbying efforts had long called for tax breaks on repatriated income, but the call for a tax holiday gained legitimacy in February 2003 with the introduction of the *Homeland Investment Act of 2003* to the House of Representatives, the *Invest in America Act of 2003* presented to the House in March, and the *Invest in the USA Act of 2003* introduced in the Senate in the same month. These bills included similar provisions for the tax holiday included in the AJCA of 2004. Under the AJCA of 2004, 85 percent of repatriated earnings would qualify for tax exemptions, the same as in the *Invest in the USA Act of 2003*. A later bill introduced in November 2003, *The American Jobs Creation Act of 2003*, also contained similar language.

Table 2: Cumulative Percent Deviation from Average Net Repatriations as a Share of Foreign Profits (Quarterly Rate)

	Sub-Period		
	News Period (2003Q2-2004Q3)	AJCA (2004Q4-2006Q1)	Post-AJCA (2006Q2-2007Q1)
Data	-63.65	258.08	-53.43
Model	-49.72	106.02	-61.89

notes: Figures are percent deviation of net repatriations as a share of foreign profits relative to their average. In the data, this is the average from 1995Q1-2003Q1. In the model the average is the steady state level of the corresponding measure. Figures are expressed as quarterly rates.

analyst Robert Wilkens indicated that legislation allowing companies to repatriate foreign earnings was "gaining momentum" and was likely to be passed into law in early 2004 (Corporate Financing Week, 2003). Other examples of anticipation of the tax holiday include Simpson and Wells (2003) who discuss firms' lobbying efforts for a tax holiday in 2003 citing provisions that would eventually be enacted in the AJCA and Sullivan (2004) who question if foreign income shifting in the years leading up through 2002 are related to tax holiday proposals in congress. Oler, Shevlin, and Wilson (2007) find that in 2003, well before the introduction and passage of the AJCA but when a future tax holiday seemed likely, stock prices had started reflecting potential tax savings from a tax holiday. This is a result that is mimicked by our model; stock prices rise in the news period in anticipation of a future tax holiday (see Figure 4).

In our model, expectations of a reduction of repatriation tax costs lead firm to reduce repatriations until the policy's resolution. We find that the behavior of firms, in the period before the AJCA, was consistent with that anticipatory effect. Returning to Figure 5, the vertical line in 2003Q1 marks the time the first bill leading up to the AJCA was introduced (the *Homeland Investment Act of 2003*). The following quarter, net repatriated dividends fell to their lowest point in the 13 year sample.

Table 2 compares our model findings with repatriation behavior in the data. We calculate – in both the empirical and in the simulated data – the percent deviation of net repatriations as a share of foreign profits from its average level. We then cumulate it into 3 sub-periods: 6 quarters of the news period beginning with the introduction of the *Homeland Investment Act of 2003*, 6 quarters of the effective period of the AJCA, and 4 quarters after the policy. All of the numbers are expressed as quarterly rates. For consistency in the comparison, we rerun our baseline model but alter its timing to be consistent with the AJCA – a 6 quarter news period and a 6 quarter tax holiday.

Quantitatively, the model matches the data very closely in the news period and in the time following the tax holiday. During the tax holiday, in both the data and model, repatriations are significantly higher with the model capturing over 40 percent of this observed increase during the AJCA. Overall, even though not constructed to explain the AJCA, our model is able to account for various features of the data and the empirical results surrounding the AJCA.

4.3 Discussion On General Equilibrium

While our focus is to understand the mechanisms driving within and cross-country asset allocation of the firm in response to a change in repatriation taxes, before proceeding it is important to note the limitations of our study when drawing aggregate implications. Specifically, by lacking general equilibrium, our model economy does not capture indirect effects that may occur via price adjustments and/or changes in resource allocation.

In our model, as firms adjust their demand for inputs in response to the policy change, input prices would adjust from changes in economy-wide demand. Likely, these price adjustments in factor inputs would also serve to dampen the responses to labor/capital and output in comparison to the already relatively small responses in our baseline model. Moreover, in general equilibrium the asset flows into the U.S. in response to a tax holiday would make consumers wealthier – from an influx of dividends and/or higher factor payments – and result in an increase in demand for goods and services. Again, we would argue changes in factor payments due to repatriations would be relatively small, causing the income and demand change from this channel to be small. Dividend payments in our model, on the other hand, fall in anticipation of, and increase at the time of, the tax change. The total effects from this channel would rely on how large the tax saving on dividends is and how large of a portion dividend payments from multinational firms make up of total household income.

In the end, the aggregate responses would also depend on the extent to which wealth effects are assumed in household preferences. What is clear, however, is that the aggregate and welfare effects of repatriation taxes would necessitate a general equilibrium to be properly quantitatively evaluated. When we consider a permanent reduction in repatriation tax rates, the general equilibrium effects would be more important to incorporate as there may exist long-run efficiency gains following a permanent reduction in distortionary taxes.[29,30] Our framework, nevertheless, highlights important mechanisms at the firm level that are consistent with the empirical literature that such a framework should capture.

[29] See, for example, Spencer (2017) for a general equilibrium model with permanent repatriation tax changes.

[30] Section OA5 of the Online Appendix considers a permanent reduction in repatriation taxes (and a further discussion of general equilibrium effects from this permanent change) as well as the permanent tax reform from the *Tax Cut and Jobs Act of 2017*.

4.4 News Effects

Policy analysis generally focuses on the effects of a repatriation tax policy change only at and after its enactment. For example, assessments of the AJCA such as the Joint Committee on Taxation (2004) estimated the tax holiday provision in the AJCA would result in \$2.8 billion in revenue gains during the holiday and over \$6 billion in losses over the next 9 years. The news period was not included in the assessment of the AJCA. In this section, we show that the responses in the news period are large and, to ensure an accurate assessment of any policy change, the entire dynamics surrounding the policy change should be taken into account.

Figure 6 reports the cumulative responses of a tax holiday for several variables of interest. Each plot also subdivides the cumulative responses into three sub-periods: the news period, at-realization, and post-realization. Additionally, we also report just the post-news cumulative response (the sum of the at-realization and post-realization responses) to highlight the implications of a policy analysis that focuses only on the responses at and after a policy change. For the figure, the units are quarterly gains/losses to that variable relative to the steady state at the time of the news. For example, a cumulative value of -1 to tax revenues indicates that total tax revenue losses are equal to 1 quarter's worth of steady state tax revenues. We further show the results for three simulations differing in the length of the news period: when there is no news period and when the news period is 1 and 4 quarters long.

Consider first the cumulative impacts in the baseline case, i.e. news period is equal to 4. On net, repatriations fall in the news period, rise during the tax holiday, and fall thereafter. If an assessment of the tax holiday on repatriations only considers the total effects at and after its implementation, it shows a net gain of over 2 quarter's worth of steady state repatriations. When all periods are taken into account, including the news period, cumulative repatriations are negligible: the policy change merely shifts the timing of transfers, which would have been repatriated anyway, to the time of the tax holiday.

In the baseline case, there are cumulative gains to U.S. capital and labor. The total gains to these variables are 1.3 percent of their quarterly steady state levels. If the news period is not taken into account, these gains are overstated. On the government side, there are net losses to U.S. tax revenues. However, looking at this set of firms, the tax holiday would appear to be approximately revenue neutral if the news period were not taken into account.

Furthermore, we find that the longer the news period the larger the losses to U.S. tax revenue. A longer news period allows the firm to take maximum advantage of the tax holiday by holding back a large amount of assets during the news period and then repatriating a large amount during the tax holiday. This larger repatriation in turn leads to an overall

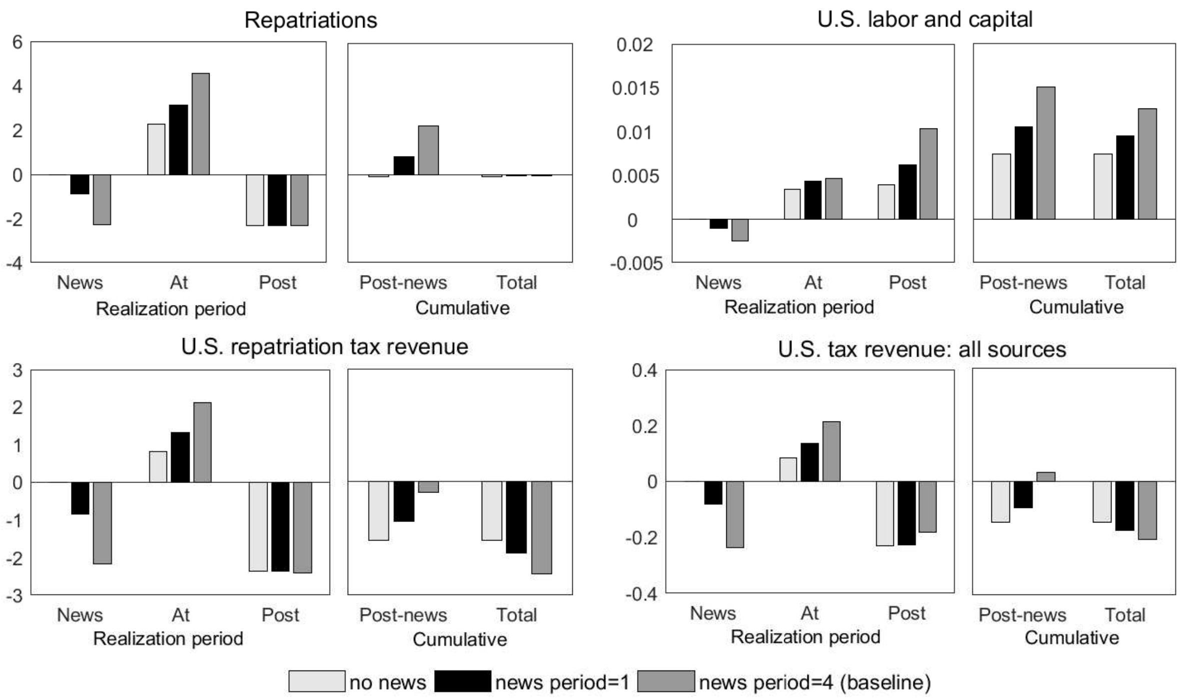

Figure 6: *Cumulative Responses to a Tax Holiday*

Notes: The cumulative effects are shown news periods for when there is no news period and when the news period is 1 and 4 quarters long. The figures subdivide the cumulative responses in the three realization periods: News period, At-realization, and Post-realization. This also shows the Post-news cumulative (sum of At- and Post-realization periods) and the total response (sum of all subperiods). Units are quarterly gain/losses to that variable relative to the steady state at the time of the news.

larger cumulative gain in the U.S. capital and labor, but at the same time also leads to a larger revenue loss by the government. Thus, there is a tradeoff between the length of advanced notice and policy outcomes: a longer news period leads to higher cumulative gains to employment but at the expense of larger tax revenue losses – although it should be noted that the gains for labor and capital are quantitatively small while the losses in U.S. tax revenue are relatively large. Put differently, if news periods are not taken into account when analyzing the behavior of firms taking advantage of the tax holiday, policymakers may overestimate the stimulative effects of the policy and underestimate the costs in terms of tax revenue losses by multinational firms.

4.5 Access to External Credit Markets

In this section we show that the magnitude of the response in a firm's production activities, given by firm-level capital and labor, is highly dependent on the level of access they have to external credit.

Figure 7 shows the cumulative impacts of a one-period tax holiday under various values of the parameter governing the ease with which firms can access to credit markets, ψ. Each figure subdivides the responses into the news, at-realization, and the post-realization periods. The cumulative response is the sum of the three sub-periods. Again, the units are in quarterly gains/losses of that variable relative to the steady state. As in the baseline, the temporary tax holiday reduces τ from 0.131 to 0.0642.

When the firm cannot access credit markets or the cost of borrowing is high, it relies heavily on internal funds and thus the marginal value of an additional dollar in tax saving from the upcoming tax holiday is high. Consequently, during the news period a credit constrained firm aggressively cuts back transfers in order to take the maximum benefits of the tax holiday. The curtailing of transfers, in combination with the lack of access to cheap credit, causes U.S. labor and capital to fall much more during the news period than in the baseline case. On the other hand, a firm that has access to less costly borrowing also reduces transfers in order to take advantage of the tax holiday. However, because they can borrow to offset this fall in transfers, there is little net effect on U.S. labor and capital for these firms during the news period. In comparison, there are large fluctuations in labor and capital for a credit-constrained firm at and after the tax holiday. These results are easy to understand within the intuition provided by the policy functions shown in Section 3.2.2. In the presence of low costs to external credit, firms are able to use debt to keep production close to its optimal scale when internally held domestic assets (A_{US}) fall due to the withholding of transfers in the news period. Likewise, the scale of production is largely unchanged once the policy change is implemented and foreign assets flow into the U.S. (A_{US} increases).

The labor and capital responses from our baseline model follow the empirical literature of

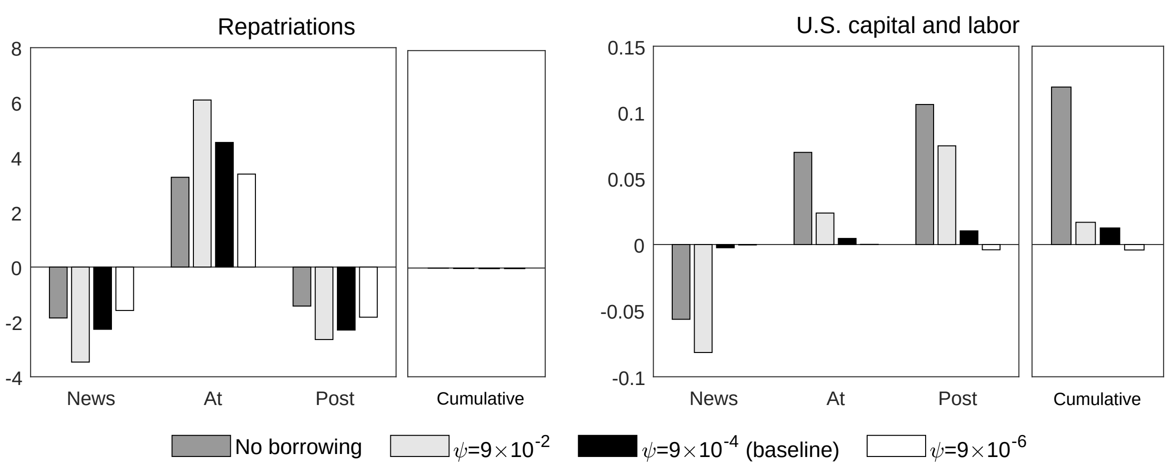

Figure 7: *Cumulative Responses for Variations in Debt-Elastic Interest Rate Parameter, ψ*

Notes: In the left panel a tax holiday is announced 4 periods in advance and in the right panel it is immediately and unexpectedly implemented. The figures subdivide the cumulative responses in the three realization periods: News period, At-realization, and Post-realization. The cumulative response is the sum of all subperiods. Units are quarterly gain/losses to that variable relative to the initial steady state.

the AJCA. The majority of the firms receiving tax benefits from the act were not financially constrained and therefore did not alter the scale of their U.S. operations (Dharmapala, Foley, and Forbes, 2011; Faulkender and Petersen, 2012). Our baseline results reinforce these findings. However, Faulkender and Petersen find that a subset of firms that were financially constrained at the time of the AJCA did increase investment (but not employment) because of the act. When analyzing the periods at and after the tax holiday, our model likewise predicts that financially constrained firms increase capital use after the holiday to a larger degree than financially unconstrained firms.

In general, our analysis shows why the ability of a firm to borrow can be very important when understanding the effects of future policy changes. For instance, Stokey (2016) shows that tax uncertainty can generate an investment boom after the resolution of the uncertainty. In her model, firms cannot borrow but can accumulate liquid assets. In the main exercise, a tax reform on revenue is announced that will be implemented at a known future date, but the size of the tax rate change is uncertain. At the announcement of this future change, firms reduce investment in new projects and accumulate liquid assets as a "wait and see" policy until the uncertainty is resolved. When the tax reform is implemented, firms develop the tabled projects and an upsurge in investment follows. Even though the exact characterization of the tax reform and economy in Stokey (2016) differs from our model, we can generate similar investment dynamics. In our model, however, a reduction in domestic capital usage in the news period and an upswing at the implementation of the tax holiday crucially depends on restricting a firm's access to credit markets. When firms can freely access external credit, the domestic operations are already operating close to their optimal scale and a repatriation tax rate reduction, or news surrounding such tax changes, has a negligible impact on domestic production.

4.6 Policy Uncertainty

In the baseline simulations, firm know with certainty that a repatriation tax holiday is going to occur at a known future date. However, in reality the legislative process is rife with uncertainty – firms are regularly uncertain about both if and when a policy being discussed will be passed. In this section, we investigate the impacts of a tax holiday when there is uncertainty in these dimensions.

4.6.1 When a Tax Holiday will Happen

Following the AJCA, firms steadily increased foreign asset holdings that were untaxed by the U.S. government (Brennan, 2010). The AJCA was penned as a one-time event, but its

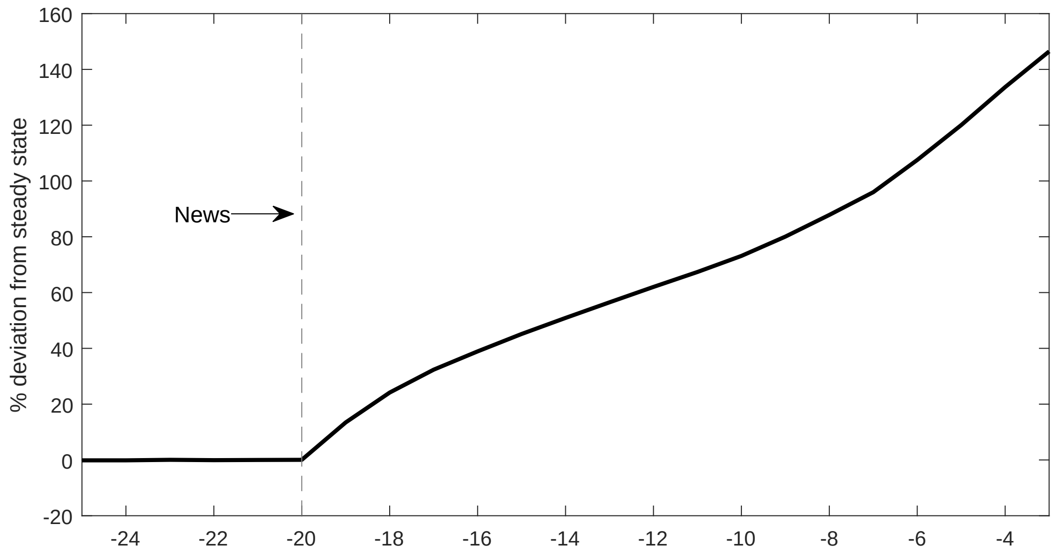

Figure 8: *Response to Foreign Financial Assets to a Temporary Reduction in the Repatriation Tax Rate When the Date of Implementation is Uncertain*

Notes: The firm receives news that a tax holiday will occur in the next 20 quarters but are unsure of the arrival date. The tax holiday is arbitrarily chosen to occur after 18 periods. The expectations in the timing of the tax holiday are uniform across all remaining periods if the tax holiday has not yet occurred. The figure shows up to two periods before the tax holiday occurs to highlight the accumulation of foreign financial assets prior to the holiday.

use as a stimulus measure may have altered expectations of the ability of policymakers to enact a future repatriation tax holiday (Clausing, 2005; De Simone, Piotroski, and Tomy, 2017). Some have hypothesized that the accumulation of foreign assets after the AJCA was due to expectations of another tax reduction at some point in the future (Levin and Coburn, 2011; Brennan, 2010). In our model, we find if the firm believes a tax holiday will occur but is uncertain about *when* it will occur, they steadily accumulate assets abroad.

Suppose the model firm receives news that a repatriation tax rate reduction will happen at an unknown date between the time of the news and a given time J in the future. Further, in each time period the firm assigns an equal probability that the tax change will occur in each remaining period through period J.[31] We set $J = 20$ and in Figure 8 plot the foreign financial asset holdings during the news period. The size of the tax rate reduction is the same as in the baseline. In these simulations, we arbitrarily let the implementation of the tax reform to occur 18 quarters after receiving the news ($t = -2$). We do not show the periods at and after the tax reductions to highlight the run up of foreign assets in the news periods.

At the time of the news, the firm begins gradually accumulating foreign financial assets.

[31] See the Online Appendix for a transition graph outlying this experiment.

After 17 quarters, these asset holdings are nearly 150 percent higher than their steady state level. Since the timing of the policy change is unknown, the firm accrues these assets to take advantage of tax gains that will occur once the tax holiday is implemented in the future.

Our model suggests that there may be merit to the conjecture that firms began accumulating assets abroad in anticipation of a future repatriation tax reduction after the AJCA. This relates to De Simone, Piotroski, and Tomy (2017) who find that many multinational firms accumulated foreign liquid assets in anticipation of a proposed, but failed, 2008 tax holiday. Arguing that the AJCA changed expectations of the likelihood of similar policy change, proposed legislation in 2008 for another tax holiday that never materialized may have been a catalyst for many multinationals to accumulate assets abroad. In this regard, our model suggests that at least part of the asset buildup abroad following the AJCA may not be from a high steady state repatriation tax rate, but may be the direct result of discussions and anticipation of a future repatriation tax rate reduction.

4.6.2 If a Tax Holiday May Happen

Next, let us consider the case where the firm is unsure *if* a tax holiday will occur. In this example, the firm receives news that in 4 quarters a one-period repatriation tax reduction might occur. After 4 quarters of receiving the news, two outcomes are possible: the news materializes whereby the repatriation tax rate is reduced as in the baseline, or the news does not materialize and the firm realizes a tax holiday will not occur. In the following simulations, the firm assigns a 50/50 likelihood of either outcome occurring.

Figure 9 shows the cumulative responses in each sub-period – the news period, at-realization, and post-realization – and the sum of all periods. The cases of uncertainty of *if* the tax holiday will occur (and if it does or not happen) are compared against the baseline where the tax holiday occurs with certainty. If the news materializes, the firm repatriates additional funds by transferring assets that would otherwise be repatriated in future periods to the time of the tax holiday. In contrast, when the tax holiday does not occur the firm has no such motive. Instead, they simply repatriate the funds they accumulated in the news period. Overall, if the firm anticipates the possibility of a future tax holiday and it does not occur, the cumulative effects are negligible. However, the mere prospect of a repatriation tax holiday disrupts the timing of repatriation decisions.

4.7 Quantifying News and Uncertainty Effects: the Shadow Tax

The prospect of a future repatriation tax reduction allows firms to take advantage of the tax holiday by holding assets abroad and reducing repatriations. Thus, news of a possible

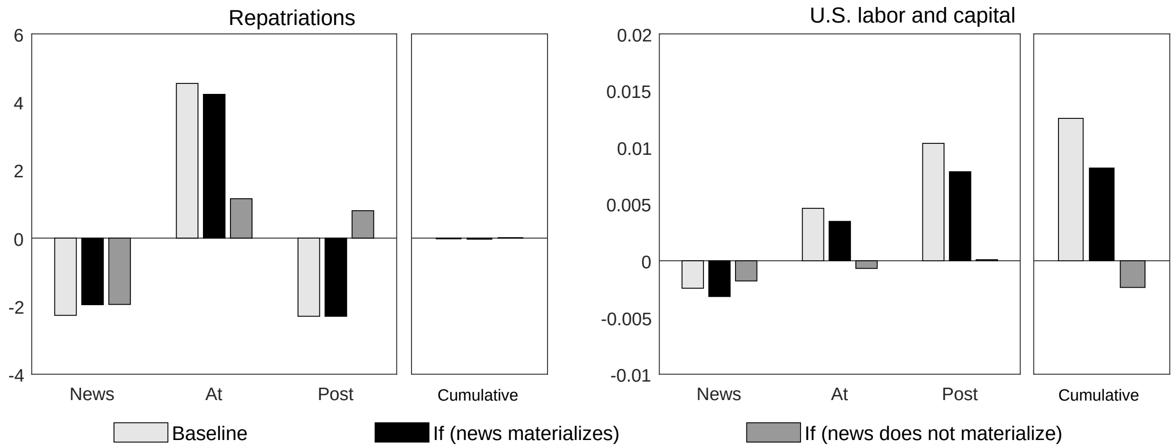

Figure 9: *Cumulative Responses When There is a 50 Percent Probability of the Tax Holiday Occurring in 4 Quarters in Advance of the News*

Notes: The figure shows the cases when the tax holiday does materialize and when it does not materialize along with the baseline when the tax holiday occurs with certainty. The figures subdivide the cumulative responses in the three realization periods: News period, At-realization, and Post-realization. The cumulative response is the sum of all sub-periods. Units are quarterly gain/losses to that variable relative to the initial steady state.

repatriation tax reduction actually generates an implicit tax – or shadow tax – on repatriating funds during the news period. In our model, we can measure this shadow tax as the subsidy rate the government will have to pay the firm in the period of receiving the news to encourage them to not hold back repatriations in this period, and keep them at the original steady state level. That is, how much would the U.S. government have to subsidize transfers by to induce the firm to keep their level of transfers unchanged in response to news of a tax holiday?

We calculate the shadow tax under various scenarios and show that this implicit tax depends on both the length of the news period and the degree of certainty of *if* and/or *when* a tax holiday will occur. In panel A of Table 3, the firm receives news of a one-time repatriation tax holiday that *may* occur in exactly J quarters from the news. We consider two cases: one in which there is a 50 percent probability the tax holiday will happen and the other where the tax holiday will happen with certainty. If the tax holiday is implemented, the repatriation tax rate reduction is the same as the baseline.

Our shadow tax measure quantifies the degree to which news of a repatriation tax reduction induces firms to accumulate foreign assets. It is growing in the likelihood of the passage of a tax holiday and shrinking in the time until the realization of the news. The motive to increase foreign asset holdings by reducing transfers at the time of the news is higher when the passage of the tax holiday is likely and when firms have less time to amass these assets in preparation for the possible tax holiday.

Table 3: Shadow Tax

Panel A: Certainty when news materializes

News materializes in J quarters	$P(if\ tax\ holiday)$ 0.5	1
$J = 1$	2.67	5.49
$J = 2$	2.08	4.58
$J = 3$	1.47	3.61
$J = 4$	0.90	1.95

Panel B: Uncertainty when news materializes

News materializes within J quarters	$P(if\ tax\ holiday)$ 0.5	1
$J = 1$	2.67	5.49
$J = 2$	2.73	4.68
$J = 3$	2.67	4.51
$J = 4$	2.24	3.72

Notes: Units are in percent. The shadow tax is the subsidized rate on a firm's repatriations at the time they receive news of a potential tax holiday that would keep transfers constant at their original steady state level in that period. In panel A the firm knows with certainty that a tax holiday will occur with a probability of 0.5 and 1 in exactly J periods. In panel B, the firm knows that a tax holiday will occur with a probability of 0.5 and 1 at some period within J periods.

Turning next to panel B of Table 3, the firm receives news of a one-time repatriation tax holiday that may occur with an unknown arrival date between the time of the news and J quarters from the news. At each time period, the firm assigns an equal probability that the tax change will occur in each of the remaining periods. We consider two cases, one where there is a 50/50 chance the tax holiday will occur and one where the tax holiday will occur with certainty. When $J = 1$, the exercises in panels A and B are identical. Comparing pairwise with panel A for $J > 1$, the shadow tax with uncertainty in when the news will materialize is always larger. When there is certainty that the arrival date is more than one quarter out, the firm can wait to accumulate foreign assets right before the tax holiday. On the other hand, when the firm is uncertain when the news will materialize, the motive of the firm to accumulate foreign assets at the time of the news is larger as they prepare for the chance the tax holiday may occur at any time.

In summary, news of a potential tax change is akin to levying an additional tax on repatriated earnings in the periods leading up to the possible policy change. Our model shows that, conditional on the probability that a repatriation tax holiday will occur, uncertainty in the timing of when the tax holiday may be implemented increases the shadow tax on repatriated foreign earnings. More generally, if discussions or proposals in congress alter the probability distribution of the tax environment, then the news itself may act as an implicit tax, with uncertainty about when the actual policy change will occur increasing this implicit tax.

5 Conclusion

This paper presents a model of a multinational firm to understand how changes in repatriation tax policy impact firm-level behavior. We discipline our framework with both aggregate and firm-level data and use the American Jobs Creation Act of 2004 to test its external validity. Our analysis serves to highlight the importance of understanding the dynamics around, and timeliness in, resolving repatriation tax policy.

We find that a policy evaluation that does not account for firm-level behavior before the policy change overestimates the benefits of reducing repatriation tax rates – by overstating both the gains to domestic production activity and the amount of assets transferred from abroad – and underestimates its costs by understating tax revenue losses. Additionally, the length of the news period and policy uncertainty of *when* and *if* a tax change will occur all have significant effects on the impact of a policy change. Furthermore, we show that a firm's access to external financing plays an important role in determining the impact of repatriation tax changes on domestic activity. Firms that have low costs of accessing external credit markets can operate at their efficient scale independent of access to foreign funds, and are thus not materially affected by changes in the repatriation tax rate. In other words, the less credit constrained the firm is, the more muted the responses of real variables are to both expected and realized changes in repatriation taxes.

In the time leading up to and after the AJCA, lawmakers actively discussed policies to lower repatriation tax rates. A widely stated aim of these reforms was to encourage U.S. based firms to repatriate foreign asset holdings. News of a potential reduction in repatriation tax rates, which may arise from policy discussions, generates a wedge that distorts the intertemporal cost of repatriating foreign assets. This wedge, or "shadow tax," on repatriating foreign earnings discourages firms to transfer income back to the US, thereby leading to an accumulation of assets abroad. The shadow tax is further magnified with uncertainty regarding the timing of the policy's resolution.

Even though lawmakers' goals of lowering the repatriation tax rate was to encourage the transfer of assets from abroad, expectations and uncertainty generated by their discussions can have the opposite effect by decreasing the incentives for firms to repatriate earnings until the resolution of the policy discussion. Although unexplored in this paper, it may be that revenue losses during this period are sufficiently large such that lawmakers have the incentive to implement a tax reduction. In other words, public discussions that indicate the intention of changing repatriation tax policy could be self-fulfilling.

Appendix: Solution Method

In this section we outline the solution method. We proceed in three steps:

Step 1: Value Function

To solve the firm's problem, we begin by using value function iteration to numerically construct the value function given by (19). Our value function is defined on a 6-dimensional discrete grid that represents the state space, $(A_{US}, A_F, \tau, \epsilon_R, z_{US}, z_F)$. To interpolate values of the value function along the $A_{US} \times A_F$ dimensions we use a combination of shape-preserving Schumacher quadratic splines and linear splines on a 61×121 point discrete grid.[32] For the shocks ϵ_R, z_{US}, and z_F we define a 7×9×9 grid and only consider values on the grid. We set ϵ_R to be a discrete uniform random variable, while the discrete versions of the AR(1) processes for z_{US} and z_F are calculated using Tauchen (1986)'s method. Finally, the grid points for τ depend on the structure of the policy being evaluated. For example, for our baseline model where the news occurs after $N = 4$ periods, τ is defined on $N = 6$ grid points, corresponding to the 6 states of the economy – the pre- and post-policy steady-state state, a state each for the 4 news periods, and a state for the period is which the policy is implemented. In total, for our baseline model our value function is numerically represented by approximately 25 million grid points.

The value function iteration requires a maximization step. After substitution, the four dimensional maximization step, $\{A'_{US}, A'_F, T, d\}$, can be reduced to a maximization step in just two dimensions, $\{A'_{US}, T\}$. We numerically maximize over these two variables using two-dimensional Golden-section search.

Finally, to construct the value function we must also find Π_{US} and Π_F. Whereas a closed form solution exists for Π_F, no closed form solution exists for Π_{US}. The closed-form solution to Π_F is as follows:

$$\Pi_F = \begin{cases} \xi_{1,F} A_F^{\alpha+\eta} + \tau_F A_F & \text{if } A_F < A_F^* \\ \\ \xi_{2,F} + \left[1 + (1-\tau_F) r\right] (A_F - A_F^*) & \text{if } A_F \geq A_F^* \end{cases}$$

[32] See Judd (1998).

where

$$
\begin{aligned}
\xi_{1,F} &= (1-\tau_F)\, e^{z_F} \left(\frac{\eta}{w}\right)^{\eta} \left(\frac{\alpha}{r^k}\right)^{\alpha} \left(\frac{1}{\alpha+\eta}\right)^{\alpha+\eta} \\
\xi_{2,F} &= \{(1-\tau_F)\,(1-\alpha-\eta)\,(1+r) + [1+(1-\tau_F)r]\,(\alpha+\eta)\} \left[\frac{e^{z_F}}{1+r}\left(\frac{\eta}{w}\right)^{\eta}\left(\frac{\alpha}{r^k}\right)^{\alpha}\right]^{\frac{1}{1-\alpha-\eta}} \\
A_F^* &= (\alpha+\eta)\left[\frac{e^{z_F}}{1+r}\left(\frac{\eta}{w}\right)^{\eta}\left(\frac{\alpha}{r^k}\right)^{\alpha}\right]^{\frac{1}{1-\alpha-\eta}}.
\end{aligned}
$$

Here A_F^* gives the level of assets where if all the firm's assets were allocated to production then the returns on them would equal the interest rate offered by financial asset holdings. Due to diminishing returns, assets in excess of A_F^* allocated to production will earn a return lower than that offered on financial assets, thus when $A_F \geq A_F^*$ the firm allocates $(A_F - A_F^*)$ to financial holdings and A_F^* to production.

For Π_{US}, as no closed form solution exists, we construct numerical solutions for the grid points in the A_{US}, A_F, and z_{US} dimensions. This solution is constructed as follows:

$$
\Pi_{US} = \begin{cases} \tilde{\Pi}_{US} & \text{if } A_{US} < A_{US}^* \\ \xi_{2,US} + [1+(1-\tau_{US})\bar{r}]\,(A_{US} - A_{US}^*) & \text{if } A_{US} \geq A_{US}^* \end{cases}
$$

where

$$
\begin{aligned}
\xi_{2,US} &= \{(1-\tau_{US})\,(1-\alpha-\eta)\,(1+r) + [1+(1-\tau_{US})r]\,(\alpha+\eta)\} \left[\frac{e^{z_{US}}}{1+r}\left(\frac{\eta}{w}\right)^{\eta}\left(\frac{\alpha}{r^k}\right)^{\alpha}\right]^{\frac{1}{1-\alpha-\eta}} \\
A_{US}^* &= (\alpha+\eta)\left[\frac{e^{z_{US}}}{1+r}\left(\frac{\eta}{w}\right)^{\eta}\left(\frac{\alpha}{r^k}\right)^{\alpha}\right]^{\frac{1}{1-\alpha-\eta}}. \qquad (20)
\end{aligned}
$$

As before, A_{US}^* gives the level of assets where if all the firm's assets were allocated to production the returns on them would equal the interest rate offered on financial asset holdings. Due to diminishing returns, assets in excess of A_{US}^* allocated to production will earn a return lower than that offered on financial assets, thus when $A_{US} \geq A_{US}^*$ the firm allocates $(A_{US} - A_{US}^*)$ to financial holdings and A_{US}^* to production.

Next, to find $\tilde{\Pi}_{US}$ we simplify and write Π_{US} in terms of a maximization problem in L_{US} and K_{US} only.

$$
\tilde{\Pi}_{US} = \max_{L_{US},K_{US}} \left\{(1-\tau_{US})e^{z_{US}}K_{US}^{\alpha}L_{US}^{\eta} + (1+r^B)(A_{US} - wL_{US} - r^K K_{US}) + \tau_{US}A_{US}\right\}
$$

where,[33]

$$r^B = r + \psi \left[\exp\left(\frac{|A_{US} - wL_{US} - r^K K_{US}|}{A_{US} + \tilde{A}_F} \right) - 1 \right].$$

We can solve this maximization problem by first substituting in $K_{US} = (\frac{w}{\eta})(\frac{\alpha}{r^K})L_{US}$, which we get from the first-order conditions, and then use golden-section search to numerically find the optimal L_{US} and thus $\tilde{\Pi}_{US}$ itself.

Step 2: Policy Functions

We use the value function found in the previous step to find the policy functions:

$$\begin{aligned} A'_{US} &= g_{US}(A_{US}, A_F, \tau, \epsilon_R, z_{US}, z_F) \\ A'_F &= g_F(A_{US}, A_F, \tau, \epsilon_R, z_{US}, z_F). \end{aligned}$$

Finding the policy functions, similar to the value function iteration, requires a maximization step. As before, we reduce the four dimensional maximization step $\{A'_{US}, A'_F, T, d\}$ to a maximization step in just two dimensions, $\{A'_{US}, T\}$ and use two-dimensional Golden-section search.

Our policy functions is defined on a 6-dimensional discrete grid that represents the state space, $(A_{US}, A_F, \tau, \epsilon_R, z_{US}, z_F)$. At 501×501, this grid is finer than the value function in the A_{US} and A_F dimensions. We do not interpolate between these points and impose the condition that A'_{US} and A'_F must also lie on the grid. Thus, for our baseline model our policy functions are numerically represented by approximately 850 million grid points that map onto a roughly 250 thousand grid point values for (A'_{US}, A'_F).

Step 3: Simulations

Finally, we use the policy functions constructed in Step 2 to simulate the economy. To construct the response of the economy to various policies we simulate our environment for 700 periods with the tax news arriving in period 600. We repeat this 700 period simulation 200,000 times keeping the tax news the same but allowing the idiosyncratic shocks ϵ_R, z_{US}, and z_F to vary. We then average across these 200,000 simulations. We include 600 period before the tax news to allow the economy to settle into its stochastic steady state.

[33] We know this because in this case $A_{US} < A^*_{US}$, which means the returns to assets allocated to production are higher than r leading the firm to borrow (i.e. $A^B_{US} < 0$).

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