Worldwide taxes, agency conflicts, and investment*

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ABSTRACT

How does moving to the territorial tax system enacted in the Tax Cut and Jobs Act of 2017 affect a US multinational's decision to invest overseas? We build a dynamic, quantitative model, calibrated to confidential data on the foreign operations of US multinationals, that incorporates key features of the tax code and agency conflicts between managers and shareholders. We show that the worldwide tax system with deferral depressed the opportunity cost of capital on foreign investment for firms with unrepatriated earnings. Despite facing a lower tax rate on foreign earnings, moving to a territorial tax system reduces the optimal level of foreign capital by 15% for the average US multinational. The reduction is half as large for services-intensive firms, which benefit 30% more from the reform than goods-intensive firms.

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1. Introduction

The foreign operations of U.S. multinationals are an increasingly large and important segment of economic activity. Figure 1 shows that the sales at foreign subsidiaries of U.S. multinationals have steadily increased over the last twenty years, reaching roughly $7 trillion by 2015. While a number of factors contribute to the growth in foreign operations of US firms, an important debate has focused on the role of tax policy in shaping this foreign activity. In this paper we build a structural model, calibrated to confidential BEA data, to understand how the recently passed Tax Cuts and Jobs Act (TCJA), the most comprehensive US tax reform in over three decades, affects the incentives of US firms to invest and operate overseas.

Until the passage of the TCJA in December 2017, the US had a worldwide tax system, meaning firms were subject to U.S. tax on foreign income, net of a credit for taxes paid to the foreign government. The U.S. parent generally had the option to indefinitely defer the tax on the foreign subsidiary's earnings by holding financial assets or reinvesting in capital abroad. Additionally, the pre-reform US statutory corporate tax rate of 35% was significantly higher than that of most other countries where US multinationals operate. The widening disparity in U.S. and foreign corporate tax rates, combined with the worldwide tax system allowing for deferral, has been viewed as responsible for driving the run-up of foreign cash balances (Foley, Hartzell, Titman, and Twite (2007)) and distorting US foreign investment (Hanlon, Lester, and Verdi (2015)).

In this paper we analyze the effect of the recent tax reform on the optimal foreign investment decisions of US multinationals. We start by developing a stylized model to illustrate the channels through which the prior worldwide tax system with deferral affected a multinational's choice of foreign investment and cash holdings. Here we show that the worldwide tax system presented a distinct set of tradeoffs with regard to cash holding and capital investment compared to what firms encounter in their domestic operations or under a territorial tax system. In particular, the worldwide tax system combined with the deferral option creates an unusual situation where optimal investment and the U.S. tax rate are positively related.

Paradoxically, firms facing a higher tax rate choose to invest *more* than they would under the territorial system in which they face lower tax rates. The worldwide system essentially lowers the relative cost of investing in physical capital because the alternatives—holding unrepatriated cash or repatriating funds to the US parent—are both increasingly costly in the US tax rate.

We then construct a quantitative dynamic model of the foreign operations of a US multinational to evaluate the effects of the tax reform on foreign investment and cash holdings. This full model incorporates key features of the US corporate tax code as well as agency conflicts between managers and shareholders. The manager, who makes investment and repatriation decisions, has private incentives that come through three distinct channels shown to be significant in Nikolov and Whited (2014): managers share in firm profits, own equity in the firm, and have the ability to divert resources for private consumption. The model features a worldwide tax system with deferral and a 35% statutory US rate, consistent with the tax code facing US firms prior to 2018. Tax reform occurs with random arrival in the model, at which point the tax code switches to a territorial system with a 21% US tax rate, consistent with major changes of the recent TCJA. By including tax reform as a random arrival in the model, we are able to examine how expectations of reform affect firm policies (De Simone et al. (2017)) and measure the causal effect of the policy (Lucas Jr (1976); Hennessy and Strebulaev (2015)). Using confidential subsidiary-level data from the Bureau of Economic Analysis (BEA) on the foreign operations of US multinationals, we calibrate the model and quantify the response of investment to the tax reform.

We find that the change from a worldwide to territorial tax system reduces the optimal foreign investment of US multinationals. As illustrated in the simple model, the worldwide tax system effectively depressed the opportunity cost of foreign capital investment for firms with unrepatriated earnings. This incentivized US multinationals with unrepatriated earnings to invest relatively more overseas than they would in a territorial regime without this tax liability. We find that the adoption of a territorial tax system and a lower US rate reduce the tax liability of a multinational's foreign operations, but also lead to a 15% reduction in

the average firm's foreign capital stock. This large reduction in foreign capital stock of US multinationals is in contrast to some predictions that the tax reform would encourage more foreign investment. The reduced taxes on foreign income leads to an increase in value of 3% for the average foreign subsidiary in our sample.

We then investigate how the reform differentially affects US multinationals. Much of the discussion in the recent literature and policy debate over international taxation has highlighted ways in which firms with transferable, intangible capital are able to implement various schemes to reduce their tax liability. To explore this, we divide the multinationals in our sample into goods and services producers, with the idea that the latter have a higher utilization of intangible capital. We compute moments and separately recalibrate the model for goods and services firms. Consistent with the argument of greater locational flexibility and more aggressive usage of tax-reducing strategies, we find that services firms face much lower average foreign and US taxes on their income compared to goods producers. Using the calibrated model, we find that the reduction in foreign capital is twice as large for goods firms relative to services firms. Additionally, the model suggests that the benefit of the tax reform is approximately 30% larger for services firms than goods firms.

The full calibrated model also allows us to evaluate how agency conflicts between managers and shareholders interact with the tax code to shape a multinational's investment policy. Under the worldwide tax system with deferral, shareholders would like a manager to avoid incurring US corporate tax by repatriating earnings. However, this deferral policy results in the foreign subsidiary accumulating a large cash balance, raising concerns that management may misappropriate these funds. In the model, we find that the worldwide tax system imposed an agency cost on shareholders by incentivizing retention of excess cash. The territorial reduces this agency cost imposed on shareholders by reducing the cost of paying out cash. We find that agency conflicts do not have a large effect on the level of capital stock for the average subsidiary in our sample. Under the baseline calibration, transition to a territorial tax system leads to a 15% reduction in the foreign capital stock. For the case of no agency conflicts, where manager and shareholder are perfectly aligned, this reduction

is 17.4%.

The results contribute to several strands of the existing literature. First, our results inform the literature on corporate cash. Faulkender, Hankins, and Petersen (2017) present evidence that a substantial portion of the cash that has recently accumulated on firms' balance sheets is held abroad and driven by tax incentives. Graham and Leary (2017) similarly cite the role of repatriation incentives in the recent run up in corporate cash balances. In the context of cross-border mergers and acquisitions, Bird, Edwards, and Shevlin (2015) find U.S. target firms' foreign cash balances are positively related to the likelihood of the acquirer being foreign. Duchin, Gilbert, Harford, and Hrdlicka (2017) show that a sizable portion of the financial assets firms hold on their balance sheets are not cash. Under certain conditions, when these non-cash financial assets are held abroad, they generate substantial income streams that are tax disadvantaged, constituting an important penalty inherent in the U.S. worldwide tax system which we address. More closely related methodologically is Gu (2017), who uses a dynamic model to show that the differential in cash holdings at multinational relative to domestic firms would diminish by 42% if repatriation taxes were eliminated. Our study builds on this work by exploring the impact of this cash on firm investment policy, particularly in its relation to agency problems.[1]

We also contribute to the corporate cash literature by exploring how the worldwide tax system distorts the cash holdings decision of firms. In Riddick and Whited (2009), firms hold cash due to a precautionary savings motive: firms trade off the reduction in the expected present value of external financing costs against the tax costs of holding cash. In our model, foreign subsidiaries do not face costly external financing but instead retain cash to avoid repatriation costs. These repatriation costs result in a distortion in their investment decisions. Nikolov and Whited (2014) builds upon Riddick and Whited (2009) to include three channels for agency conflicts to affect the firm's cash holdings decision. Our model employs the same agency conflicts as in Nikolov and Whited (2014). In our model, however, the trade off faced by managers is different because the tax costs of repatriation

[1]Bakke and Gu (2017) also study cash with a dynamic model, although they do not consider the geographic aspect of firms' cash holdings.

are sufficiently high that the subsidiary avoids paying a dividend. Because it is optimal for both managers and shareholders to accumulate cash indefinitely, managers have a greater ability to divert resources.

Our results also relate to the literature on the role of tax policy in the location of investment. Hines and Rice (1994) and Devereux and Griffith (1998) show that corporate taxes are a key determinant in where U.S. multinational firms locate their foreign subsidiaries. Desai, Foley, and Hines (2004) highlight the importance of indirect taxes in multinational firms' investment decisions. Hines (1996) finds that foreign direct investment in the U.S. is sensitive to state corporate tax rates.[2] Our findings extend this literature in that we explore the interaction between tax incentives and financing and agency frictions in firms' decisions to invest abroad.

Finally, our findings relate to the work on the tax holiday provided for under the American Jobs Creation Act (AJCA) of 2004. The AJCA allowed firms to repatriate foreign earnings at a reduced 5.25% tax rate provided the funds were invested in the U.S. Dharmapala, Foley, and Forbes (2011) find that while firms indeed repatriated a substantial amount of foreign earnings, on average there was no significant impact on corporate investment. Instead, funds earmarked for investment were paid out to shareholders and were replaced by the repatriated foreign earnings. Faulkender and Petersen (2012) also analyzes the investment impact of the AJCA. They also find no change in investment on average. When considering a subset of financially constrained firms, however, they do find evidence that funds repatriated under the AJCA facilitated domestic investment. Our work is complementary in that we also consider the impact of a policy change permitting the repatriation of foreign earnings at a reduced tax rate but instead focus on investment by U.S. multinationals outside the U.S.

2. Illustrative model

In order to understand the qualitative effects of the tax code on investment, cash holdings, and repatriation decisions, this section presents a simplified model of the foreign subsidiary

[2]The empirical literature is large. Devereux and Maffini (2007) provide a survey.

with a single investment and cash holdings decision. This static model allows for analytic solutions and comparative statics for optimal firm policies. In Section 3 we present the full dynamic model, augmented to allow for a manager's private incentives to differ from that of shareholders, for quantitative evaluation.

2.1. Setup

We assume that at time 0 the foreign subsidiary has unrepatriated earnings of E_0; it is equivalent whether these earnings were earned in the current period or a previous period where the repatriation was deferred. The firm can immediately repatriate these funds by paying a dividend from the subsidiary to the parent or it can defer repatriation by holding cash and/or investing in foreign productive assets. To simplify the exposition of the main effects, we assume that the current stock of unrepatriated earnings, E_0, is sufficiently large to cover the investment choice of the subsidiary, i.e., the subsidiary does not need financing from the parent.

Foreign profits face immediate foreign taxes at a rate τ_F. Time-0 repatriation is taxed at a rate τ_{US} minus a tax credit for foreign taxes paid. The firm can defer repatriation by investing in foreign capital K and by holding cash C (more generally, financial assets which generate a nominal return). We allow the US parent to be financially constrained in year 0 in that they value time-0 dividends at $(1+\xi) \geq 1$. This is a reduced form way of modeling financial constraints for the parent. Conditional on the firm's chosen investment and cash holdings decisions, the after-tax value of the dividend in the first period is

$$(1+\xi)\frac{1-\tau_{US}}{1-\tau_F}\left[(1-\tau_F)E_0 - K - C\right]. \tag{1}$$

All decisions—investment, cash holding, and repatriation/deferral—are made at time 0. At time T, the cash flow from the firm's production is realized, and all assets of the firm are paid as a dividend to the parent facing a repatriation tax rate of τ_R and the model ends. We assume that there is some likelihood of tax reform that occurs at time T such that $\mathbb{E}[\tau_R] \leq \tau_{US}$. The firm produces at time T, and the firm's after-tax cash flow from

production is the sum of earnings plus a tax credit for depreciation plus the residual value of capital:

$$\Pi(K) = \frac{1-\tau_R}{1-\tau_F}[(1-\tau_F)AK^\alpha + \tau_F\delta K + (1-\delta)K] \tag{2}$$

$$= \frac{1-\tau_R}{1-\tau_F}[(1-\tau_F)(AK^\alpha - \delta K) + K], \tag{3}$$

where $0 < \alpha < 1$ is the returns to scale, and $0 < \delta \leq 1$ is depreciation. Productivity A is assumed to be deterministic for simplicity.

Any cash C held by the firm is held in financial assets that generate a pre-tax one-period return of r. Return on financial assets are considered passive income (subpart F income) and are therefore subject to immediate US taxation at rate τ_{US}. In other words, the tax code prohibits the firm from deferring repatriation of income on financial assets. This generates a tax holding cost of cash that depends on the US tax rate and nominal interest rate. This tax holding cost of cash makes capital investment look relatively more attractive for firms which defer repatriation.

The expected present value of the firm is the sum of any immediate dividend paid to the parent (repatriation), plus the expected value of cash held inside the firm, plus the expected value of cash flow from operations:

$$V = \max_{K\geq 0, C\geq 0} \Bigg\{ \underbrace{(1+\xi)\frac{1-\tau_{US}}{1-\tau_F}\left[(1-\tau_F)E_0 - K - C\right]}_{\text{Immediate repatriation}} + \frac{1}{1+\hat{r}}\Big(\underbrace{(1-\tau_{US})\hat{r}C}_{\text{After-tax interest}} + \underbrace{\frac{1-\mathbb{E}[\tau_R]}{1-\tau_F}C}_{\text{After-tax value of cash principal}} + \underbrace{\frac{1-\mathbb{E}[\tau_R]}{1-\tau_F}[(1-\tau_F)(AK^\alpha - \delta K) + K]}_{\text{Value of repatriated non-cash assets}} \Big) \Bigg\}. \tag{4}$$

where $\hat{r} \equiv (1+r)^T - 1$ represents the T-period discount rate and pre-tax return on financial assets (cash holdings).

2.2. Repatriation decision

At time 0, the subsidiary makes the decision on how much, if any, of their earnings to repatriate. Because both the benefit and costs of deferring repatriation are linear in cash

C, the firm will choose either to immediately repatriate or to defer all earnings not used for capital investment in year 0; the firm's repatriation decision is binary. This also means that the repatriation decision is made independently from the capital investment decision, which we explore in the next section. From Eq. (4), the marginal value of immediate repatriation is

$$(1+\xi)\frac{1-\tau_{US}}{1-\tau_F} \tag{5}$$

while the expected marginal value of deferral is

$$\frac{1}{1+\hat{r}}\left((1-\tau_{US})\hat{r}+\frac{1-\mathbb{E}[\tau_R]}{1-\tau_F}\right). \tag{6}$$

Comparing these values generates two corner cases for repatriation and cash holdings.

Proposition 1. *Case 1 (immediate repatriation): If the condition*

$$(1+\xi)\frac{1-\tau_{US}}{1-\tau_F} \geq \frac{1}{1+\hat{r}}\left((1-\tau_{US})\hat{r}+\frac{1-\mathbb{E}[\tau_R]}{1-\tau_F}\right) \tag{7}$$

is satisfied, the firm immediately repatriates all earnings and holds no cash, i.e. $C=0$.

Case 2 (deferred repatriation): If condition (7) *is not satisfied, the firm defers repatriation holds all earnings not used for capital investment as cash, i.e.* $C=(1-\tau_F)E_0-K$.

Note that this decision depends only on the tax and discount rates and the parent's financing constraint, and not foreign investment opportunities or production parameters. A higher time-0 value of cash at the parent (higher ξ) will increase the region of the parameter space in which the firm repatriates immediately.

2.3. Investment decision

Investment in physical capital has diminishing marginal returns. For firms that optimally choose to immediately repatriate any earnings not used for capital investment (Case 1), the subsidiary makes capital investment decisions by trading off these decreasing returns with the after-tax value of repatriation. For firms which optimally choose to defer repatriation (Case 2), the firm trades off the return to capital investment with the after-tax value of holding cash and repatriating in the future under a possibly lower, post-reform, rate. In what follows, we derive the optimal capital investment choice for each these two cases.

2.3.1. Case 1: immediate repatriation

When condition (7) holds, the firm immediately repatriates any year-0 earnings not used for investment, i.e. $C = 0$. The value of the subsidiary becomes

$$V = \max_{K \geq 0} \left\{ (1+\xi) \frac{1-\tau_{US}}{1-\tau_F} \left[(1-\tau_F)E_0 - K \right] + \frac{1}{1+\hat{r}} \frac{1-\mathbb{E}[\tau_R]}{1-\tau_F} [(1-\tau_F)(AK^\alpha - \delta K) + K] \right\}. \tag{8}$$

The first-order condition with respect to capital K gives an interior optimal level of investment (due to decreasing returns to scale of production):

$$K^{*,\text{repat}} = \left(\alpha A \frac{(1-\tau_F)(1-\mathbb{E}[\tau_R])}{(1+\xi)(1+\hat{r})(1-\tau_{US}) - [1-\delta(1-\tau_F)](1-\mathbb{E}[\tau_R])} \right)^{\frac{1}{1-\alpha}}. \tag{9}$$

2.3.2. Case 2: deferred repatriation

When condition (7) does not hold, the firm defers repatriation and holds as cash all year-0 earnings not used for investment, i.e. $C = (1-\tau_F)E_0 - K$. The value of the subsidiary becomes

$$V = \max_{K \geq 0} \frac{1}{1+\hat{r}} \left\{ \left((1-\tau_{US})\hat{r} + \frac{1-\mathbb{E}[\tau_R]}{1-\tau_F} \right) \left[(1-\tau_F)E_0 - K \right] + \frac{1-\mathbb{E}[\tau_R]}{1-\tau_F} [(1-\tau_F)(AK^\alpha - \delta K) + K] \right\}. \tag{10}$$

The first order condition with respect to capital K gives the optimal level of investment:

$$K^{*,\text{defer}} = \left(\alpha A \frac{(1-\mathbb{E}[\tau_R])}{(1-\tau_{US})\hat{r} + (1-\mathbb{E}[\tau_R])\delta} \right)^{\frac{1}{1-\alpha}}. \tag{11}$$

2.3.3. Optimal investment

For a given set of parameters, the firm either repatriates all earnings immediately (Case 1) or defers repatriation, and holds cash, until tax reform occurs (Case 2). The firm chooses investment of either $K^{*,\text{repat}}$ or $K^{*,\text{defer}}$ corresponding to this optimal repatriation timing decision. Formally, let ϕ be the indicator function that is equal to one when condition (7) is satisfied, i.e. the firm chooses to immediately repatriate, and zero otherwise. Optimal investment is then given by

$$K^* = \phi K^{*,\text{repat}} + (1-\phi) K^{*,\text{defer}}. \tag{12}$$

2.3.4. Special case: investment under the territorial tax system

A special case of the model is when the firm only faces taxes in the foreign country, i.e. the territorial tax system. This case is parameterized by $\tau_F = \tau_{US} = \tau_R$. In this case, the firm always pays earnings in excess of investment as a dividend at time 0, and optimal investment is

$$K^{*,\text{terr}} = \left(\alpha A \frac{1 - \tau_F}{(1+\xi)(1+\hat{r}) + \delta(1-\tau_F) - 1} \right)^{\frac{1}{1-\alpha}}. \tag{13}$$

This is analogous to a standard neoclassical investment model in that the firm faces a single tax rate on earnings and there is no deferral option. We will use this case in the comparative statics to demonstrate the effect of taxes on investment in the "standard," or domestic, setting.

2.4. Comparative statics on investment and repatriation

The analytic expressions for optimal capital investment derived in the previous section allow us to explore the relation between the tax rates and other parameters of interest and investment choice. We report these comparative statics in Table I. Column (1) reports whether the region in which the firm chooses to defer is weakly increasing (+), decreasing (−), or unchanging (0) in the given parameter, under the worldwide tax system. Cases in which the sign of the relation depends on other parameters are denoted by ∼. Similarly, columns (2) and (3) report the sign of the comparative static on the capital choice K for Case 1 (immediate repatriation) and Case 2 (deferred repatriation), respectively. Throughout, we assume that the expected repatriation tax rate in year T is less than the current US rate, which are both greater than the foreign tax rate, specifically, $\tau_F < \mathbb{E}[\tau_R] < \tau_{US}$. While many of the results hold more generally, this is the most relevant case and allows for a simplified discussion. Finally, column (4) reports the sign of the comparative static on the capital choice under the territorial system defined in Section 2.3.4.

2.4.1. Tax rates

The first row of Table I shows that a firm is more likely to defer repatriation when facing a higher US corporate tax rate under the worldwide tax system, as this represents the cost of immediate repatriation. Perhaps surprisingly, foreign capital investment is also increasing in the US tax rate. This positive relation exists whether or not the firm prefers immediate repatriation or deferral. Conditional on the firm optimally choosing to immediately repatriation any earnings not used for capital investment (Case 1), a higher US tax rate means the firm faces a higher cost of repatriating immediately, and the benefit of investing in physical capital looks relatively more attractive as the firm faces an expected lower future repatriation rate ($\mathbb{E}[\tau_R] < \tau_{US}$). In Case 2, when the firm holds as cash all earnings not used for capital investment, the higher US tax rate makes the tax holding cost of cash higher, making capital investment look relatively more attractive. In both cases, a higher US tax rate creates an incentive for the firm to investment more in the foreign subsidiary.[3] For a similar reason, the region of deferred repatriation and investment choice is declining in the expected future repatriation tax rate, $\mathbb{E}[\tau_R]$, shown in the second row. The effect of the foreign tax rate on investment is ambiguous in the worldwide case, shown in the third row. The foreign tax rate isn't as critical as the US rate because firms receive US tax credits for foreign taxes paid.

While the relation between the US tax rate and foreign investment is unambiguously positive, the distinct trade-offs faced by firms under Case 1 and Case 2 make the sensitivity of investment to the US tax rate differ across these two regions. Figure 2 shows the firm's optimal cash holdings and investment choices, as well as the resulting firm value, as a function of the US tax rate. The case without external financing costs for the parent ($\xi = 0$) is shown on the top row. Panel A shows that for low US tax rates, the firm pays all earnings as a dividend to the parent because repatriation costs are low. For high enough US tax rates, the firm prefers to defer repatriation and holds as cash all earnings not used for capital investment. Panel B shows the positive relation between the US tax rate and the quantity of

[3]This postiive relation between the US tax rate and investment holds even when the expected repatriation rate is increasing the US tax rate, as long as $\mathbb{E}[\tau_R] < \tau_{US}$. Specifically, the positive relation holds if $\mathbb{E}[\tau_R] = a\tau_{US}$ for $a < 1$.

investment. The regions of immediate repatriation and deferred repatriation are separated by the vertical dashed line. The shape and slope of positive relation differ in the two regions as the firms in each region face different trade-offs. Finally, Panel C shows that despite investment increasing the US tax rate, the total firm value is, of course, declining.

Panels D–F of Figure 2 show similar relations in the presence of parent external financing costs ($\xi = 5\%$). The main effect of these external financing costs is that the firm prefers repatriation at higher US tax rates because the immediacy of time-0 dividends have value to the parent. One of the key motivations of the territorial tax reform bill of 2017 was to allow firms to bring back unrepatriated foreign earnings ("trapped cash") to promote US investment. However, it is firms that are the least financially constrained (low ξ) that are most likely to defer repatriation and have significant trapped cash. As a consequence, newly repatriated cash will flow to the firms that are the least likely to use it for US investment.

The worldwide tax system combined with the deferral option creates an unusual situation where optimal investment and the tax rate (both the US statutory and expected average effective tax rates) are positively related. Paradoxically, firms facing a higher tax rate choose to invest *more* than they would under the territorial system in which they face lower tax rates. This is because the worldwide system lowers the relative cost of investing in physical capital because the alternatives—either holding unrepatriated cash or repatriating to the US—are both increasingly costly in the US tax rate. In the territorial case defined in 2.3.4, where the firm faces a single tax rate (in this case τ_F) and no deferral option, the relation between the tax rate and investment is negative. This is the standard neoclassical case where higher taxes discourage investment. Figure 6 shows this typical negative relation by plotting the optimal capital investment, $K^{*,\text{terr}}$, and resulting firm value in the territorial system as a function of the foreign tax rate. The sensitivity of investment to the tax rate depends significantly on the depreciation rate δ—seen across Panels A and B for $\delta = 1$ and $\delta = 0.5$, respectively—because the ability to deduct depreciation expense affects the value of investment and the timing of cash flows.

2.4.2. External financing costs, interest rates, and production parameters

The fourth row of Table I shows that the higher is a parent's external financing costs ξ, the more likely they are to immediately repatriate earnings, as the parent benefits more from subsidiary dividends today. For firms that choose to immediately repatriate, a higher ξ also decreases investment, as this increases the opportunity cost of investing. In contrast, for firms that choose to defer repatriation, ξ has no effect on their investment decision.

Because the tax on financial assets are based on nominal, rather than real, returns, higher interest rates increase the tax cost of holding cash. This effect holds even though the discount rate and return on financial assets held inside the firm are the same. Figure 6 shows the expected present value of a dollar of cash held inside the firm as a function of the one-period interest rate r (Panel A) and the number of periods T (Panel B). For low interest rates, the firm is more likely to defer because the tax holding cost of cash is lower. As the interest rate increases, the higher tax holding cost decreases the value of that dollar, and for high enough interest rates the firm prefers to immediately repatriate that dollar. A similar pattern holds for the number of periods T. If the firm expects to hold the cash inside the firm for only a short time, the firm waits and is willing to pay the tax holding cost. As the expected time the cash must be held is high enough, the firm prefers to immediately repatriate that dollar.

The final two rows of Table I show that the production technology—α and A—do not affect the repatriation decision, as this decision is a pure tax trade-off. Of course, capital investment is increasing in both of these parameters as they also increase the returns to the production technology.

3. Full dynamic model

In order to quantify the effects of taxes and agency conflicts on the investment—as well as cash holdings and repatriation decisions—of foreign subsidiaries, we extend the model from the previous section to be fully dynamic and allow for managers to make decisions in response to their private incentives. The model will allow us to predict the change in foreign

investment for US multinationals following the shift to a territorial tax system in 2018.

3.1. Setup

For simplicity, we model the foreign subsidiary of a US multinational as having production opportunities independent from the parent and other subsidiaries. Each period, the foreign subsidiary generates earnings before taxes of

$$E_t = Z_t K_t^{\alpha} - \delta K_t - f\,. \tag{14}$$

where K_t is physical capital, f is the fixed cost of production, δ is the depreciation rate, and $\alpha < 1$ is the returns to scale. The profitability process follows an AR(1) in logs:

$$\log(Z_{t+1}) = \rho \log(Z_t) + \sigma \epsilon_{t+1} \tag{15}$$

where ϵ_t follows a truncated standard normal distribution. The firm accumulates physical capital according to:

$$K_{t+1} = (1-\delta)K_t + I_t \tag{16}$$

where I_t is investment in new capital. The firm faces convex costs of adjustment to physical capital of

$$\Phi(I_t, K_t) \equiv \frac{\phi}{2}\left(\frac{I_t}{K_t}\right)^2 K_t. \tag{17}$$

The foreign government immediately taxes earnings at a rate τ_F, leaving after-tax earnings of

$$(1-\tau_F)E_t. \tag{18}$$

As earnings can be negative, we assume for simplicity that the firm receives the full value of foreign tax losses through the use of carryforwards and carrybacks.

While the US parent generates a US tax liability for the earnings of its foreign subsidiary, firms have the option to defer this tax liability by keeping the earnings at the foreign subsidiary. The subsidiary can use these unrepatriated earnings to further invest in foreign operations or to buy financial assets. We denote by $C_t \geq 0$ the accumulated unrepatriated foreign earnings the firm generated in the periods prior to time t. These assets are held in

liquid financial assets that we will refer to, for convenience, as "cash." The firm may freely invest cash in physical assets, but must pay US corporate income tax at a rate τ_{US}, less any credit for foreign taxes paid, in order for the US parent to access this cash for domestic investment or to pay a dividend to shareholders.

Each period, the unrepatriated cash C_t generates return at a rate r that is immediately taxed at a combined rate of τ_{US}. The return or interest on financial assets is classified as passive income by the IRS, and is not eligible for deferral. The value, after repatriation tax, of the return on financial assets is

$$F_t \equiv (1 - \tau_{US}) r C_t. \tag{19}$$

We allow for potential agency conflicts between management and shareholders by allowing management to make financing and investment decisions that maximize their own utility. These distortions arise from the compensation contract as well as perquisite consumption following the approach of Nikolov and Whited (2014). First, we specify the manager's compensation using standard contracts observed in the data. In particular, the manager holds a fraction θ of equity in the firm, and receives fraction b of per-period profits as a form of cash compensation, i.e. a bonus. We assume that managers and shareholders are risk-neutral, which means that equity holdings help to align the manager with shareholders. Bonus compensation, in contrast, may encourage managers to increase output at the expense of equity value. Finally, we allow the manager to enjoy private consumption of a portion s of current cash flows and cash holdings. This captures the manager's ability to divert firm resources towards utility-enhancing projects or for private use.

Each period, the foreign subsidiary pays the following dividend (a repatriation event) to the US parent:

$$\tilde{d}_t = (1 - b - s)(1 - \tau_F) E_t + \delta K_t + (1 - s)(1 + (1 - \tau_{US}) r) C_t - C_{t+1} - I_t - \Phi(I_t, K_t). \tag{20}$$

When the dividend to the US parent exceeds the after-tax return on financial assets F_t, which is automatically repatriated, a repatriation tax is paid. The dividend to the US parent, after

accounting for repatriation taxes, is given by

$$d_t = \tilde{d}_t - \frac{\tau_{US} - \tau_F}{1 - \tau_F} \max\left\{0,\, \tilde{d}_t - F_t\right\}. \tag{21}$$

The expression $\frac{\tau_{US}-\tau_F}{1-\tau_F}$ represents the cost of repatriating a dollar of foreign earnings, after accounting for foreign tax credits.

We assume that the US parent has current investment opportunities in the US that increase the value of a dividend when the US parent is financially constrained. Specifically, the US parent values the dividend at $(1 + \xi)d_t$, where ξ represents the shadow value of a dollar of cash today given the parent's financial constraints and investment opportunities. For simplicity, we assume that this shadow value of cash is constant. A firm with $\xi = 0$ is either financially unconstrained and/or does not have investment opportunities that are not freely funded by internal cash flows from US operations.

The manager makes investment, cash holdings, and repatriation decisions in order to maximize her own utility. Given her equity holdings θ, bonus compensation b, and ability to divert resources at a rate s, the manager's per-period utility is given by

$$u(Z_t, K_t, C_t, K_{t+1}, C_{t+1}) = \theta(1 + \xi)d_t + (b + s)(1 - \tau_F)E_t + s(1 + (1 - \tau_{US})r)C_t. \tag{22}$$

Note that the manager will choose policies to maximize shareholder value (i.e., the case with no agency conflicts) when $\theta = 1$, $b = 0$, and $s = 0$.

3.2. Tax reform: moving to a territorial system

In 2017, US multinationals held $2.5 trillion in unrepatriated foreign earnings, a significant fraction of the cash holdings of all US firms. One likely explanation for this accumulation was that firms expected that tax reform or a tax holiday would occur at some future date, allowing firms to bring back unrepatriated earnings at a lower rate (De Simone, Piotroski, and Tomy, 2017). As this anticipation effect may have had important consequences for the chosen cash and investment policies of firms, we build the possibility of tax reform into the model. This will also allow us to evaluate how a dynamic tax policy, and expectations about tax changes, interacts with firm decisions.

We assume that each period there is a time-invariant probability λ that the US government permanently changes the tax code such that the unrepatriated cash holdings, C_t, are repatriated at the rate τ_R and future foreign earnings are taxed only by the foreign country in which they are derived (a territorial tax system). In addition, at the time of reform the US government levies a tax at rate $\tau_{R,K}$ on unrepatriated earnings that have been reinvested in capital K.[4] The rates τ_R and $\tau_{R,K}$ correspond to the differential rates on cash (and cash equivalents) and "illiquid assets"—15.5 and 8%, respectively—specified in the 2017 tax bill. At the time of reform and one-time repatriation costs, the firm receives credit for foreign taxes paid. Note that given there are no costs of financing, under the territorial tax system it is no longer shareholder-optimal to hold cash in the foreign subsidiary. However, we allow the manager to maintain cash holdings to allow for potential agency conflicts. In a territorial tax system, the dividends from the foreign subsidiary to the US parent are

$$d^{\text{terr}} = (1-b-s)(1-\tau_F)E_t + \delta K_t + (1-s)(1+(1-\tau_F)r)C_t - C_{t+1} - I_t - \Phi(I_t, K_t) \quad (23)$$

and the manager receives per-period utility of

$$u^{\text{terr}}(Z_t, K_t, C_t, K_{t+1}, C_{t+1}) = \theta(1+\xi)d^{\text{terr}} + (b+s)(1-\tau_F)E_t + s(1+(1-\tau_F)r)C_t \quad (24)$$

with the manager maximizing her expected utility by choosing investment and cash:

$$U^{\text{terr}}(Z_t, K_t, C_t) = \max_{K_{t+1}, C_{t+1}} \left\{ u^{\text{terr}}(Z_t, K_t, C_t, K_{t+1}, C_{t+1}) + \beta \mathbb{E}_t \left[U^{\text{terr}}(Z_{t+1}, K_{t+1}, C_{t+1}) \right] \right\}. \quad (25)$$

Given this manager-chosen investment and cash holdings policies, $K^{*,\text{terr}}(\cdot)$ and $C^{*,\text{terr}}(\cdot)$, the market value of the foreign subsidiary under a territorial tax system is

$$V^{\text{terr}}(Z_t, K_t, C_t) = (1+\xi)d_t^{\text{terr}} + \mathbb{E}_t \left[\beta V^{\text{terr}}(Z_{t+1}, K^{*,\text{terr}}(Z_t, K_t, C_t), C^{*,\text{terr}}(Z_t, K_t, C_t)) \right]. \quad (26)$$

On the arrival of tax reform, all unrepatriated cash holdings and capital are taxed at the rate τ_R and $\tau_{R,K}$, respectively, and paid as a dividend to the US parent. The manager's

[4] In the model, we do not separately account for contributed and reinvested capital and assume that all foreign capital has been purchased with unrepatriated foreign earnings.

expected total utility, prior to the realization of the tax reform shock, is

$$U(Z_t, K_t, C_t) = \lambda \left\{ \theta(1+\xi) \left[\frac{1-\tau_R}{1-\tau_F}(1+(1-\tau_F)r)C_t - (\tau_{R,K} - \tau_F)K_t \right] + U^{\text{terr}}(Z_t, K_t, 0) \right\} + (1-\lambda) \max_{K_{t+1}, C_{t+1}} \{ u_t + \beta \mathbb{E}_t [U(Z_{t+1}, K_{t+1}, C_{t+1})] \}. \quad (27)$$

Define $K^*(\cdot)$ and $C^*(\cdot)$ as the manager's optimal capital and cash holdings policies. The market value of the firm is then given by

$$V(Z_t, K_t, C_t) = \lambda \left\{ (1+\xi) \left[\frac{1-\tau_R}{1-\tau_F}(1+(1-\tau_F)r)C_t - (\tau_{R,K} - \tau_F)K_t \right] + V^{\text{terr}}(Z_t, K_t, 0) \right\} + (1-\lambda) \{ (1+\xi)d_t + \mathbb{E}_t [\beta V(Z_{t+1}, K^*(Z_t, K_t, C_t), C^*(Z_t, K_t, C_t))] \}. \quad (28)$$

3.3. The value of cash and the repatriation decision

Under the worldwide tax system in place prior to 2018, foreign earnings could be immediately repatriated and taxed in the US, or this US tax liability could be deferred indefinitely by investing in foreign operations or holding cash. How do firms decide when to repatriate foreign earnings, and what is the marginal value of an extra dollar of foreign earnings?

3.3.1. The expected present value of cash

In order to understand the repatriation decision, we must quantify the marginal benefit of repatriating and of holding cash. For a firm choosing to immediately repatriate, the marginal value of foreign earnings (after foreign income tax) is its after-tax value, accounting for the parent's value of present cash flow (ξ):

$$(1+\xi)\frac{1-\tau_{US}}{1-\tau_F}. \quad (29)$$

For a firm that defers repatriation, and expects to hold an additional dollar of cash until tax reform occurs, the marginal value of cash depends on the likelihood of reform and the expected tax rates on reform, as well as the interest rate on financial assets and intermediate taxation of interest income. Define η as the expected present value of the after-tax value of a dollar that is held inside the subsidiary until tax reform occurs. This expected present value

of cash does not depend on the state variables and only on the parameters of the model and is therefore constant. In Appendix A.1, we show that

$$\eta = \frac{\beta(1+\xi)\{\lambda\frac{1-\tau_R}{1-\tau_F}[1+(1-\tau_F)r]+(1-\lambda)(1-s)(1-\tau_{US})r\}}{1-\beta(1-\lambda)(1-s)}. \tag{30}$$

For subsidiaries with little unrepatriated foreign earnings, the marginal value of a dollar held inside the firm may exceed η because that dollar may be used to finance investment before reform. The alternative approach to financing—using financing from the parent—is tax-disadvantaged in the model because the firm, upon the realization of a bad shock and disinvestment, cannot return that contributed capital to the parent without incurring a repatriation tax. However, we find in the model that the marginal value of cash is extremely close to η because firms that choose to defer repatriation accumulate significant cash holdings and negative shocks are rarely large enough to cause significant negative investment.[5] Therefore, the firm is approximately indifferent between having an extra dollar of unrepatriated cash holdings and η:

$$\frac{\partial \mathbb{E}_t V(Z_{t+1}, K_{t+1}, C_{t+1})}{\partial C_{t+1}} \approx \eta. \tag{31}$$

3.3.2. The expected present value of the manager's resource diversion

For the manager, cash held inside the foreign subsidiary allows for resource diversion each period at a rate s. Using a similar approach as before, we can show (see Appendix A.2 for details) that the expected present value of the manager's resource diversion on a dollar held inside the firm until tax reform is

$$\gamma \equiv \frac{\beta(1-\lambda)[1+(1-\tau_{US})r]s}{1-\beta(1-\lambda)(1-s)}, \tag{32}$$

and consequently

$$\frac{\partial \mathbb{E}_t U(Z_{t+1}, K_{t+1}, C_{t+1})}{\partial C_{t+1}} \approx \gamma. \tag{33}$$

[5] We verify that the value of an additional dollar of cash within the model is very close to η.

3.3.3. The repatriation decision

Given the expressions for the expected present value of a marginal dollar of cash held inside the foreign subsidiary, η, and similarly for resource diversion, γ, we can quantify under what conditions the firm will immediately repatriate a marginal dollar of earnings. The shareholder prefers immediate repatriation (rather than holding cash in the foreign subsidiary) if

$$(1+\xi)\frac{1-\tau_{US}}{1-\tau_F} \geq \eta. \tag{34}$$

Conveniently, just as in the case of the illustrative model in Section 2, the decision to repatriate in a function only of the parameters and is time-invariant.

From the perspective of the manager, the decision to immediately repatriate trades off the tax costs with the ability to divert resources on cash held inside the subsidiary. The manager prefers immediate repatriation only when the manager's share of the dividend exceeds the expected present value of holding the cash in the foreign subsidiary until tax reform occurs, i.e.:

$$(1+\xi)\theta\frac{1-\tau_{US}}{1-\tau_F} \geq \theta\eta + \gamma.$$

Dividing through by θ gives

$$(1+\xi)\frac{1-\tau_{US}}{1-\tau_F} \geq \eta + \frac{\gamma}{\theta}. \tag{35}$$

The conditions for immediate repatriation (34) and (35) differ only by the term γ/θ, which shows that a manager who derives some value from diverting resources ($\gamma > 0$) is less likely to immediately repatriate. When the manager is unable to divert resources ($s = 0 \Rightarrow \gamma = 0$), conditions (34) and (35) are identical. Similarly, higher equity ownership θ reduces disagreement between the manager and shareholder in the repatriation decision.

3.3.4. The accumulation of cash

Under many reasonable parameterizations, the foreign subsidiary's optimal policy is to never repatriate any foreign earnings. This means that the foreign subsidiary will accumulate

cash until tax reform occurs. This anecdotally matches the behavior by many US multinationals; for example, Apple, Pfizer, and Microsoft have accumulated a total of roughly $600 billion (see Toplensky, 2018). For these firms, the cash variable C_t will tend to have positive drift until the tax reform occurs. Computationally, this is a challenge that we address by allowing the firm and manager to exchange unrepatriated cash holdings for the expected present value of that cash and resource diversion. For details on this approach, see Appendix B.

4. Data and calibration

We focus on a sample of foreign affiliates of US multinationals from BEA's annual surveys on US Direct Investment Abroad.[6] The surveys are conducted pursuant to the International Investment and Trade in Services Survey Act (hereafter the Act). The Act stipulates that the "use of an individual company's data for tax, investigative, or regulatory purposes is prohibited." Willful noncompliance with the Act may result in imprisonment for up to one year. For these reasons, in addition to their monitoring of corporate events and a system of internal data integrity checks, BEA believes the surveys accurately capture virtually complete data on the universe of U.S. direct investment abroad.

BEA's surveys provide detailed data on the foreign affiliates' financial and operating characteristics, including information on their income statements and balance sheets. We limit the sample to majority-owned affiliates, which are commonly referred to as "subsidiaries," the term used in this paper. In addition, we omit subsidiaries in the financial services (SIC 6000-6999) and regulated utilities (SIC 4900-4999) industries.

We merge these data with Execucomp to obtain data on managers' bonus compensation and their equity ownership. This results in a sample period of 1990–2010, inclusive. 1990 is the first year for which data are available from Execucomp. 2010 is last year for which BEA's microdata have been finalized at the time of writing.

[6]These data are collected for the purpose of producing publicly available aggregate statistics on the activities of multinational enterprises.

The model parameters used in the benchmark specification are shown in Table II. First, we choose parameters for the discount rate, r, consistent with the existing literature. We assume that the discount factor is consistent with this rate: $\beta \equiv 1/(1+r)$. We set the foreign corporate income tax rate, τ_F, to 13.8%, the median[7] effective rate faced by subsidiaries in our sample. The effective tax rate is calculated as the ratio of taxes paid to taxable income. Taxable income is the sum of taxes paid and net income. To obtain a US corporate income tax rate, we follow Foley et al. (2007) and rely on marginal taxes rates from Graham (1996) and Graham et al. (1996). We find that the median[8] parent faces a marginal tax rate of 27.5%. This estimated US corporate income tax rate likely understates the marginal tax rate that these firms face, and we therefore consider alternative rates as part of our analysis.

Second, we choose the production parameters such that the moments from the model-simulated data approximate their empirical counterparts in the BEA data on the foreign subsidiaries of US multinationals. Specifically, we attempt to match the means, standard deviations, and serial correlations of the investment rate and profitability, as well as the frequency of negative earnings. These seven moments help to identify the parameters of the profitability process Z_t (specifically, persistence ρ, volatility σ, and returns to scale α), the fixed costs of production f, the adjustment cost parameter ϕ, and the depreciation rate δ.

We calculate the investment rate as the ratio of capital expenditures to lagged gross property, plant, and equipment. Profitability is the ratio of taxable income to total assets. Taxable income is the sum of net income and foreign taxes paid. We winsorize all variables constructed from the data at the 2.5% and 97.5% thresholds of their empirical distributions to mitigate the influence of outliers.

Finally, we choose parameters for the manager's compensation using data from Execucomp. For this sample of CEOs, the average equity ownership is 2.0%, and the ratio of bonus to operating income is 0.1%. We use these values for the ownership and bonus parameters θ and b, respectively. For the resource diversion parameter, s, which we cannot directly

[7]To satisfy confidentiality requirements, we do not report the true median, as it corresponds to a value reported by a respondent. Instead, we report the average of the inner five observations.

[8]As before, this is the average of the inner five observations.

observe, we use the estimates from Nikolov and Whited (2014) for the sample of large firms: $1000 \times s = 0.04$. This corresponds to an ability of the manager to expropriate 0.4 basis points of cash and profits each period. Given we are unable to directly estimate this parameter using the identification approach of Nikolov and Whited (2014) due to data limitations (we do not have market prices for foreign subsidiaries), we explore different values for this parameter to quantify its importance.

The basic moments from the benchmark calibration of the model, along with their empirical counterparts, are shown in Table III. The model performs very well in matching the targeted data moments.

5. Tax reform and investment

In this section we use the calibrated model to assess the effect of the territorial tax reform on the capital investment of US companies in foreign operations. In addition, we show how this reform is expected to change an array of firm characteristics. We contrast these outcomes with alternative, counterfactual tax policies, and show how the reform has heterogeneous effects in the cross-section. Next we explore the role of managerial incentives and agency conflicts on the effect of tax reform, and how we expect incentives to change post-reform. Finally, we assess the sensitivity of the parameter choices to our benchmark findings.

5.1. Territorial tax reform

On December 22, 2017, the Tax Cuts and Jobs Act (TCJA) was signed into law less than two months after its introduction in Congress. Two of the most significant legislative changes made to the tax code were a reduction in the US federal corporate income tax rate from 35% to 21% and removal of most of the worldwide tax provisions for US companies.[9] Any unrepatriated earnings held overseas face a one-time tax of 15.5 and 8% for cash (and

[9]The bill maintained a global minimum tax to discourage excessive income shifting to low-tax jurisdictions, and thus did not move to a truly pure territorial system. While the interpretation of the global minimum tax is still underway, for our purposes we will treat the enacted system as territorial.

cash equivalents) and illiquid assets (e.g. physical capital), respectively.

As we demonstrated in Section 2, the worldwide system combined with the option to defer repatriation encourages increased investment in foreign operations because of lowered opportunity costs for unrepatriated earnings. Using the quantitative model in Section 3, we can predict and quantify the expected reduction in foreign investment to occur following the reform. The model is partial equilibrium and therefore we are unable to make statements about welfare or general equilibrium outcomes that may include changes in product markets, exchange rates, labor markets, entry/exit, etc. Our results should be interpreted as the expected response of an incumbent US multinational to an isolated change in the tax code alone. While this partial equilibrium approach does not provide definitive policy guidance, the goal is to quantify the direct tax effect on investment and firm policies.

The first column of Table IV reports, in percent, the predicted post-TCJA changes in investment and other firm characteristics for the average firm. The model is simulated using the pre-reform, worldwide calibration, where firms place a probability λ each year of passing a bill with the provisions specified in the TCJA. Average values for capital stock, revenue, earnings before taxes, firm size (non-cash equity value), foreign tax revenue, and global tax revenue are calculated from this model-simulated data. Similarly, the average values for each of these variables are calculated from simulations of the counterfactual post-reform, territorial model. The table reports the difference between the territorial mean and the worldwide mean, in percent, giving the expected steady state change in each variable following reform. For example, negative values indicate a model-predicted decline in the variable following the reform.

The model predicts that the territorial tax system will have a significant dampening effect on foreign investment, with the level of capital stock dropping about 15.0% following the transition. This reduction in investment results in a higher marginal product of capital (MPK) due to decreasing marginal returns in production, i.e. foreign subsidiaries are more productive after reform. The average subsidiary declines in size, measured as non-cash equity value, by 4.6%, corresponding to this smaller optimal size. Foreign tax revenue declines only

slightly, while global tax revenue declines about 38.6% due to the elimination of the US tax on foreign earnings. In addition, the reform shock generates an equity return on the foreign subsidiary of 3.02% (on operations before accounting for the reduced cost of repatriating past earnings) as the foreign subsidiary faces a lower tax rate going forward.

The model predicts that while foreign operations face a lower tax rate following the move to a territorial system, firms optimally choose to reduce investment in those operations. As discussed in the illustrative model in Section 2, this is because the worldwide tax code lowers the opportunity cost of investing in physical capital, resulting in higher investment before the reform. For firms that choose to immediately repatriate, the current high repatriation tax makes investment look relatively more attractive because future earnings from that capital may be repatriated at lower, post-reform rates. For firms that defer repatriation, the tax cost of holding cash overseas makes capital investment look relatively more attractive. Moving to a territorial system eliminates both the repatriation cost and the tax holding cost, removing the distortion that causes higher investment. Thus, while US multinationals are more competitive in their overseas operations after reform, the model predicts a smaller international presence.

In the last two columns of Table IV, we explore counterfactual policy changes to the tax code. The second column shows the change resulting from lowering the US corporate tax rate to 21% but maintaining the worldwide tax system, while the final column shows the removal of the deferral option (foreign earnings are required to be immediately repatriated) within the worldwide system. In both cases, as with the first column, we assume that agents do not expect subsequent tax changes to occur.[10]

A lower US rate under a worldwide system, which was one policy that received some attention in the discourse prior to the passage of TCJA, leads to a 16.4% decline in the capital stock following the reform. First, following reform, firms do not expect future tax changes and therefore immediately repatriate any foreign earnings. Second, firms face a high

[10]In order to keep agent expectations consistent across the three columns, we assume that agents expect a territorial tax reform with probability λ in each specification. Therefore, the denominators in each column are the same, allowing us to focus on the post-reform effects. The alternative tax policies in the second and third columns can be thought of as a surprise to the agents.

tax rate on future foreign earnings because they do not expect to receive a future territorial reform. Thus the firm faces a higher tax rate on future earnings than in the territorial system. These effects significantly reduces investment and optimal firm size following reform.

Removing the deferral option, shown in the final column, causes an even more significant decline in investment. This case is similar to column 2 in that the firm now immediately repatriates all earnings, but in addition faces a higher, 27.5%, tax rate on repatriation. This makes investment far less attractive. Global tax revenue, however, increases in this case, as firms are paying significantly more US tax because of forced repatriation.

5.2. Goods producers versus service firms

For various reasons, firms operating in different industries face different tax rates. For example, technology and pharmaceutical companies have used aggressive tax strategies to move intellectual property and firm profits to low- or no-tax jurisdictions (Griffith, Miller, and O'Connell, 2014). To explore the heterogeneous effects of tax reform across types of firms, we calibrate the model separately for the subsamples of goods producers and service firms. While this division is coarse, it provides some insight into the differences across capital-intensive firms and those that rely more on intellectual property.

Table V reports the results of the goods producers and service firms calibrations. Panel A reports the predicted effect of the territorial reform of the TCJA for goods producers and service firms. Panel B reports the calibrated parameters, with the calibrated moments reported in Panel C. Strikingly, as supported by anecdotes about the aggressive tax strategies of technology companies, service firms face a significantly lower effective foreign tax rate of 2.7%, versus a 14.8% rate for goods producers. Service firms also face a lower marginal US tax rate (24.7% vs. 28.3%). Service firms also provide somewhat stronger equity-based incentives for their CEOs (2.5% vs. 1.9%).

Panel A reveals that the model predicts a decline in foreign investment that is half the size for service firms than for goods producers (-7.6% vs. -14.4%). There are two primary reason for this difference. First, service firms face a much lower foreign tax rate, so the value

of investment after reform is much higher. Second, their US rate is lower, making the tax cost of holding unrepatriated cash lower. This lower tax cost of holding cash means that capital investment does not look as cheap as for goods producers that face a higher tax holding cost. This difference also means that global tax collections from service firms is predicted to decline by much more than for good producers.[11] The equity return on the firm's non-cash assets is also higher for service firms (4.02% vs. 3.06%). Coupled with the service firms' more significant reduction in repatriation taxes on past unrepatriated earnings (due to a larger spread between the US and foreign rates), the model predicts that the benefit of the tax reform to service firms is significantly greater than for goods producers.

5.3. Managerial incentives and agency conflicts

The manager makes investment, savings, and repatriation decisions for the foreign subsidiary. In order to better understand how the manager's private incentives affect the firm's policy, we change the agency conflicts away by moving the incentive parameters away from the benchmark and explore the change in model outcomes. Table VI reports, in percent, the predicted response to the tax reform (Panel A) and the effect of agency on pre-reform (worldwide system) outcomes (Panel B), for various compensation contracts and managerial resource diversion abilities.

Panel A shows that the predicted change in the capital stock in response to reform is somewhat larger in magnitude (-17.4% vs. -15.0%) for a firm which has a manager with perfectly aligned incentives, shown in column 2, than for the benchmark case, reproduced in column 1. The perfectly aligned manager (no agency) case is given by $b = 0$, $s = 0$, and $\theta = 1$. Columns 3 and 4 show that simply shutting off bonus compensation (and the incentive to invest more than shareholders prefer)—$b = 0$—or the ability to divert resources—$s = 0$—has only a small effect on the predicted response to reform. In contrast, columns 5 and 6 show the response for firms with low equity/high bonus and high equity/low bonus compensation,

[11] The global minimum tax provisions in the TCJA may mitigate these effects for certain firms facing low foreign rates.

respectively, revealing that agency has a significant effect for certain firms.[12] Firms with CEOs that receive low equity ownership and high bonus are less aligned with shareholders and choose a high level of investment both under the worldwide and territorial systems in order to maximize bonus compensation. The model predicts that tax reform leads to a smaller 5.3% decline in capital stock for firms with this low equity/high bonus compensation contract relative to the 15.0% decline for the benchmark contract. CEOs with high equity, low bonus compensation contracts behave closely to the benchmark case, with a decline in capital stock of 16.2% following reform; the benchmark level of equity ownership does well in aligning incentives.

Panel B shows how agency conflicts distorts investment and other firm characteristics in the pre-reform period. All values are taken from simulations prior to the reform, and are reported relative to the benchmark calibration as a percent difference. Column 1 shows that the effect of agency on capital choice was insignificant for the average firm. This is because bonus compensation and resource diversion work in opposite directions. Bonus compensation creates higher investment by 2.6%, while resource diversion reduced investment by 1.0%. As shown in Panel A, this does not mean managerial incentives were not quantitatively important for certain firms. Columns 4 and 5 report the value for the low equity/high bonus and high equity/low bonus compensation contracts. As before, the low equity/high bonus compensation provides significantly distorted incentives, and these CEOs had an incentive to choose capital stock 6.3% higher than the average firm.

One of the interesting features of the worldwide tax system with deferral option is that shareholders often prefer the manager to accumulate, rather than payout, cash. This creates a situation where CEOs have access to large amounts of cash that can be misused by management. For example, Hanlon, Lester, and Verdi (2015) find that unrepatriated cash holdings are associated with more frequent and less profitable foreign acquisitions. Moving to a territorial system reduces the ability of the manager to hoard cash for private benefit.

[12]High and low bonus compensation is the average bonus to operating income before depreciation for firms above and below the median, respectively. High and low equity ownership is constructed similarly using CEO equity ownership as defined in Section 4.

How do we expect the sensitivity of investment to the compensation contract and resource diversion ability to change under the territorial system?

Figure 5 plots the investment distortion caused by agency conflicts as a function of the resource diversion parameter s, bonus compensation b, and equity compensation θ, under both the worldwide (solid line) and territorial (dotted line) systems. The plot is constructed as the mean capital stock for the benchmark model while varying a single parameter (one variable for each panel), relative to the case with no agency conflicts, reported as a percent difference. The slope of the lines indicate the sensitivity of investment with respect to a parameter under each tax system.

In Panel A, investment is declining in the resource diversion parameter s under the worldwide system, as the manager prefers to hold more cash enabling greater diversion. Under the territorial system, the relationship is flat because the manager chooses not to hold foreign cash, shutting down the trade off. In other words, the ability to divert resources is a much greater concern to shareholders under the worldwide system because it is optimal to accumulate cash. The territorial system removes this concern.

Panel B shows the effect on investment from varying bonus compensation b. In both the worldwide and territorial systems, bonus compensation encourages higher investment, with similar sensitivity under both systems.

For equity compensation, shown in Panel C, the response of investment to compensation differs significantly across the two tax systems. Under the worldwide system, investment is generally only sensitive to equity ownership for low values of θ. The same is true under the territorial system, however, the investment distortion is considerably larger in this region of low equity ownership. This increased sensitivity is a result of the change in the value of resource diversion. Under the worldwide system, the manager's ability to divert resources makes holding cash more valuable, and in turn makes investment less desirable. On the other hand, bonus compensation makes investment more desirable. These two forces tend to balance each other out under the worldwide system, even for managers with low equity compensation and therefore little incentive to maximize firm value. In contrast, under the

territorial system it is no longer optimal for the manager to hold cash and the value of resource diversion is greatly diminished. In this case, the incentives of bonus compensation are unchecked and higher investment occurs, an incentive conflict that is highest for managers with only a small amount of equity ownership.

5.4. Sensitivity analysis

The benchmark parameters for our analysis, reported in Table II, were chosen to approximate the average firm in the cross-section. In this section, we assess the sensitivity of our main results to alternative parameter values. Table VII reports the model-predicted effect of territorial tax reform (as enacted in the TCJA) on foreign investment and other firm characteristics by varying a single parameter of the model. The benchmark results from Table IV are reported in the first column of each panel for comparison.

5.4.1. Tax rates and parent financial constraints

Panel A of Table VII reports the predicted change, in percent, of territorial tax reform for alternative US and foreign corporate tax rates (τ_{US} and τ_F) as well as the parent's financial constraint parameter (ξ). As shown in the second column, for firms facing a lower, 20%, US tax rate, the effect of tax reform results in a smaller, 12.0%, decline in capital stock. Firms facing the top US statutory rate of 35% reduce their capital stock by 16.7% following reform. As shown in the final row, the managers (and shareholders) find it optimal to defer repatriating foreign earnings until tax reform, meaning that these firms pay a tax holding cost of carrying cash because returns on these financial assets face the US corporate rate. The tax cost of holding cash is increasing in the US corporate rate, and firms facing a higher US rate find it optimal to invest more in physical capital, as the opportunity cost for this investment is lower. In addition, the reduction in global tax revenue is greater for US firms facing a higher US tax rate, and the return on non-cash assets they realize from this reform is higher.

Varying the foreign tax rate, shown in the next two columns of Panel A, has a similar

effect on the change in capital stock following reform: higher foreign tax rates correspond to a larger drop in capital following reform. Prior to reform, the foreign subsidiary is largely indifferent between high and low foreign tax rates because they will receive a foreign tax credit in the US to offset this cost. As a result, the capital choice before reform are similar for both high and low foreign tax rates. After reform, a higher foreign tax rate reduces the returns to investment, and therefore the investment level is decreasing in the foreign tax rate under the territorial system.

The final two columns of Panel A report the effects for parents with external financing costs, a cost that makes the shadow value of a dollar of dividend to the parent greater than one. For example, $\xi = 0.01$ corresponds to 1 dollar of dividend today being worth 1.01 dollars to the parent because the parent has both external financing costs and unfunded investment opportunities. As shown in the final columns of Panel A, the effect of ξ on the response to the territorial reform are negligible. The reason is that because ξ is constant, both the value of the dividend today and the value of future returns to investment and cash holdings are increasing in ξ. As a result, higher ξ leads to an increase in the value of the foreign subsidiary by a proportional amount, but investment decisions are not affected. A richer model that includes time variation in the external financing costs to the parent would cause investment to respond to changes in ξ.

5.4.2. Tax reform expectations

Panel B of Table VII explores the effect of the tax reform parameters on the predicted response to tax reform. In the model, the tax reform event is characterized by the one-time repatriation tax rates on cash (τ_R) and capital ($\tau_{R,K}$), as well as the likelihood that tax reform occurs (λ). The second and third columns show that the response to capital investment following reform is increasing in magnitude with the tax rate on cash (τ_R), while decreasing in magnitude with the tax rate on capital ($\tau_{R,K}$). This is because a higher repatriation tax rate on cash makes capital look relatively more attractive, and vice versa for the repatriation tax rate on capital. The expected relative tax costs between cash and

capital may have played an important role in investment decisions of managers prior to reform. For example, if managers expected to avoid US taxes on capital altogether but expected to face a high repatriation tax rate on cash, this would have encouraged a high investment in foreign operations. In addition, the expectations for the tax rates that would be specified in future tax reform legislation likely varied across managers leading to additional heterogeneity in pre-reform investment as well as the response to tax reform.

The final three columns of Panel B show the effect of the likelihood of reform, λ. For very low likelihood of reform ($\lambda = 0.01$), the firm operates nearly as if the worldwide system will not change, and the firm optimally chooses to repatriate earnings immediately. Under the worldwide system, the firm operates at a low level of capital because it faces a high expected tax rate; the incentive to invest heavily (as seen in the benchmark case) is reduced because the firm does not expect to face a lower tax rate on earnings in the future. After territorial reform occurs, the capital stock declines only 2.2%, however, the value of this reform is very high and the firm's non-cash assets increase in value by 16.5%, much more than the 3.0% return in the benchmark case. As λ increases, shown in the next two columns, the value of holding unrepatriated cash and capital increases and as a result the decline in investment following reform is also increasing. Of course, λ has no effect on the investment decision after reform occurs under the (assumed to be) permanent territorial system. Therefore, all the variation in the response to reform seen across the three values for λ is due to pre-reform investment choices. The high sensitivity of the pre-reform investment choice to the expectations of reform suggests that tax policy uncertainty can have significant effects on the real economy.

5.4.3. The discount rate and technology parameters

Panel C of Table VII reports the sensitivity of our main results to the discount rate and technology parameters. The second column shows that the expected response to territorial reform is greater in magnitude for higher discount rates (recall that the discount factor $\beta \equiv 1/(1+r)$, where r is the return on cash holdings). For firms that hold unrepatriated

cash, the tax holding cost is increasing in the interest rate r because taxes are based on nominal returns. A higher tax holding cost makes capital investment look relatively cheaper, causing a higher capital stock before reform occurs. Therefore, after reform the decline in capital is larger. Because of this positive relation between the tax holding cost of cash and interest rates, US multinationals have faced relatively low costs of holding cash over the low-interest rate period following the financial crisis and this may have contributed to the accumulation of unrepatriated cash. Under a high interest rate environment, firms are more likely to immediately repatriate foreign earnings.

The final six columns of Panel C show the effect of the persistence and volatility in profitability (ρ and σ), and returns to scale (α) parameters. Each of these parameters is perturbed by $\pm 25\%$ from their benchmark values. The quantitative findings are not overly sensitive to the production technology parameters.

6. Conclusion

Using an investment model of U.S. multinationals' foreign operations, we find that the worldwide tax system induces significantly greater foreign investment. This holds even in the absence of agency conflicts. In addition, we find that tax incentives to encourage repatriation of foreign earnings may instead have the unintended consequence of increasing foreign investment. We also consider the revenue implications of the U.S. moving from a worldwide to a territorial tax system. Under the baseline parameterization, foreign corporate tax revenue would be impacted minimally.

Our results inform the ongoing debate on reforming the U.S. tax code. Switching from a worldwide to a territorial tax system would have substantial repercussions for the real foreign operations of U.S. multinational firms. However, the reform's impact would operate primarily through the reduction in the effective tax rate the firms pay, not the avoidance of agency costs due to diminshed cash holdings abroad.

References

Bakke, T.-E., Gu, T., 2017. Diversification and cash dynamics. Journal of Financial Economics 123, 580–601.

Bird, A., Edwards, A., Shevlin, T. J., 2015. Does the US system of taxation on multinationals advantage foreign acquirers? Working paper .

De Simone, L., Piotroski, J. D., Tomy, R. E., 2017. Repatriation taxes and foreign cash holdings: The impact of anticipated tax policy .

Desai, M. A., Foley, C. F., Hines, J. R., 2004. Foreign direct investment in a world of multiple taxes. Journal of Public Economics 88, 2727–2744.

Devereux, M., Maffini, G., 2007. The impact of taxation on the location of captial, firms and profit: a survey of empirical evidence .

Devereux, M. P., Griffith, R., 1998. Taxes and the location of production: Evidence from a panel of us multinationals. Journal of public Economics 68, 335–367.

Dharmapala, D., Foley, C. F., Forbes, K. J., 2011. Watch what i do, not what i say: The unintended consequences of the homeland investment act. The Journal of Finance 66, 753–787.

Duchin, R., Gilbert, T., Harford, J., Hrdlicka, C., 2017. Precautionary savings with risky assets: When cash is not cash. The Journal of Finance 72, 793–852.

Faulkender, M., Petersen, M., 2012. Investment and capital constraints: repatriations under the american jobs creation act. The Review of Financial Studies 25, 3351–3388.

Faulkender, M. W., Hankins, K. W., Petersen, M. A., 2017. Understanding precautionary cash at home and abroad. Tech. rep., National Bureau of Economic Research.

Foley, C. F., Hartzell, J. C., Titman, S., Twite, G., 2007. Why do firms hold so much cash? a tax-based explanation. Journal of Financial Economics 86, 579–607.

Graham, J. R., 1996. Debt and the marginal tax rate. Journal of financial Economics 41, 41–73.

Graham, J. R., Leary, M. T., 2017. The evolution of corporate cash. Tech. rep., National Bureau of Economic Research.

Graham, J. R., et al., 1996. Proxies for the corporate marginal tax rate. Journal of Financial Economics 42, 187–221.

Griffith, R., Miller, H., O'Connell, M., 2014. Ownership of intellectual property and corporate taxation. Journal of Public Economics 112, 12–23.

Gu, T., 2017. US multinationals and cash holdings. Journal of Financial Economics .

Hanlon, M., Lester, R., Verdi, R., 2015. The effect of repatriation tax costs on us multinational investment. Journal of Financial Economics 116, 179–196.

Hennessy, C., Strebulaev, I., 2015. Natural experiment policy evaluation: A critique .

Hines, J. R., 1996. Altered states: taxes and the location of foreign direct investment in america. The American Economic Review 86, 1076–1094.

Hines, J. R., Rice, E. M., 1994. Fiscal paradise: Foreign tax havens and american business. The Quarterly Journal of Economics 109, 149–182.

Lucas Jr, R. E., 1976. Econometric policy evaluation: A critique. In: *Carnegie-Rochester conference series on public policy*, Elsevier, vol. 1, pp. 19–46.

Nikolov, B., Whited, T. M., 2014. Agency conflicts and cash: Estimates from a dynamic model. The Journal of Finance 69, 1883–1921.

Riddick, L. A., Whited, T. M., 2009. The corporate propensity to save. The Journal of Finance 64, 1729–1766.

Toplensky, R., 2018. Multinationals pay lower taxes than a decade ago. The Financial Times, March 11, 2018 .

Table I: **Comparative statics for the illustrative model**

Parameter		(1) Region of deferred repatriation	(2) **Worldwide** Case 1: $K^{*,\text{repat}}$ (Immediate repat.)	(3) Case 2: $K^{*,\text{defer}}$ (Defer repat.)	(4) **Territorial** $K^{*,\text{terr}}$
US tax rate	τ_{US}	+	+	+	0
Future repatriation tax rate	$\mathbb{E}[\tau_R]$	−	−	−	0
Foreign tax rate	τ_F	$\sim$	$\sim$	0	−
Parent financing constraint	ξ	−	−	0	−
Discount/interest rate	r	+	−	−	−
Decreasing returns to scale	α	0	+	+	+
Productivity	A	0	+	+	+

This table presents comparative qualitative comparative statics for various parameters in the illustrative model defined in Section 2. Column (1) reports whether the region in which the firm chooses to defer is weakly increasing (+), decreasing (−), or unchanging (0) in the given parameter, under the worldwide tax system. Cases in which the sign of the relation depends on other parameters are denoted by $\sim$. Similarly, columns (2) and (3) report the sign of the comparative static on the capital choice K for Case 1 (immediate repatriation) and Case 2 (deferred repatriation), respectively. Throughout, we assume that the expected repatriation tax rate in year T is less than the current US rate, which are both greater than the foreign tax rate, specifically, $\tau_F < \mathbb{E}[\tau_R] < \tau_{US}$. Finally, column (4) reports the sign of the comparative static on the capital choice under the territorial system defined in Section 2.3.4.

Table II: **Benchmark model parameters**

Symbol	Parameter	Value
ρ	Persistence in productivity	0.72
σ	Volatility of productivity	0.34
α	Returns to scale	0.48
δ	Depreciation rate	0.12
f	Fixed costs	0.035
ϕ	Adjustment costs	0.06
r	Discount rate	0.04
τ_F	Foreign tax rate	0.138
τ_{US}	US tax rate on domestic earnings	0.275
λ	Tax reform arrival probability	0.1
τ_R	Reform repatriation tax rate on cash	0.155
$\tau_{R,K}$	Reform repatriation tax rate on illiquid assets	0.08
θ	Manager equity ownership	0.02
$100 \times b$	Bonus to operating income ratio	0.1
$1000 \times s$	Manager resource diversion	0.04

The table presents benchmark parameter values used in the quantitative model. Values are reported at an annual frequency, where applicable. For more details on the calibration, see Section 4.

Table III: **Model moments**

Moment	Data	Model
Profitability, mean	0.10	0.10
Profitability, standard deviation	0.14	0.14
Profitability, serial correlation	0.58	0.58
Investment rate, mean	0.13	0.14
Investment rate, standard deviation	0.19	0.18
Investment rate, serial correlation	0.29	0.29
Frequency of negative earnings	0.19	0.20

The table presents moments from the BEA data on the foreign affiliates of US multinationals and model-simulated data used to calibrate the model parameters reported in Table II. All values are at an annual frequency where applicable. See Section 4 for a description of the data and the calibration approach.

Table IV: **Predicted response to territorial (TCJA) and alternative tax reforms**

	Enacted (TCJA)	**Counterfactual**	
	Territorial reform	Lower US rate ($\tau_{US} = 21\%$), maintain worldwide tax	Remove deferral option, maintain worldwide tax
Capital stock (K)	−14.95	−16.35	−23.16
MPK	8.77	9.09	14.86
Revenue	−7.11	−8.46	−11.25
Earnings before taxes	−3.98	−6.13	−6.82
Firm size	−4.59	−13.66	−22.87
Foreign tax revenue	−3.90	−6.25	−8.21
Global tax revenue	−38.63	−9.52	16.13

This table presents the model-predicted response to various firm outcomes under the enacted TCJA territorial tax reform as well as alternative, counterfactual reforms. The first column of Table IV reports, in percent, the predicted post-TCJA changes in investment and other firm characteristics for the average firm. The model is simulated using the pre-reform, worldwide calibration. Average values for capital stock, revenue, earnings before taxes, firm size (non-cash equity value), foreign tax revenue, and global tax revenue are calculated from this model-simulated data. Similarly, the average values for each of these variables are calculated from simulations of the counterfactual post-reform, territorial model. The table reports the difference between the territorial mean and the worldwide mean, in percent, giving the expected steady state change in each variable following reform. For example, negative values indicate a model-predicted decline in the variable following the reform. The last two columns explore counterfactual policy changes to the tax code. The second column shows the change resulting from lowering the US corporate tax rate to 21% but maintaining the worldwide tax system. The final column shows the removal of the deferral option (foreign earnings are required to be immediately repatriated) within the worldwide system. In both cases, as with the first column, we assume that agents do not expect subsequent tax changes to occur.

Table V: **Predicted response to territorial reform (TCJA) for goods producers and service firms**

Panel A: Predicted effect of moving to a territorial system (percent)

	Goods producers	Service firms
Capital stock (K)	−14.36	−7.55
MPK	7.97	3.83
Revenue	−7.06	−2.81
Earnings before taxes	−3.37	1.10
Firm size	−5.09	5.57
Foreign tax revenue	−3.31	1.08
Global tax revenue	−35.64	−85.08

Panel B: Parameters

	τ_{US}	τ_F	ρ	σ	α	f	ϕ	θ	$b\times 100$
Goods producers	0.283	0.148	0.70	0.38	0.52	0.033	0.053	0.019	0.14
Service firms	0.247	0.027	0.64	0.50	0.58	0.020	0.047	0.025	0.15

Panel C: Calibrated moments

	Goods producers		Service firms	
	Data	Model	Data	Model
Profitability, mean	0.09	0.09	0.07	0.10
Profitability, standard deviation	0.18	0.15	0.18	0.16
Profitability, serial correlation	0.58	0.57	0.46	0.45
Investment rate, mean	0.12	0.14	0.16	0.15
Investment rate, standard deviation	0.19	0.21	0.22	0.24
Investment rate, serial correlation	0.27	0.29	0.25	0.26
Frequency of negative earnings	0.24	0.24	0.26	0.26

This table reports the predicted response to the territorial reform (TCJA) separately for goods producers and service firms. The predicted responses are reported in Panel A as a percent change under the territorial system relative to the pre-reform levels. The construction follows the same approach as in Table IV. The calibrated parameters for each subsample, reported in Panel B, are chosen using the same approach as for the benchmark calibration described in Section 4. The model-simulated and BEA data moments are reported in Panel C.

Table VI: **Effect of managerial incentives**

Panel A: Predicted response to territorial tax reform (percent)

	Benchmark (with agency)	No agency	No bonus ($b = 0$)	No resource diversion ($s = 0$)	Low equity, high bonus	High equity, low bonus
Capital stock (K)	−14.95	−17.36	−14.69	−15.99	−5.34	−16.22
MPK	8.77	10.23	8.61	9.48	2.91	9.51
Revenue	−7.11	−8.36	−6.97	−7.62	−2.58	−7.76
Earnings before taxes	−3.98	−4.87	−4.04	−4.21	−1.38	−4.51
Firm size	−4.59	−5.51	−4.46	−5.01	2.56	−5.06
Foreign tax revenue	−3.90	−4.77	−3.95	−4.13	−1.35	−4.42
Global tax revenue	−38.63	−39.02	−38.65	−38.63	−40.93	−38.86

Panel B: Pre-reform levels relative to benchmark (percent)

	No agency	No bonus ($b = 0$)	No resource diversion ($s = 0$)	Low equity, high bonus	High equity, low bonus
Capital stock (K)	−0.18	−2.56	1.02	6.31	−1.22
MPK	−0.03	1.40	−0.66	−3.28	0.47
Revenue	−0.41	−1.17	0.31	3.08	−0.86
Earnings before taxes	−0.87	−0.57	−0.18	1.88	−1.03
Firm size	−0.01	−0.77	0.32	0.17	−0.39
Foreign tax revenue	−0.91	−0.50	−0.22	1.63	−1.00
Global tax revenue	−1.16	−0.51	−0.43	8.52	−1.10

This table reports, in percent, the predicted response to the territorial tax reform (TCJA) in Panel A and the effect of agency conflicts on pre-reform (worldwide system) outcomes in Panel B, for various compensation contracts and managerial resource diversion abilities. For each variable of interest, Panel A reports the percent change under the territorial system relative to the pre-reform levels. The construction follows the same approach as in Table IV, and the benchmark result are reproduced in the first column of Panel A. Panel B reports comparative statics on the pre-reform levels of the variables of interest by varying the incentive parameters. Reported are the percent change under the specified incentive parameters relative to the benchmark model calibration, both in the pre-reform period. For both panels, no agency indicates a manager perfectly aligned with shareholders: $s = 0$, $b = 0$, and $\theta = 1$. High and low bonus compensation is the average bonus to operating income before depreciation for firms above and below the median, respectively. High and low equity ownership is constructed similarly using CEO equity ownership as defined in Section 4.

Table VII: **Sensitivity analysis**

Panel A: Tax rates and parent financial constraints

		τ_{US}		τ_F		ξ	
	Benchmark	0.2	0.35	0.05	0.2	0.01	0.1
Capital stock (K)	−14.95	−11.95	−16.71	−11.34	−16.31	−14.98	−15.01
MPK	8.77	6.93	10.01	6.21	9.83	8.80	8.82
Revenue	−7.11	−5.62	−7.99	−5.21	−8.01	−7.13	−7.15
Earnings before taxes	−3.98	−3.21	−4.39	−2.50	−5.21	−4.00	−4.01
Firm size	−4.59	−3.92	−4.82	4.34	−8.46	−4.63	−4.81
Foreign tax revenue	−3.90	−3.14	−4.29	−2.44	−5.11	−3.92	−3.93
Global tax revenue	−38.63	−32.80	−43.40	−75.13	−17.64	−38.63	−38.63
Return from reform	3.02	2.41	3.60	3.78	2.30	3.02	3.01
Defer until reform	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Tax reform expectations

		τ_R		$\tau_{R,K}$		λ		
	Benchmark	0.08	0.2	0.04	0.155	0.01	0.05	0.2
Capital stock (K)	−14.95	−7.19	−19.67	−19.41	−5.45	−2.16	−9.97	−21.53
MPK	8.77	4.08	11.94	11.88	2.95	1.15	5.65	13.47
Revenue	−7.11	−3.41	−9.52	−9.44	−2.35	−0.65	−4.52	−10.65
Earnings before taxes	−3.98	−2.17	−5.15	−5.23	−1.08	0.24	−2.33	−6.03
Firm size	−4.59	−3.32	−5.55	−7.43	0.92	13.66	1.12	−9.22
Foreign tax revenue	−3.90	−2.12	−5.04	−5.12	−1.06	0.24	−2.28	−5.91
Global tax revenue	−38.63	−17.27	−47.04	−39.40	−36.83	−49.29	−46.03	−31.94
Return from reform	3.02	1.33	4.09	3.48	2.29	16.47	6.79	1.27
Defer until reform	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

Panel C: Technology and discount parameters

		r		ρ		σ		α	
	Benchmark	0.02	0.08	0.54	0.90	0.26	0.43	0.36	0.60
Capital stock (K)	−14.95	−12.84	−16.70	−16.15	−11.39	−15.28	−13.60	−13.70	−14.83
MPK	8.77	7.34	9.69	9.49	6.77	9.02	7.91	9.83	7.07
Revenue	−7.11	−6.03	−8.12	−8.04	−4.90	−7.47	−6.16	−5.10	−8.14
Earnings before taxes	−3.98	−1.62	−7.73	−5.44	−1.63	−4.87	−2.77	−2.61	−4.18
Firm size	−4.59	−2.97	−5.98	−5.90	−1.56	−5.50	−3.30	−1.82	−7.17
Foreign tax revenue	−3.90	−1.60	−7.36	−5.28	−1.62	−4.73	−2.73	−2.55	−4.10
Global tax revenue	−38.63	−29.49	−48.61	−39.33	−38.58	−39.06	−38.10	−37.53	−40.69
Return from reform	3.02	1.21	6.72	3.25	2.29	3.15	2.88	2.78	3.51
Defer until reform	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the predicted response to the territorial reform (TCJA) for various alternative parameter values. The predicted responses are reported as a percent change under the territorial system relative to the pre-reform levels. The construction follows the same approach as in Table IV, and the benchmark predictions are reproduced in the first column of each Panel. For each parameter, the response to territorial reform is calculated for the alternative paramater value while holding all other parameters are their benchmark values. Firm size is the non-cash value of assets. Return from reform is the return on non-cash assets of the subsidiary from the realization of the reform shock. The final row of each Panel reports whether the manager chooses to defer repatriation until tax reform occurs.

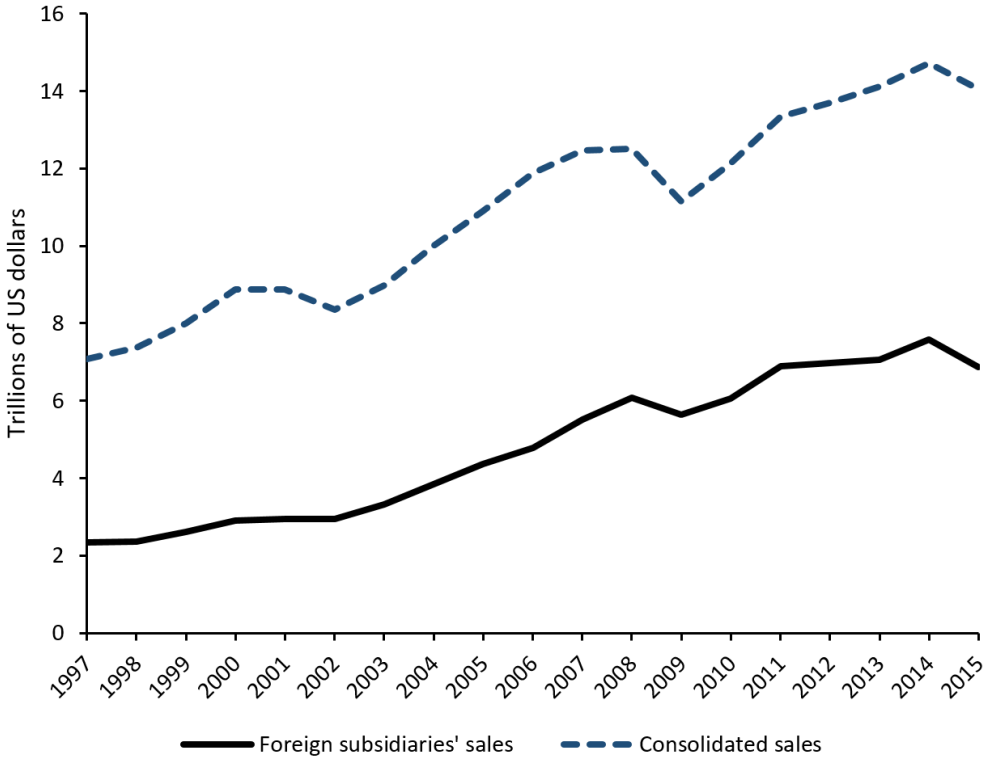


Fig. 1. **Total Sales and Foreign Subsidiary Sales of US Multinationals** The figure plots the aggregate total sales (dashed line) and foreign subsidiary sales (solid line) of US multinationals for the period 1997–2015.

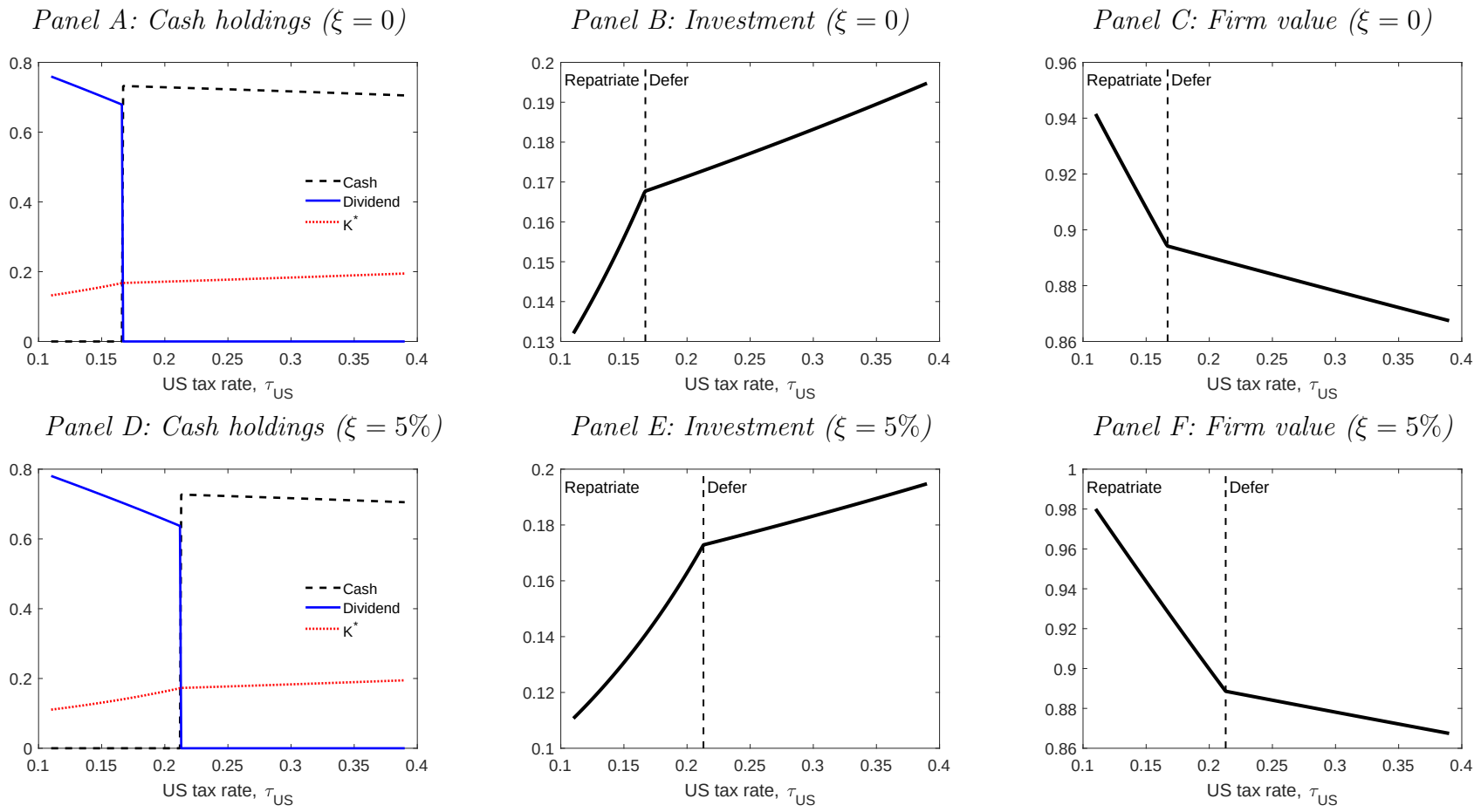
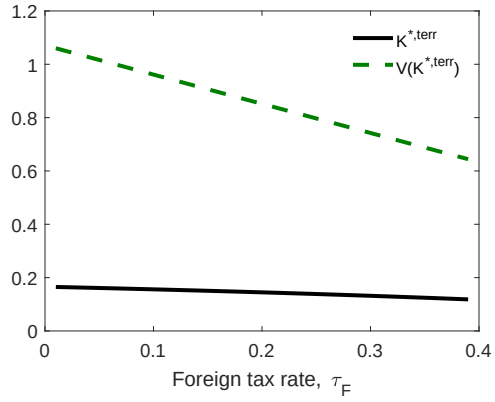


Fig. 2. **Varying the US tax rate: cash holdings, investment, and firm value.** Plots the cash holdings, time-0 dividends, and optimal investment K^* (first column), investment (second column), and firm value (final column) while varying the US tax rate τ_{US}. The top row assumes no external financing costs for the parent, $\xi = 0$, and the bottom row assumes $\xi = 5\%$. The other parameters are held fixed at $\tau_F = 0.10$, $\tau_R = 0.15$, $r = 0.05$, $T = 4$, $\alpha = 0.7$, $A = 1$, $E_0 = 1$. The regions of immediate repatriation and deferral are separated by a vertical dashed line in Panels B, C, E and F.

Panel A: $\delta = 1$



Panel B: $\delta = 0.5$

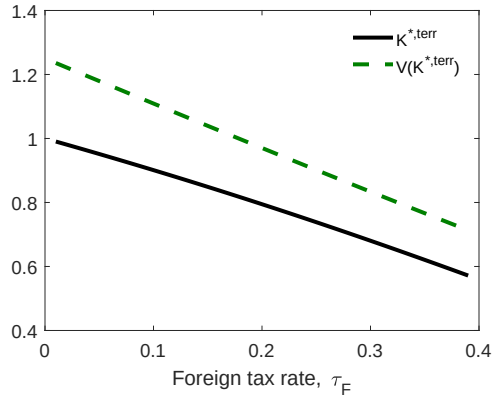
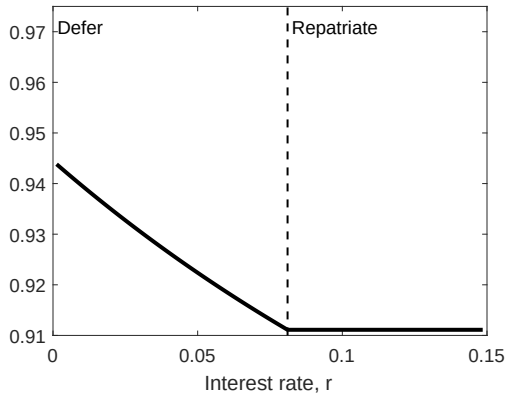


Figure 3: **Varying the foreign tax rate: investment under the territorial system.** Each panel plots the optimal capital choice ($K^{*,\text{terr}}$) and firm value ($V(K^{*,\text{terr}})$ under the territorial system while varying the foreign tax rate (τ_F). The other parameters are held fixed at $r = 0.05$, $\xi = 0$, $\alpha = 0.7$, $A = 1$, $E_0 = 1$. Panels A and B plot these values for a depreciation rate of 1 and 0.5, respectively.

Panel A



Panel B

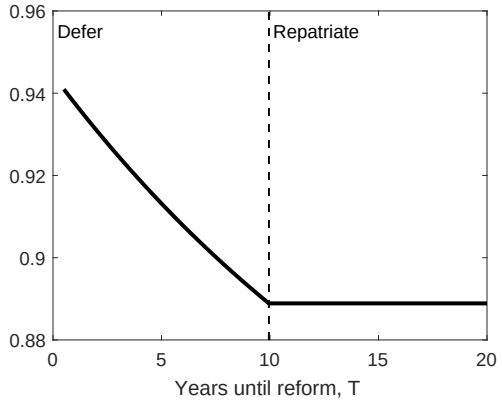
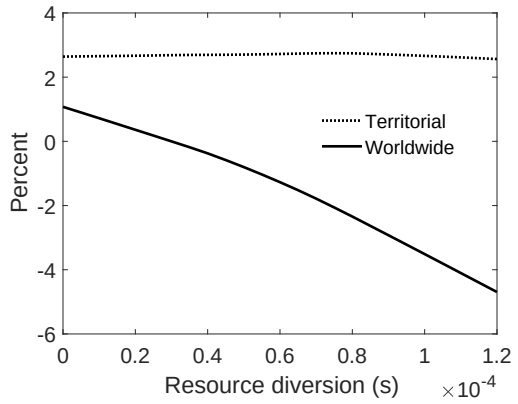
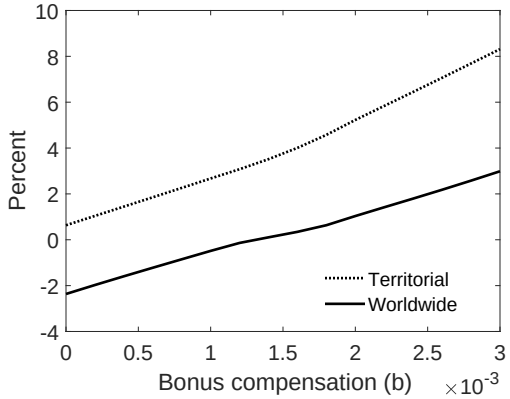


Figure 4: **Varying the discount rate r and time until reform T: the expected present value of a dollar of cash.** Each panel plots the expected present value of a dollar of cash held inside the foreign subsidiary. Panel A varies the one-period interest rate r, and sets $T = 4$. Panel B varies the number of periods until reform T, and sets $r = 0.05$. The other parameters are held fixed at $\tau_F = 0.10$, $\tau_{US} = 0.18$, $\tau_R = 0.15$, $\xi = 0$, $\alpha = 0.7$, $A = 1$, $E_0 = 1$.

Panel A



Panel B



Panel C

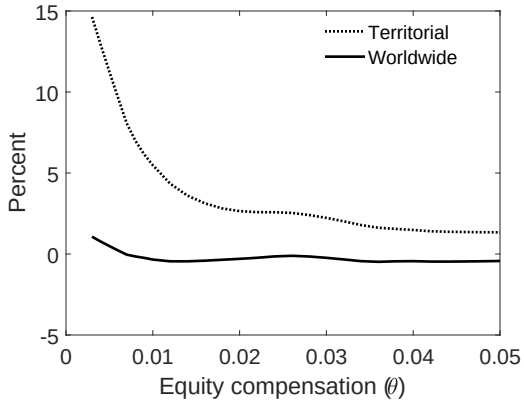


Fig. 5. **The investment distortion caused by agency conflicts.** This figure plots the investment distortion caused by agency conflicts as a function of the resource diversion parameter s (Panel A), bonus compensation b (Panel B), and equity compensation θ (Panel C), under both the worldwide (solid line) and territorial (dotted line) systems. The plot is constructed as the mean capital stock for the benchmark model while varying a single parameter (one variable for each panel), relative to the case with no agency conflicts ($s = 0$, $b = 0$, and $\theta = 1$), reported as a percent difference, and smoothed.

Appendix A. The value of foreign cash

In this section, we derive the expected present value of unrepatriated foreign earnings held inside the firm until tax reform occurs, as well as the expected present value of the manager's resource diversion on those cash holdings.

A.1. The expected present value of foreign cash

Define η as the expected present value of a series of after-tax interest payments and the final repatriation value of the cash balance (of which a fraction s erodes each period) when tax reform occurs. Specifically,

$$\begin{aligned}\eta &= \beta\lambda X + \beta(1-\lambda)(1-s)[Y + \beta\lambda X + \beta(1-\lambda)(1-s)[Y + \beta\lambda X + \cdots \\ &= \beta\lambda X \sum_{i=0}^{\infty}[\beta(1-\lambda)(1-s)]^i + Y\sum_{i=1}^{\infty}[\beta(1-\lambda)(1-s)]^i \\ &= \frac{\beta[\lambda X + (1-\lambda)(1-s)Y]}{1-\beta(1-\lambda)(1-s)}\end{aligned}$$

where

$$\begin{aligned}X &\equiv (1+\xi)\frac{1-\tau_R}{1-\tau_F}[1+(1-\tau_F)r], \\ Y &\equiv (1+\xi)(1-\tau_{US})r.\end{aligned}$$

This gives Eq. (30).

A.2. The expected present value of the manager's resource diversion

Define γ as the expected present value of the stream of diversions that the manager captures from a dollar of cash held until tax reform occurs. Each period, the dollar earns interest which is repatriated, and the manager diverts fraction s out of both the interest and principal. We assume that the manager does no resource diversion in the period that tax

reform occurs. Specifically,

$$\begin{aligned}\gamma &= \beta(1-\lambda)[1+(1-\tau_{US})r]s \\ &+ \beta^2(1-\lambda)^2(1-s)[1+(1-\tau_{US})r]s \\ &+ \beta^3(1-\lambda)^3(1-s)^2[1+(1-\tau_{US})r]s \\ &+ \cdots \\ &= [1+(1-\tau_{US})r]\frac{s}{1-s}\sum_{i=1}^{\infty}[\beta(1-\lambda)(1-s)]^i = \frac{\beta(1-\lambda)[1+(1-\tau_{US})r]s}{1-\beta(1-\lambda)(1-s)}.\end{aligned}$$

This gives Eq. (32).

Appendix B. Computational approach

For computational convenience, we can rewrite the firm's problem where it has the option to convert unrepatriated cash holdings into its expected present value η, defined in Eq. (30), by setting the repatriation tax rate to the minimum of the statutory rate and $(1-\frac{\eta}{1+\xi})$:

$$\hat{d}_t = \tilde{d}_t - \min\left\{\frac{\tau_{US}-\tau_F}{1-\tau_F}, 1-\frac{\eta}{1+\xi}\right\}\max\left\{0,\, \tilde{d}_t - F_t\right\} \tag{36}$$

This specification differs from Eq. (21) only when the repatriation rate (after accounting for foreign tax credits) is greater than $(1-\frac{\eta}{1+\xi})$. In this case, the foreign subsidiary can pay a dividend to the US parent equal to the expected present value of holding cash inside the firm until repatriation is forced through tax reform. One way to think of this dividend is that the firm has the option to put unrepatriated foreign earnings into a savings account that generates return r until tax reform occurs, where the balance cannot be withdrawn by the firm. This cost to the firm of this withdrawal restriction becomes small as the level of liquid assets, C_t, becomes sufficiently high. Therefore, the expected present value of a marginal dollar inside the foreign subsidiary is

$$\max\left\{(1+\xi)\frac{1-\tau_{US}}{1-\tau_F}, \eta\right\} \tag{37}$$

The manager receives the present value of the future resource diversion from the cash holdings until tax reform occurs, given by γ in Eq. (32), in addition to the present value

of future dividends proportional to their equity holdings. In this setting the manager's per-period utility is given by

$$u(Z_t, K_t, C_t, K_{t+1}, C_{t+1}) = \theta(1+\xi)\hat{d}_t+(b+s)(1-\tau_F)E_t+s(1+(1-\tau_{US})r)C_t+\gamma \max\left\{0,\, \tilde{d}_t - F_t\right\}. \tag{38}$$

Given this new per-period utility, the manager's total utility is still defined by Eq. (27), with the additional constraint that $C_t < \bar{C}$. For $\bar{C}$ sufficiently large, the firm's value will closely approximate the firm with unconstrained cash. We verify the chosen $\bar{C}$ is sufficiently large by testing that increasing this upper bound does not change the solution.

Appendix C. Comparative statics on the value of cash, managerial resource diversion, and the repatriation decision

Figure A.1 plots the expected present value of a dollar of earnings (after foreign tax) η, given in Eq. (30), by varying parameter values in the model. All other parameter values are held at their benchmark values, the construction of which are discussed in Section 4 and are reported in Table II. Panel A varies the probability of the tax reform, λ, shown for three different US tax rates. The expected present value of a dollar held as cash is weakly increasing in λ, as the expected time until tax reform is decreasing in the arrival intensity. The value is decreasing in the US tax rate because a high US tax rate increases the tax cost of holding cash. For sufficiently low value of λ, the firm immediately repatriates which can be seen as the flat regions of the plot.

Panel B varies the tax reform repatriation cost, τ_R. Recall that the repatriation cost conditional on reform, τ_R, is the rate before foreign tax credits, where $\tau_R = \tau_F$ corresponds to the foreign tax credit fully offsetting any US taxes triggered by repatriation. At a low US tax rate of 15%, the manager always immediately repatriates and therefore the tax rate during tax reform is irrelevant. For higher US tax rates, higher repatriation rates lower the value of cash, where immediate repatriation occurring when the rate is sufficiently high. Panel C shows a similar pattern for varying the rate of return on investment. Because taxes

on the return to financial assets are based on nominal values, higher nominal rates increase the tax costs of holding cash.

Holding cash inside the foreign subsidiary allows the manager to divert resources to create private value. Figure A.2 plots the value of γ, given in Eq. (32), for various parameter values. All other parameter values are held at their benchmark values.

Panel A shows the value of γ for a range of US tax rates and for low, medium, and high resource diversion parameters. For low US tax rates, the manager immediately repatriates cash and therefore receives no value from diverting resources from the foreign subsidiary's cash holdings. For higher US tax rates, the manager defers repatriations and receives a present value of resource diversion that is increasing in s. The magnitudes of γ are quantitatively small in comparison to the manager's share of the cash holdings through her stock ownership ($\theta\eta$).

Panel B reports the value of γ for a range of tax reform arrival intensities λ for low, medium, and high US tax rates. For low values of λ, the manager prefers to immediately repatriate and γ is zero. When the probability of tax reform is sufficiently high, the manager prefers to wait for tax reform and holds cash inside the subsidiary, diverting resources each period. The time until tax reform decreases in λ, and therefore so does the manager's expected present value of resource diversion, γ. Panel C shows the value for a range of US tax rates for low, medium, and high values for λ. Again, we see that immediate repatriation occurs at lower US tax rates when λ is high. In addition, conditional on holding cash inside the foreign subsidiary, instead of immediately repatriating, the expected present value of resource diversion is significantly decreasing in λ.

The effect of the manager's equity ownership is shown in Panel D. The higher the ownership, the less value the manager gets from resource diversion, γ, relative to her value of direct ownership of the cash holdings, $\theta\eta$. Therefore, immediate repatriation is less likely to occur when the manager's equity ownership is low. Instead, the manager prefers to hold cash and divert resources.

Having explored the expected present value of holding cash until tax reform, as well as

the present value of the manager's resource diversion, we now turn to the decision of whether to immediately repatriate. Figure A.3 explores how the decision to either immediately repatriate or defer repatriation varies with the model parameters. Immediate repatriation occurs when condition (35) is satisfied. Each panel shows the regions under which the manager chooses to defer repatriation until tax reform occurs (white) and to immediately repatriate and pay US corporate income taxes (gray) by varying the parameter values shown on the horizontal and vertical axes. The model parameters not shown on the axes are held at the benchmark values given in Table II.

Panel A shows the repatriation decision as a function of the US and foreign tax rates. A higher spread between the US and foreign tax rates generates a higher cost of immediate repatriation, seen in the left hand side of expression (35). The tax cost of holding cash inside the foreign subsidiary is also increasing in the spread in the tax rates, which can be seen in the expression for η given in Eq. (30). Together, the manager repatriates only when the spread between the US and foreign rates are small, shown in the lower right hand corner.

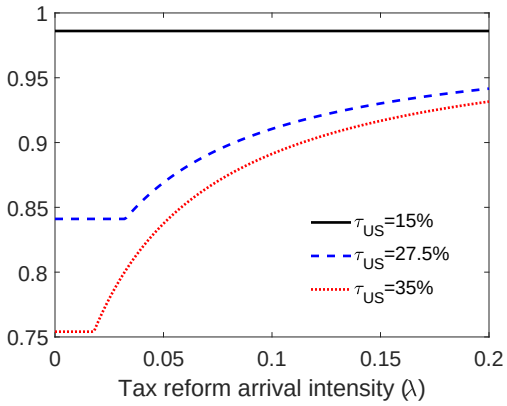
The effect of the manager's personal value of resource diversion from holding cash in the foreign subsidiary, γ, is quantitatively small at the benchmark level of equity holding. This can be seen in Panel B which shows the repatriation decision for different US tax rates and diversion parameter s. The manager's value of holding cash, γ, is increasing in s, and the present value of holding cash until repatriation, η, is decreasing in s. The latter effect dominates, causing immediate repatriation to be increasing in s. However, the quantities are sufficiently small at reasonable resource diversion parameter values that the positive slope is not perceptible.

Panel C shows the repatriation decision for different levels of the US tax rate and the probability of tax reform, λ. Immediate repatriation is decreasing in the US tax rate, as this corresponds to lower repatriation costs. Repatriation is also decreasing in the arrival intensity, as a higher λ lowers the present value of tax costs the firm pays while waiting for tax reform.

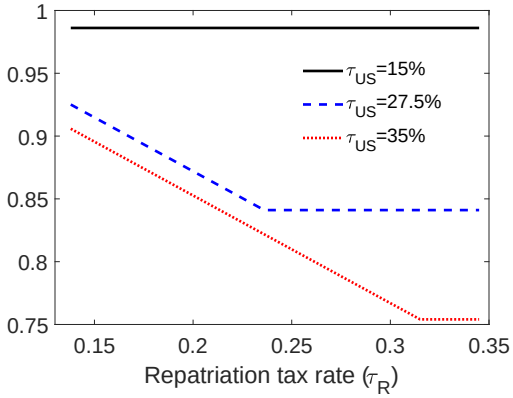
Finally, Panel D varies the tax reform repatriation cost, τ_R, and the probability of tax

reform, λ. A higher repatriation cost τ_R means that the expected costs of waiting to repatriate are increasing, making immediate repatriation relatively more attractive. This interacts with the tax reform arrival intensity λ, which has the same effect as described in Panel C. Deferral is most attractive when reform is likely to happen and repatriation costs conditional on reform are low.

Panel A



Panel B



Panel C

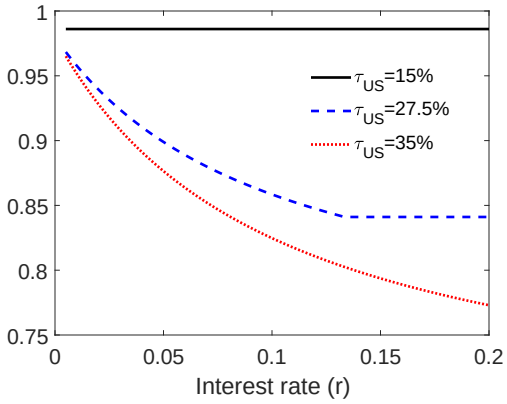


Fig. A.1. **Expected present value of a dollar of cash held inside the foreign subsidiary.** Each panel plots the expected present value of a marginal dollar of cash held inside the subsidiary by varying the tax reform arrival intensity λ (Panel A), the repatriation tax rate on reform τ_R (Panel B), and the interest rate on cash r (Panel C). Each plots shows the value of a dollar for three different US corporate tax rates, τ_{US}. All other parameters are kept at their benchmark values given in Table II. The expected present value of a dollar is defined in Eq. (37). For Panel C, which varies r, the discount factor is kept consistent with r, specifically $\beta = 1/(1+r)$.

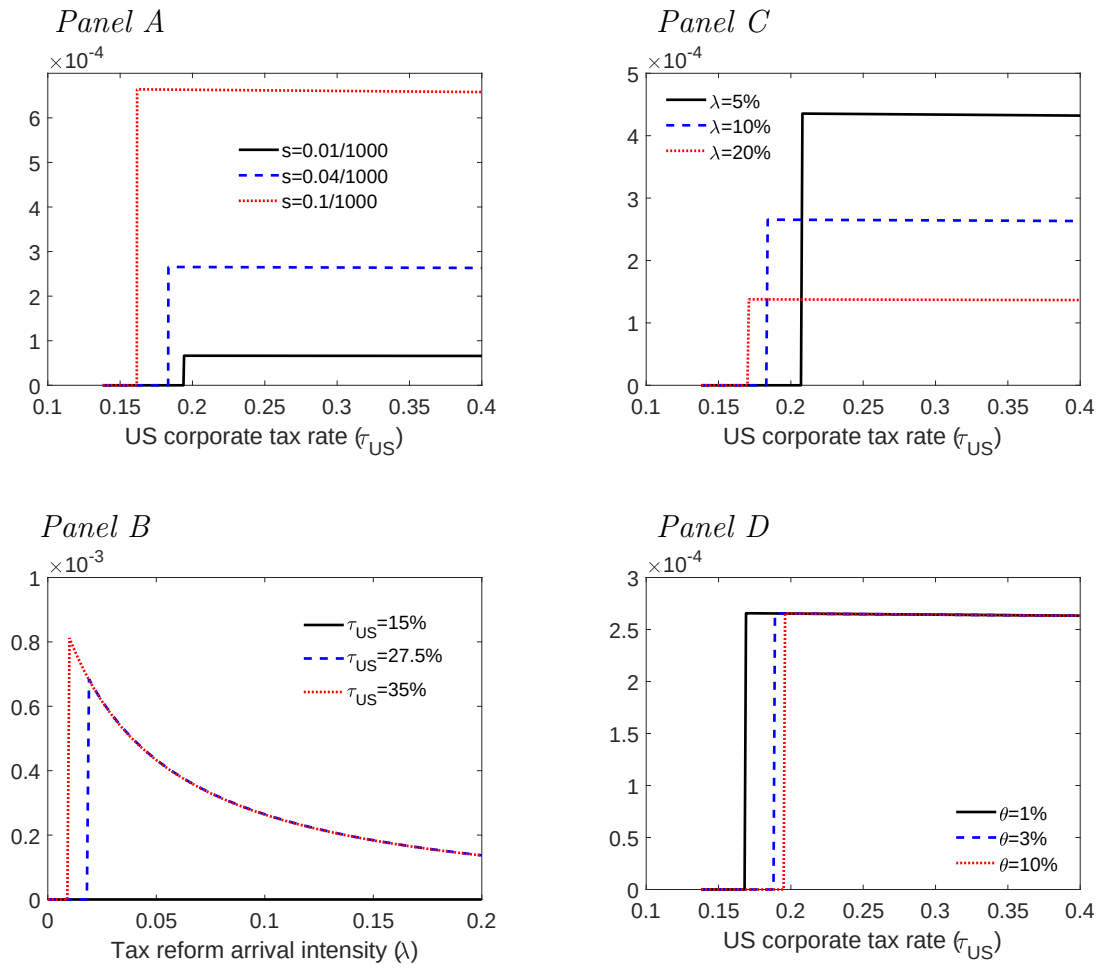


Fig. A.2. **Expected present value of the manager's resource diversion of a marginal dollar of cash.** Each panel plots the expected present value of the manager's resource diversion of a marginal dollar of cash held inside the subsidiary. A single parameter is varied, shown on the horizontal axis, for three different values of another parameter corresponding to each of the three lines. All other parameters are held at their benchmark values given in Table II. The plotted value is equal to γ, defined in Eq. (32), when the manager chooses to defer repatriation until tax reform, and equal to zero when the manager chooses immediate repatriation. Immediate repatriation occurs when condition (35) is satisfied.

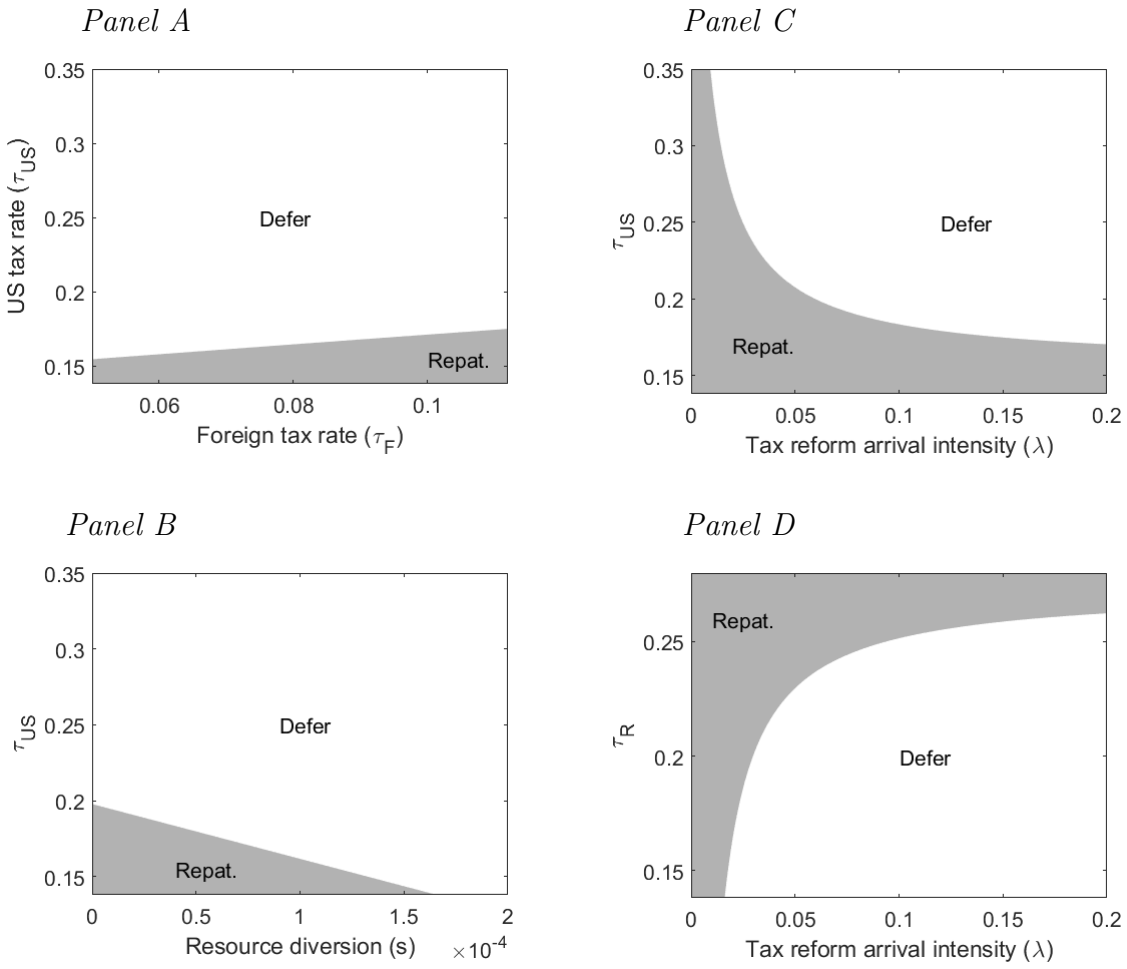


Fig. A.3. **The decision to immediately repatriate or accumulate cash.** Each panel shows the regions of the parameter space, by varying the parameters shown on the axes, for which the firm defers repatriation (white) and repatriates immediately (gray). Immediate repatriation occurs when condition (35) is satisfied.