“Foreign investment of US multinationals: the effect of tax policy and agency conflicts”

By

James F. Albertus
Carnegie Mellon University, Tepper School of Business

Brent Glover*
Carnegie Mellon University, Tepper School of Business

Oliver Levine
University of Wisconsin – Madison, Wisconsin School of Business

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Foreign investment of US multinationals: the effect of tax policy and agency conflicts*

James F. Albertus\textsuperscript{a}, Brent Glover\textsuperscript{a}, Oliver Levine\textsuperscript{b}

\textsuperscript{a} Carnegie Mellon University, Tepper School of Business, 5000 Forbes Avenue, Pittsburgh, PA 15213, USA
\textsuperscript{b} University of Wisconsin–Madison, Wisconsin School of Business, Finance Department, 975 University Avenue, Madison, WI 53706, USA

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ABSTRACT

We develop a model to study how the change from a worldwide to territorial tax system, enacted under the Tax Cuts and Jobs Act (TCJA), affects the incentives for US multinationals to invest abroad. Although the worldwide tax system imposed a higher tax liability on foreign income, we show that it in fact encouraged excess foreign investment by depressing the opportunity cost of capital. Calibrating our dynamic model to confidential data, we find the TCJA reduces foreign investment by 9.7\% for the average firm. The decline is larger for goods producers and firms with less severe agency conflicts.

\textit{JEL classification:} G31, G32, G35, F23, H25

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Corresponding author: Levine, oliver.levine@wisc.edu
The foreign operations of US multinationals are an increasingly large and important segment of economic activity, with capital investment abroad reaching nearly $2 trillion in 2014. This figure represents about 31% of these firms’ global investment, demonstrating that a significant proportion of US multinationals’ operations are overseas. An ongoing debate has focused on the role of tax policy in shaping this foreign activity. In particular, until recently the US taxed income that its corporations earned in foreign countries when these earnings were repatriated, a so-called worldwide tax system. This meant that US companies faced a tax disadvantage when competing overseas, and had an incentive to leave earnings abroad by either holding them as cash or by reinvesting in foreign operations. Many argued that the US tax treatment of foreign earnings distorted the overseas investment of US multinationals and led to the accumulation of large foreign cash balances. With the passage of the Tax Cuts and Jobs Act (TCJA), in 2018 the US transitioned to a territorial tax system, eliminating US tax on the foreign income of its multinationals.

In this paper, we build a dynamic model, calibrated to confidential BEA data, to evaluate how eliminating US taxes on foreign profits, as enacted by the TCJA, affects the incentives of US multinationals to invest and operate overseas. We start by using the model to explore the incentives created by the worldwide tax system. Clearly, US taxation of foreign income increases the expected tax rate the firm faces on its foreign earnings, in turn lowering its incentive to invest overseas. Thus, one would expect the worldwide tax system to lower foreign investment of US multinationals through a direct tax channel, just as a higher tax rate leads to lower investment in a domestic setting.

Perhaps surprisingly, we find the opposite to be true: taxing foreign profits, combined with the option to defer payment by keeping those earnings overseas, increases the incentive

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1 These statistics are based on Table I.A. 1 and Table I.K.1 of Bureau of Economic Analysis (2017).
2 Boot, Logue, and Spatt (2017) discuss key elements of the tax debate and also provide policy recommendations. They favored cutting the corporate rate while retaining the worldwide system.
3 Following the passage of the TCJA, the US tax code is still not a pure territorial system in that the bill introduced a global minimum tax, implemented by the BEAT (base erosion anti-abuse tax), GILTI (global intangible low-taxed income), and FDII (foreign-derived intangible income) provisions, to discourage excessive income shifting to low-tax jurisdictions. However, for our purposes we will treat the enacted system as territorial.
to invest overseas. This is because the worldwide system lowers the opportunity cost of reinvesting foreign earnings by making the alternatives—holding cash overseas or distributing funds to the US parent—more costly. We show that this opportunity cost of capital channel dominates the direct tax channel, under mild assumptions, and firms choose to invest more in their overseas operations under a worldwide system than they would under a territorial system, despite facing a higher tax rate. As a result, we find that the move to a territorial system, following the passage of the TCJA, leads to reduced foreign investment by US multinationals because the opportunity cost of capital channel is removed.

Next, we calibrate the model to assess the quantitative effects of the TCJA on foreign investment. To do so, we require detailed data on the foreign operations of US multinationals. Since these unconsolidated data are not publicly available, we obtain access to the confidential balance sheets and income statements of US multinationals’ foreign subsidiaries collected by the Bureau of Economic Analysis (BEA). These data constitute the highest quality source of information on US multinational firms’ foreign operations and their use is well established in the literature (see, for example, Foley, Hartzell, Titman, and Twite (2007) and Dharmapala, Foley, and Forbes (2011)). Using the calibrated model, we find that the adoption of the TCJA leads to a 9.7% reduction in the average firm’s foreign capital stock. Despite a significant reduction in the effective tax rate facing foreign income, the reform results in only a 3.7% return on the market value of foreign operations (excluding previously accumulated unrepatriated earnings) for the average subsidiary in our sample.\footnote{We use the term “reform” in this paper only to indicate a significant change to the tax code. Slemrod (2018) notes that the TCJA was not a tax “reform” in the traditional sense of the term, as it did not have a goal of reducing the marginal tax rate while broadening the tax base in a revenue neutral manner.}

In the model, tax reform occurs with random arrival, at which point the tax code switches from the worldwide system in place prior to 2018 to the territorial system enacted in the TCJA. The small return reflects the fact that much of the value of the reform is already impounded in prices: for a (counterfactual) firm that assumed the worldwide tax system was permanent, the TCJA increases the expected value of foreign operations by 18%. By including tax reform as a random arrival in the model, we are also able to examine how
expectations of reform affect firm policies.

While we use a dynamic structural model in pursuit of quantitatively credible estimates of the distortions, we also demonstrate that the key findings and economic mechanisms are comparable in a two-period model that is solved analytically. We show that higher investment under the worldwide system occurs as long as the firm expects future repatriation tax rates to decline.

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 strategies to reduce their tax liability.\(^5\) To explore this, we divide the multinationals in our sample into goods producers and services firms, with the idea that the latter have a higher utilization of intangible capital. Using empirical moments from the two subsamples, we separately calibrate the model for goods and services firms. Consistent with the argument of their greater locational flexibility and more aggressive usage of tax-reducing strategies, we find that services firms face much lower foreign and US tax rates on their income compared to goods producers. Using the calibrated model, we find that the predicted reduction in foreign capital is larger by a third for goods producers as it is for services firms. Additionally, the model indicates that the benefit of the tax reform is approximately 13% larger for services firms.

Under a worldwide tax system, firms may choose to accumulate large cash holdings in order to avoid repatriation taxes. Even though this policy may be optimal for the shareholder, this creates a situation in which managers have increased access to cash holdings, exacerbating the potential for a free cash flow problem (Jensen, 1986). Indeed, Hanlon, Lester, and Verdi (2015) find evidence that agency-driven foreign acquisitions are increasing in a firm’s tax-induced foreign cash holdings, while Harford, Wang, and Zhang (2017) find that

\(^5\)For example, Albertus (2017) shows that after a regulatory change by the US Treasury that inadvertently loosened restrictions on profit shifting, US multinationals transferred intellectual property to low tax jurisdictions abroad and increased their innovative activities. Meanwhile Albertus, Glover, and Levine (2018) argue that the combination of firms’ increasing reliance on transferable capital and features of the pre-TCJA tax system allowed US multinationals to reduce their tax obligations by undertaking riskier projects.
shareholders may discount the value of foreign cash holdings because of agency frictions.

To explore and quantify how the tax code interacts with these potential agency frictions, the manager makes investment, cash holdings, and repatriation decisions in the model, and these choices may differ from the shareholders’ preferred policy. Following the modeling approach of Nikolov and Whited (2014), managers face private incentives derived from three sources: managers share in firm profits through bonus pay, own equity in the firm, and have the ability to divert resources for private benefit. These three incentive channels interact to shape the manager’s chosen policies.

We find that the worldwide tax system imposed an agency cost on shareholders by providing managers with increased access to cash and by distorting the repatriation decision. The territorial reform reduces this agency cost by reducing the cost of paying out cash. Quantitatively, we find that agency conflicts have a modest effect on the level of capital stock for the average subsidiary in our sample. For the case without agency conflicts, where the CEO and shareholder are perfectly aligned, the foreign capital stock is reduced by 12.2% under the territorial reform, compared to 9.7% in the benchmark calibration with agency. However, we find significant cross-sectional variation in these agency costs. For certain compensation contracts, the effect of agency conflicts on the investment response to reform can be quite large, in particular when equity ownership is low and bonus compensation is large. In addition, we show that the sensitivity of investment choice to the compensation contract is altered by the TCJA because the manager faces a new set of tradeoffs following the reform. While outside of the model, this suggests that the optimal compensation contract may change to reflect the new incentives of management.

Our paper contributes to several strands of the existing literature. Broadly, we build upon the corporate finance literature of dynamic models of firm investment and financing, such as Gomes (2001), Moyen (2004), and Hennessy and Whited (2005, 2007). Strebulaev and Whited (2012) provide a survey of this literature.

Recent work has examined how the worldwide tax system affects corporate policies. In a closely related paper, Gu (2017) uses a dynamic model to quantify the extent to which the
worldwide tax system distorts the cash holdings of US multinationals relative to domestic firms.\(^6\) Her findings support those of Foley, Hartzell, Titman, and Twite (2007), who show that the accumulation of cash by US multinationals, and firms generally, is substantively driven by repatriation tax costs. Our work complements Gu (2017) by explicitly modeling the possibility of tax reform, by exploring how the worldwide tax system, as well as territorial reform, affects the foreign investment decisions of US multinationals, and by examining the role of agency conflicts in the repatriation, cash holdings, and investment decisions. Spencer (2017) also studies the effect of a territorial reform, building upon the international trade model of Helpman, Melitz, and Yeaple (2004), which gives rise to a set of tradeoffs distinct from those in our model.

In 2009, the UK and Japan moved from worldwide to territorial tax systems, providing an opportunity for direct empirical tests on firm behavior. The reduced-form evidence on multinationals’ foreign investment decisions following these reforms has been mixed: Arena and Kutner (2015) find evidence of a reduction in foreign investment, while Liu (2018) finds an increase. Our structural approach complements these studies by demonstrating and quantifying the economic channels through which investment is likely to be affected, as well as focusing on the tax environment specific to the United States. The model shows how a firm’s type (goods vs. services), as well as agency conflicts, affect its response to the tax reform. Furthermore, our framework allows us to quantitatively compare the effects of the TCJA reform with those of alternative tax reforms.

Our findings also relate to prior work studying the effect of the 2004 tax holiday under the American Jobs Creation Act (AJCA) (Dharmapala, Foley, and Forbes, 2011 and Faulkender and Petersen, 2012). 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. However,\(^6\)

while the AJCA offered a temporary tax holiday that resulted in a one-time cash flow shock to the US parents of multinationals, we focus on a permanent legislative change in tax policy. Part of our contribution is to provide a framework for understanding how the TCJA, the most substantial corporate tax change since 1986, affects US firms’ incentives to invest abroad. The significant shift in the tax incentives brought about by the TCJA will be a fruitful laboratory for future empirical work, and our study presents predictions and testable implications for corporate investment, agency conflicts, and taxation.

Finally, our paper connects to a large literature addressing the effect of tax policy more broadly on firm outcomes. In particular, our work is related to an ongoing debate on the effect of dividend taxes on capital investment decisions. In the traditional view, dividend taxes increase the cost of capital and suppress investment (e.g. Harberger, 1962, and Poterba and Summers, 1984). In contrast, the “new view” suggests that dividend taxes are irrelevant for capital investment for firms using retained earnings as their marginal source of financing (e.g. Auerbach, 1979; Auerbach, 2002; and Yagan, 2015). In our paper, repatriation taxes are similar to dividend taxes but with two important distinctions. First, there are tax costs associated with holding cash, reducing the tax advantage of using retained earnings for investment. Second, unlike most models of dividend taxes, agents incorporate beliefs about the possibility of future tax changes into their decisions. Our framework highlights the importance of tax policy uncertainty in the interaction of taxes and investment.

1. Model

In order to assess the effects of taxes and agency conflicts on the investment choice—as well as cash holdings and repatriation decisions—of foreign subsidiaries, we develop a dynamic model of firm investment that incorporates the details of the tax code in an international setting. In particular, the model allows us to assess how corporations will respond to changes in the corporate tax code brought about by the TCJA and the move from a worldwide to a territorial tax system.

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7See Hassett and Hubbard (2002) and Graham (2003) for surveys of this literature.
1.1. 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

\[ E_t = Z_t K_t^\alpha - \delta K_t - f, \]

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

\[ \log(Z_{t+1}) = \rho \log(Z_t) + \sigma \epsilon_{t+1}, \]

where \( \epsilon_t \) follows a truncated standard normal distribution. The firm accumulates physical capital according to:

\[ K_{t+1} = (1 - \delta) K_t + I_t, \]

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

\[ \Phi(I_t, K_t) \equiv \frac{\phi}{2} \left( \frac{I_t}{K_t} \right)^2 K_t. \]

The foreign government immediately taxes earnings at a rate \( \tau_F \), leaving after-tax earnings of

\[ (1 - \tau_F) E_t. \]

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.\(^8\)

While the US parent generates a US tax liability from the earnings of its foreign subsidiary, it has 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 financial assets held by the foreign subsidiary prior to time \( t \). These assets are held in liquid

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\(^8\)In practice, tax loss carryforwards could result in changes to the firm’s cash flow dynamics. Favilukis, Giammarino, and Pizarro (2017) and Schiller (2016) study the effect of this for equity returns.
financial assets that we will refer to, for convenience, as “cash.” The firm may freely invest in foreign physical assets, but must pay US corporate income tax at a rate $\tau_{US}$, 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 $\tau_{US}$. The return or interest on financial assets is classified as passive income by the IRS, and is not eligible for deferral. Consequently, the value, after repatriation tax, of the return on financial assets is

$$F_t \equiv (1 - \tau_{US})rC_t. \quad (6)$$

As we discussed in the introduction, prior literature has noted that large foreign cash holdings, induced by the high tax cost of repatriation in the worldwide system, can potentially exacerbate agency conflicts between management and shareholders. An important question is how the TCJA reform, or the change to a territorial tax system more generally, interacts with these agency conflicts to affect investment and financing policies. Motivated by these concerns, we incorporate agency conflicts into the model 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 $\theta$ 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’s incentives with shareholders’ interests. Bonus compensation, in contrast, may encourage managers to increase investment and 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. Our model nests the case with no agency conflicts ($\theta = 1$, $b = 0$, and $s = 0$).

Each period, the foreign subsidiary pays the following dividend to the US parent, with
positive values representing a repatriation event:

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

(7)

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.\(^9\) The dividend to the US parent, after accounting for repatriation taxes, is given by

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

(8)

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

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

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

(9)

The manager’s total utility, \( U \), will be defined recursively in the next section after the introduction of uncertainty over future tax policy.

1.2. Tax reform: moving to a territorial system

In 2014, US multinationals held offshore almost $2 trillion in unrepatriated cash, a significant fraction of the cash holdings of all US firms.\(^{10}\) 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 (Hennessy and Strebulaev, 2015 and Lucas, 1976).

\(^9\)For tractability, we abstract from personal taxes in our analysis. See Morellec and Schürhoff (2009) for a model illustrating the effects of personal taxes on corporate investment and financing.

\(^{10}\)See Tables I.B. 1 of Bureau of Economic Analysis (2017).
We assume that each period there is a time-invariant probability $\lambda$ that the US government permanently changes the tax code such that the unrepatriated cash holdings, $C_t$, are repatriated by incurring a one-time tax at rate $\tau_R$ 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 one-time tax at rate $\tau_{R,K}$ on unrepatriated earnings that have been reinvested in capital $K$.$^{11}$ Under the post-reform, territorial tax system, the dividends from the foreign subsidiary to the US parent are

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

and the manager receives per-period utility of

$$u_{t}^{\text{terr}}(Z_t, K_t, C_t, K_{t+1}, C_{t+1}) = \theta d_{t}^{\text{terr}} + (b + s)(1 - \tau_F)E_t + s(1 + (1 - \tau_F)r)C_t$$

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

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

(12)

Given the manager-chosen investment and cash holdings policies, $K^{*, \text{terr}}(\cdot)$ and $C^{*, \text{terr}}(\cdot)$, that maximize Eq. (12), the market (or shareholder) value of the foreign subsidiary under a territorial tax system is

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

(13)

On the arrival of a tax reform, all unrepatriated cash holdings and capital are taxed at the rate $\tau_R$ and $\tau_{R,K}$, respectively, (before credits for foreign taxes paid) and the remaining cash is paid as a dividend to the US parent. For notational convenience, we define the repatriation tax rate after accounting for foreign tax credits as $\tau_{R}^{*}$ and $\tau_{R,K}^{*}$. The manager’s expected total utility, prior to the realization of the tax reform shock, is the probability ($\lambda$)

$^{11}$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. Separately specifying the two rates allow for the differential treatment of earnings held as cash (and cash equivalents) and “illiquid assets,” a distinction that exists in the 2017 tax bill. These rates include any credits received for foreign taxes paid.
weighted sum of the values under the two possible tax systems:

\[
U(Z_t, K_t, C_t) = \lambda \left\{ \theta \left[ (1 - \tau_h^*) (1 + (1 - \tau_F) r) C_t - \tau_{R,K}^* K_t \right] + U^\text{terr}(Z_t, K_t, 0) \right\} \\
+ (1 - \lambda) \max_{K_{t+1}, C_{t+1}} \{ u_t + \beta \mathbb{E}_t [U(Z_{t+1}, K_{t+1}, C_{t+1})] \}. \tag{14}
\]

Define \( K^*(\cdot) \) and \( C^*(\cdot) \) as the manager’s optimal capital and cash holdings policies that maximizes Eq. (14). The market (or shareholder) value of the firm is then given by

\[
V(Z_t, K_t, C_t) = \lambda \left\{ \left[ (1 - \tau_h^*) (1 + (1 - \tau_F) r) C_t - \tau_{R,K}^* K_t \right] + V^\text{terr}(Z_t, K_t, 0) \right\} \\
+ (1 - \lambda) \left\{ d_t + \mathbb{E}_t [\beta V(Z_{t+1}, K^*(Z_t, K_t, C_t), C^*(Z_t, K_t, C_t))] \right\}. \tag{15}
\]

Note that the dividend to the US parent, \( d_t \), is not valued at a premium. In other words, we implicitly assume that the US parent is not financially constrained and therefore does not value a dollar of subsidiary distributions at more than a dollar.\(^{12}\) This assumption is consistent with the data: in our sample of US multinationals, 83% of the parents are in the first (“unconstrained”) tercile of financial constraints as measured by the index of Whited and Wu (2006), with only 7% falling in the third (“constrained”) tercile. This modeling choice is complementary to the decision to assume separability in foreign and domestic production technologies by not explicitly modeling domestic investment. Jointly modeling US and foreign operations would significantly complicate the problem. We instead choose parsimony and assume independence across US and foreign production technologies.\(^ {13}\)

2. Comparative Statics and Optimal Policies

In this section, we use our model to explore the trade-offs facing the firm and manager under a system of worldwide taxation. We proceed in three steps. First, we demonstrate the conditions under which the shareholder prefers to either immediately repatriate foreign earnings or defer the US tax liability. We then explore the firm’s optimal choice of investment

\(^{12}\)Adding a constant premium on the distribution to the parent simply scales the value function without a significant effect on the policy functions of the firm.

\(^{13}\)For an empirical analysis of the interaction between domestic and foreign investment, see, for example, Feldstein (1995), Desai, Foley, and Hines (2005), and Desai, Foley, and Hines (2009).
in its foreign operations and how this is distorted by the presence of worldwide taxation and the possibility of reform. Last, we show how the manager’s private incentives affect the firm’s repatriation and investment decisions. The benchmark parameter values referenced in this section are discussed in Section 3 where we describe the model calibration.

2.1. The repatriation decision

Earnings generated overseas are immediately taxed in the foreign country. For convenience, unless otherwise noted we will refer to foreign earnings net of foreign taxes paid simply as “earnings.” Under the worldwide tax system in place prior to 2018, firms could then choose to either 1) immediately repatriate these earnings and trigger a US tax liability, or 2) keep these earnings inside the foreign subsidiary (as financial assets or reinvested in real operations) which defers the US tax liability. To understand the repatriation decision separate from the investment decision, we begin by focusing on the choice between immediate and deferred repatriation of foreign earnings not used for real investment. To do this, we define “residual earnings” as any foreign earnings that remain after internally financing next-period’s capital choice, \( K^*(Z_t, K_t, C_t) \). Conditioning on the optimal investment choice allows us to quantify the marginal values of repatriation and deferral and understand this trade-off distinct from the investment decision. We discuss the optimal investment choice in the next subsection.

The marginal value of residual earnings that are immediately repatriated is simply

\[
\frac{1 - \tau_{US}}{1 - \tau_F},
\]

where the denominator reflects the US tax credit for foreign taxes paid. If the marginal value of residual earnings retained inside the foreign subsidiary, call this \( \omega(Z_t, K_t, C_t) \), exceeds its repatriated value, i.e.,

\[
\frac{1 - \tau_{US}}{1 - \tau_F} \leq \omega(Z_t, K_t, C_t),
\]

then the shareholder prefers to defer repatriation of a marginal dollar of residual earnings.

The dynamic nature of the model does not permit an analytic expression for \( \omega(Z_t, K_t, C_t) \) or the deferral condition. However, we can gain intuition for the deferral decision by deriv-
ing an analytic expression that closely approximates \( \omega(Z_t, K_t, C_t) \). Specifically, if residual earnings are held as cash (more precisely, interest-bearing financial assets) inside the foreign subsidiary until reform, we show in Appendix A.1 that the expected present value of that dollar is

\[
\eta \equiv \frac{\beta \{ \lambda (1 - \tau_B^*) [1 + (1 - \tau_F) r] + (1 - \lambda) (1 - s) (1 - \tau_{US}) r \}}{1 - \beta (1 - \lambda) (1 - s)}.
\] (18)

Notice that, unlike \( \omega(Z_t, K_t, C_t) \), this value is constant and admits an analytic solution. It depends only on the firm’s parameters, and not on the state variables. In practice, \( \eta \) closely approximates \( \omega(Z_t, K_t, C_t) \). In brief, this is because the foreign subsidiary does not face external financing costs (it can raise capital from its unconstrained parent), and therefore the commitment to hold this dollar as cash until reform does not constrain the subsidiary. The cost is not zero for technical reasons; see Appendix A.1 for a discussion. Note that we do not rely on this approximation when solving the model, it is simply for convenience in the exposition of the repatriation and investment decisions.

We first consider the case with no agency conflicts (\( \theta = 1, b = 0, s = 0 \)) and focus on the condition for deferred repatriation approximated by

\[
\frac{1 - \tau_{US}}{1 - \tau_F} \leq \eta.
\] (19)

Panel A of Figure 1 plots the left and right hand sides of Eq. (19) as a function of the US tax rate (\( \tau_{US} \)) while holding all other parameters at their benchmark values in Table II. The marginal value of immediate repatriation is shown with a solid line, and the marginal value of residual earnings held as cash, \( \eta \), is shown with a dashed line. The vertical dotted line separates the regions for which the deferral condition given in Eq. (19) is satisfied, labeled “Defer,” and not satisfied, labeled “Repatriate.” Both the marginal value of immediate repatriation and \( \eta \) are linear and decreasing in \( \tau_{US} \), making the optimal amount of repatriation a corner solution: the firm either repatriates or defers all residual earnings. The marginal value of residual earnings given the optimal repatriation decision is shown in Panel B of Figure 1 as a function of \( \tau_{US} \).

Importantly, whether the firm immediately repatriates or defers, the marginal value of residual earnings is decreasing in the US tax rate, but for different reasons. Clearly, under
immediate repatriation, the repatriation tax rate is increasing in $\tau_{US}$. When the firm defers repatriation and holds residual earnings as cash, the returns on these financial assets are considered passive (Subpart F) income and are subject to immediate taxation in the US. This generates a tax cost for holding unrepatriated foreign earnings, making deferral costly and increasing in the US tax rate.

Panels C–F of Figure 1 show the marginal value of residual earnings as a function of the reform repatriation tax rate $\tau_{R}$, the interest rate $r$, the probability of reform $\lambda$, and the foreign tax rate $\tau_{F}$, respectively. First consider the regions in which deferral is optimal. In these regions, the expected value of a deferred dollar is decreasing in the reform repatriation tax rate $\tau_{R}$, the interest rate $r$, and the expected time until reform $(1/\lambda)$. This interest rate effect is driven by the fact that taxes are levied on nominal returns: even though the discount factor impounds interest rates ($\beta \equiv 1/(1+r)$), higher nominal rates increase passive income taxation and the cost of holding unrepatriated foreign earnings in financial assets. This implies that deferral is more attractive when nominal interest rates are low. Similarly, lower $\lambda$ corresponds to a longer expected horizon before repatriation occurs and therefore more periods of incurring this tax holding cost of cash. The foreign tax rate, $\tau_{F}$, has little effect on the marginal value of deferred residual earnings.

For the regions in which immediate repatriation is optimal, the marginal value of residual earnings is a function of only $\tau_{US}$ and $\tau_{F}$. This is reflected by the downward and upward slopes in Panels B and F, respectively, and by horizontal lines for the other parameters.

2.2. Optimal foreign investment under the worldwide tax system

Having explored the repatriation decision, we now turn to the optimal investment decision for the foreign subsidiary. To provide clearer intuition on the effect of taxes, we continue with the case of no agency conflicts. Figure 2 plots the level of capital and effective total tax rate as a function of the US tax rate ($\tau_{US}$), holding other parameters fixed at their benchmark values in Table II.\textsuperscript{14} Panel A reports the average capital stock under the worldwide tax system.
system relative to its value in a territorial tax system. Panel B reports the average effective total tax rate constructed as the total expected present value of all tax costs in both the US and the foreign countries, as a fraction of pre-tax earnings. This measures the real expected tax burden that foreign operations face, and includes all immediate and future tax costs, including those from future repatriation and the tax costs associated with deferral. In each of the panels, the vertical dotted lines separate the regions for which the deferral condition given in Eq. (19) is satisfied, labeled “Defer,” and not satisfied, labeled “Repatriate.”

Perhaps surprisingly, the foreign capital stock is increasing in $\tau_{US}$, shown in Panel A, despite the fact that the tax rate the firm faces on these foreign profits is also increasing in $\tau_{US}$, shown in Panel B. Typically, a higher tax rate would induce lower investment, what we call the direct tax channel. However, in the case of worldwide taxation, there is a countervailing effect in that a higher $\tau_{US}$ lowers the opportunity cost of foreign investment. The opportunity cost of foreign investment is either immediate repatriation or holding cash. As we saw previously in Panel B of Figure 1, the opportunity costs are declining in $\tau_{US}$ whether the firm chooses immediate repatriation or deferral. This opportunity cost of capital channel dominates the direct tax channel, and we find that a higher US tax rate leads to higher foreign investment.

Under a territorial tax system, where the firm faces a single tax rate (in this case $\tau_{F}$), the relation between the tax rate and investment is negative. This is the standard case where higher taxes discourage investment. Figure 3 shows this typical negative relation by plotting the average capital stock (Panel A), and the average effective tax rate (Panel B) as a function of the foreign tax rate under the territorial system. Under the territorial system, there is no opportunity cost of capital channel, leaving only the direct tax channel.

In Panels A and B of Figure 2, the repatriation tax rates on reform (after foreign tax credits), $\tau_{R}$ and $\tau_{R,K}$, are held fixed. In Panels C and D, we consider the case where the reform repatriation tax rates are a function of pre-reform US tax rates. Specifically, we assume that $\tau_{R}$ and $\tau_{R,K}$ are a linear function of $\tau_{US}$ in which the intercept and slope are determined by
the benchmark rates specified in the TCJA.\footnote{We construct the one-time transition tax rates as a function of the US tax rate $\tau_{US}$, after accounting for foreign tax credits, as $\tau^*_R(\tau_{US}) = \frac{0.135}{1-0.138} \tau_{US} - (1-0.557) \times 0.138$ and $\tau^*_{R,K}(\tau_{US}) = \frac{0.65}{1-0.138} \tau_{US} - (1-0.771) \times 0.138$. See Footnote 20 for additional details.} Thus, $\tau^*_R$ and $\tau^*_{R,K}$ are proportional to and increasing in $\tau_{US}$. Panel C shows that investment is still increasing in the US tax rate. In fact, the incentive to invest is somewhat stronger in the deferral region because the relative tax savings of investing in capital (i.e., that $\tau^*_{R,K} < \tau^*_R$) is increasing in $\tau_{US}$ in this setting.

Panels A and C of Figure 2 also show that at the benchmark calibration, and for most values of $\tau_{US}$, firms invest more under the worldwide tax system than in a territorial system. Again, the reason is that 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 more costly under the worldwide system.

In Appendix D we show that the qualitative relationships we have described thus far hold more generally. There we develop a simplified, two-period version of the model that allows for analytic solutions of the investment, cash holdings, and repatriation decisions. We show that foreign investment is increasing in the US tax rate in the worldwide tax system under mild and reasonable parameter restrictions: the firm expects post-reform repatriation rates to be lower than the current US tax rate, and that this post-reform repatriation rate exceeds the foreign tax rate (i.e., the repatriation tax rate is not expected to be negative after accounting for foreign tax credits). Specifically, $\tau_F < \mathbb{E}[\tau_R] < \tau_{US}$. We also provide analytic comparative statics on other parameters in the model. In addition, with this parameter restriction, we show that the foreign subsidiary always invests more under the worldwide tax system than under the territorial system, despite facing a higher tax rate. In other words, the opportunity cost of capital channel always dominates the direct tax channel.

2.3. The effect of agency conflicts on repatriation and investment

We now consider the repatriation and investment decisions in the presence of agency conflicts. One of the interesting features of the worldwide tax system is that shareholders often prefer the manager to accumulate, rather than pay out, residual earnings. This cre-
ates 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. Similarly, when managers have control over the deferral decision, their ability to divert resources makes the option to defer relatively more attractive.

Each period, the manager diverts for personal benefit a fraction $s$ of the cash held inside the foreign subsidiary. We show in Appendix A.2 that when a dollar of cash is held inside the subsidiary until reform occurs, the stream of diverted resources to the manager has expected present value

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

(20)

Just as in the case of $\eta$, this value depends only on the parameters and therefore does not vary over time. For reasons similar to those regarding $\eta$, this variable $\gamma$ closely approximates the expected marginal value of residual earnings held inside the foreign subsidiary in terms of the manager’s resource diversion. As before, we use the analytic approximation in Eq. (20) for exposition of the repatriation decision and do not rely on the approximation when solving the model.

The manager prefers to defer repatriation of foreign earnings when the manager’s share of the dividend is less than the marginal value of deferral:

$$\frac{\theta}{1 - \tau_F} \leq \theta \eta + \gamma.$$  

(21)

Dividing by $\theta$ provides a convenient representation for the manager’s condition for deferral:

$$\frac{1 - \tau_{US}}{1 - \tau_F} \leq \eta + \frac{\gamma}{\theta}.$$  

(22)

This condition for deferred repatriation differs from the shareholder’s preferred deferral condition given in Eq. (19) only by the term $\gamma/\theta \geq 0$. This shows that a manager who is able to divert resources, which implies $\gamma > 0$, is more likely to defer repatriation and accumulate cash. When the manager is unable to divert resources ($\gamma = 0$), the shareholder and manager’s deferral conditions are identical. Similarly, higher equity ownership $\theta$ reduces
disagreement between the manager and shareholder in the repatriation decision. Conversely, as equity ownership goes to zero, the manager does not value dividends and always holds cash in order to maximize resource diversion.

Figure 4 repeats the exercise of Figure 1 in the presence of agency conflicts at their benchmark levels \((\theta = 0.02, b = 0.001, s = 0.04/1000)\). Panel A of Figure 4 plots the marginal value of immediate repatriation given in Eq. (16) (solid line) and \(\eta\), the marginal value of residual earnings held as cash (dashed line) as a function of the US tax rate \((\tau_{US})\) while holding all other parameters at their benchmark values. This differs from Panel A of Figure 1 in that \(\eta\) has declined slightly due to \(s > 0\) and the threshold for the deferral region defined by Eq. (21) (the vertical dotted line) has shifted to the left. The benchmark parameters give \(\gamma/\theta \approx 0.0132\), which corresponds to the magnitude of the shift relative to the no agency case. Panel B shows that this leftward shift generates a jump in the marginal value of residual earnings conditional on the manager’s deferral decision. The distortion due to agency conflicts on the repatriation choice and the marginal value of residual earnings is quantitatively modest under the benchmark parameters.

In contrast, Panels C and D show managerial parameter values for which the agency distortion is significant. Panel C assumes a much higher ability of the manager to divert resources \((s = 0.2/1000)\), while Panel D assumes low equity ownership \((\theta = 0.005)\). In both cases, the manager’s private value of deferral increases, shifting the deferral threshold significantly to the left. This generates a significant jump in the marginal value of residual earnings around this threshold. Note that the jump is in the shareholder’s marginal value of residual earnings: the manager’s utility is continuous across this threshold. An implication of this is that certain parameters indicate a significant value loss to shareholders when the manager does not repatriate. The converse is not a concern: managers will never repatriate when the shareholder prefers deferral because \(\gamma/\theta\) is nonnegative. Note that, in contrast to equity ownership and resource diversion, the manager’s bonus compensation \(b\) does not distort the repatriation decision.

Figure 5 reports the average level of capital under the worldwide system with agency
conflicts as a function of the US tax rate, shown with solid lines. For reference, the case without agency conflicts is shown with dashed lines and is invariable across panels. In both cases, capital is scaled by the level of capital in the territorial, no agency benchmark (a constant across values of $\tau_{US}$) and reported as a percent. The vertical dotted line separates the repatriation and deferral regions chosen by the manager that are given in Eq. (21).

Panel A of Figure 5 shows investment in the presence of agency conflicts at their benchmark level. Just as we saw in Panels A and B of Figure 4, there is a slight leftward shift of the deferral threshold relative to the no agency case. In addition, the investment policy is very slightly lower in the deferral region in the presence of agency conflicts. This is because the manager faces a different trade-off in the deferral region than does the shareholder: each additional dollar of foreign earnings not invested in capital allows for resource diversion, making cash relatively more attractive. In contrast, the value of bonus compensation dominates the value of resource diversion in the region of immediate repatriation, leading to higher investment.

Panels B–D of Figure 5 repeat this comparative static by varying a single incentive parameter. Panels B and C show the significant leftward shift in the deferral region in the case of high resource diversion ($s = 0.2/1000$) and low equity ownership ($\theta = 0.005$), respectively. With high resource diversion shown in Panel B, holding cash is relatively more valuable to the manager in the deferral region, leading to lower investment. Just as in Panel A, bonus compensation becomes relatively more important in the repatriation region leading to higher investment. This dominance of bonus compensation in the repatriation region is even more significant in Panel C where equity ownership is low. Finally, Panel D shows that higher bonus compensation ($b = 0.01$) leads to higher investment in both the repatriation and deferral regions, but does not shift the repatriation threshold relative to the benchmark case in Panel A.
2.4. The change in managerial incentives following reform

Moving to a territorial system eliminates the friction causing the accumulation of foreign cash, and therefore reduces the manager’s ability to divert resources for private benefit. How do we expect the sensitivity of investment to the compensation contract and resource diversion ability to change under the territorial system?\(^{16}\)

Figure 6 plots the investment distortion caused by agency conflicts as a function of the resource diversion parameter \(s\), bonus compensation \(b\), and equity compensation \(\theta\), 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 slopes 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 allowing for 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 of 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 \(\theta\). 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

\(^{16}\)Panousi and Papanikolaou (2012), Glover and Levine (2015), and Glover and Levine (2017) show that the structure of the manager’s compensation contract, i.e. the mix of stock and options, helps to explain firm investment.
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.

3. Data and Calibration

In this section we discuss the data sources and descriptive statistics before turning to parameter calibration.

3.1. Sample and descriptive statistics

The study of US multinationals’ foreign response to tax policy relies crucially on high quality data detailing their operations abroad. Unfortunately, such data are not publicly available. For example, data in Compustat’s geographic segment file are reported inconsistently across firms and are usually limited to information on sales. Given the scope of our study, we require many more data items of higher quality. To obtain this information, one of the authors applied for and was granted access to the confidential income statements and balance sheets of US multinationals’ foreign affiliates, maintained on secure government servers at the Bureau of Economic Analysis.

We focus on the foreign affiliates of US multinationals from BEA’s annual surveys on US Direct Investment Abroad.\textsuperscript{17} The surveys are conducted pursuant to the International Investment and Trade in Services Survey Act (hereafter the Act). The Act stipulates that

\textsuperscript{17}These data are collected for the purpose of producing publicly available aggregate statistics on the activities of multinational enterprises.
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 US direct investment abroad.

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 information on managers’ bonus compensation and their equity ownership. This results in a sample period of 1992–2010, with 1992 being the first year for which data are available from Execucomp. As of the time of writing, 2010 is the last year for which BEA’s microdata have been finalized. The sample consists of 63,272 subsidiary-year level observations corresponding to 17,931 unique subsidiaries and 994 unique parent companies.

In Table I, we present descriptive statistics for both the parent companies (Panel A) and the foreign subsidiaries (Panel B). Throughout the paper, financial variables are recorded in millions of 2009 US dollars. In addition, we winsorize each variable at the 2.5% and 97.5% thresholds of its empirical distribution to mitigate the influence of outliers. Table I shows that average parent assets are $8.6 billion, indicating the companies in our sample are comparable in size to Compustat firms satisfying similar selection criteria. The average parent has 12 subsidiaries in 8 different foreign countries.

The statistics on foreign subsidiaries reflect the significant economic activity US multinationals undertake overseas. The average subsidiary has assets of roughly $213 million and employs 432 workers. The parent and subsidiary dividend statistics suggest the parents are not reliant on their subsidiaries for financing. While the average parent pays out $187.3 million to shareholders, it receives less than a quarter of this figure ($42.7 million) in dividends from its foreign subsidiaries combined.
3.2. Calibration

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, \( \tau_F \), to 13.8\%, the median effective rate faced by subsidiaries in our sample.\(^{18}\) The effective tax rate is calculated as the ratio of taxes paid to taxable income.\(^{19}\) Taxable income is the sum of taxes paid and net income. To obtain a US corporate income tax rate, we follow Foley, Hartzell, Titman, and Twite (2007) and rely on marginal tax rates from Graham (1996a,b). We find that the median parent faces a marginal tax rate of 27.5\%. We specify the one-time transition tax rates on cash and illiquid assets, \( \tau_R \) and \( \tau_{R,K} \), to be consistent with the 2017 Tax Cuts and Jobs Act, which specifies rates of 15.5\% and 8\%, respectively, before accounting for foreign tax credits. Accounting for allowable credits for foreign taxes paid gives \( \tau_R^* = 10.9\% \) and \( \tau_{R,K}^* = 5.6\% \).\(^{20}\)

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 \( Z_t \) (persistence \( \rho \), volatility \( \sigma \)), returns to scale \( \alpha \), the fixed costs of production \( f \), the adjustment cost parameter \( \phi \), and the depreciation rate \( \delta \). We calculate the investment rate as the ratio of capital expenditures to lagged gross property, plant, and equipment. Profitability is measured as the ratio of taxable income to total assets.

\(^{18}\)To satisfy BEA’s confidentiality requirements, we do not report the true median, as it may correspond to a value reported by a respondent. Instead, we report the average of the inner five observations. In what follows, we use the term “median” to refer to the average of the inner five observations from BEA’s subsidiary data.

\(^{19}\)For a complete set of variable definitions see Appendix C.

\(^{20}\)The TCJA disallows 55.7\% and 77.1\% of foreign tax credits for past earnings held as cash and non-cash assets, respectively, in calculating the transition tax. We construct the one-time transition tax rates, after accounting for foreign tax credits, as \( \tau_R^* = \frac{0.155 - (1 - 0.557) \times 0.138}{1 - 0.138} \approx 0.109 \) and \( \tau_{R,K}^* = \frac{0.08 - (1 - 0.771) \times 0.138}{1 - 0.138} \approx 0.056 \).
In the model, $\lambda$ is the time-invariant probability of a tax reform occurring each year. Unfortunately, we do not have data on the expectations of a tax reform that would allow us to identify this probability. In our benchmark calibration, we set $\lambda = 0.1$, which implies an expected time until reform of 10 years. In Section 4.4, we consider alternative values for $\lambda$.

Finally, we assume that the firm’s CEO makes financing, repatriation, and investment decisions and use data from Execucomp to calibrate the CEO’s compensation contract. For our 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 $\theta$ and $b$, respectively. For the resource diversion parameter, $s$, which we cannot directly 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. 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 consider alternative parameter values in the sensitivity analysis of Section 4.4.

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

4. The Response to Tax Reform

In this section we use the calibrated model to assess the effect of territorial tax reform on the capital investment of US companies’ foreign operations. We start by evaluating the effect of the TCJA reform, which moved from a worldwide to territorial tax system and reduced the US corporate tax rate. Then we use the model to evaluate two alternative tax reforms and compare these results to those obtained in our TCJA reform. In the first of these alternative reforms, we maintain the worldwide tax system but cut the US corporate rate to 21%. In the second alternative reform, we maintain the US tax rate and the worldwide system but eliminate the option to defer US taxes on unrepatriated foreign earnings.
Next, we examine heterogeneity in the effect of the TCJA reform on US firms’ foreign investment. Specifically, we calibrate the model separately for subsamples of goods producers and services firms, motivated by the idea that the latter rely more heavily on intangible capital. The model implies notable differences in the effects of the TCJA reform on the investment policies of these two groups of firms. We then proceed to evaluate how managerial incentives affect the investment response to the reform. The model shows that cross-sectional differences in manager incentives, resulting from variation in compensation contracts, can produce significant variation in the firm policy responses to the reform. Finally, we assess the sensitivity of our benchmark findings to the parameter choices.

4.1. The TCJA and alternative reforms

On December 22, 2017, the Tax Cuts and Jobs Act (TCJA) was signed into law less than two months after its introduction in Congress. Most significantly, the legislative change reduced the US federal corporate income tax rate from 35% to 21% and removed most of the worldwide tax provisions for US companies. Any unrepatriated earnings held overseas face a one-time transition tax of 15.5% and 8% for cash (and cash equivalents) and illiquid assets (e.g. physical capital), respectively.

Using the model, calibrated to BEA’s subsidiary level data, we quantify the change in foreign investment 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, etc. Instead, our approach isolates the direct effect of taxes, and managerial incentives, on the investment incentives of US firms that operate overseas.

The first column of Table IV reports, in percent, the post-TCJA changes in investment and other firm characteristics for the average firm, computed from the model. The model is simulated using the pre-reform, worldwide calibration, where firms place a probability \( \lambda \) each year of passing a bill with the provisions specified in the TCJA. Average values

\[ ^{21}\text{The TCJA is officially titled “An Act to provide for reconciliation pursuant to titles II and V of the concurrent resolution on the budget for fiscal year 2018.”} \]
for capital stock, revenue, earnings before taxes, enterprise value (non-cash equity value), and the foreign and global tax revenues from the foreign operations of US multinationals are calculated from the 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-implied decline in the variable following the reform.

In the model, moving to a territorial tax system has a significant dampening effect on foreign investment, with the level of capital stock dropping about 9.7% 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 decline in the enterprise value is minimal as the smaller optimal size is offset by a lower tax rate on future profits. Foreign tax revenue from the foreign operations of US multinationals declines only slightly, while global tax revenue declines about 50% due to the elimination of the US tax on foreign earnings. In addition, the reform shock generates a (one-time) equity return on the foreign subsidiary of 3.69% (on operations before accounting for the reduced cost of repatriating past earnings) as the foreign subsidiary faces a lower tax rate going forward. The relatively small return reflects the fact that much of the value of the reform is already impounded in prices: for a (counterfactual) firm that assumed the worldwide tax system was permanent ($\lambda = 0$), the TCJA increases the value of foreign operations by 18.1%.

The model shows 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 Section 2, this is because the worldwide tax code, with the immediate US taxation of passive income imposed by Subpart F, lowers the opportunity cost of investing in physical capital, resulting in higher investment before the reform to a territorial tax system. 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 a future tax rate that is, in expectation, lower than the current rate. 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 for incumbent firms.

In the last two columns of Table IV, we consider two alternative reforms 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 repatriated immediately) within the worldwide system. In both cases, as with the first column, we assume that agents do not expect subsequent tax changes to occur.22

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 10.3% 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 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 reduce investment and optimal firm size following reform.

Removing the deferral option, shown in the final column, causes an even larger decline in investment of 18.3%. This case is similar to the second column in that the firm now immediately repatriates all earnings, but the firm 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.

\[ \text{22In order to keep agent expectations consistent across the three columns, we assume that agents expect a territorial tax reform with probability } \lambda \text{ in each specification. Therefore, the denominators in each column are the same, allowing us to focus on the post-reform effects. The alternative tax policies in the second and third columns can be thought of as a surprise to the agents.} \]
4.2. *Goods producers versus service firms*

For various reasons, firms operating in different industries face different tax rates. For example, firms with more intellectual property can use aggressive tax strategies to move profits to low-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, with the idea that the latter rely more heavily on intangible capital.\footnote{BEA’s data disaggregates total sales into goods and services categories. We classify a firm as a goods producer if 50% or more of its consolidated sales result from the sale of goods, and a services firm otherwise.}

Table V reports the results of the calibrations for goods producers and service firms. Panel A reports the 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 anecdotal evidence on 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%). Finally, service firms provide somewhat stronger equity-based incentives for their CEOs through higher equity ownership (2.5% vs. 1.9%).

Panel A of Table V reveals that the model produces a decline in foreign investment from the TCJA reform that is about 25% larger for goods producers than for service firms (−8.33% vs. −6.26%). There are two primary reasons 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 tax 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 it does for goods producers that face a higher tax holding cost. This difference also means that global tax collections from service firms are predicted to decline by much more than for good producers.\footnote{The global minimum tax provisions in the TCJA may mitigate these effects for certain firms facing low foreign rates.} The equity return on the firm’s non-cash assets is also higher for service firms (4.17% vs. 3.69%). For the (counterfactual) case in which the reform was completely
unexpected ($\lambda = 0$), the value of foreign operations increase by 28.3% and 18.1% for service firms and good producers, respectively. The reduced repatriation taxes on past earnings also benefits service firms more than goods producers due to the relative spread between the US and foreign rates. Overall, the model results suggest that the benefit of the tax reform to service firms is significantly greater than for goods producers although the investment response is smaller.

4.3. Managerial incentives and agency conflicts

The previous results assume the manager has incentives specified by the calibrated benchmark parameters. We now use the model to compute the magnitude of the distortions caused by agency conflicts, and consider alternative incentive parameters. Table VI reports, in percent, the response to the TCJA tax reform (Panel A) and the effect of agency on pre-reform (worldwide system) outcomes (Panel B), for alternative compensation contracts and managerial resource diversion abilities.

Panel A of Table VI shows that the change in the capital stock in response to reform is somewhat larger in magnitude ($-12.2\%$ vs. $-9.7\%$) for a firm that has a manager with perfectly aligned incentives, shown in column 2, than for the benchmark case, reproduced in column 1. Columns 3 and 4 show that simply shutting off bonus compensation and the ability to divert resources, respectively, 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, respectively, revealing that agency conflicts have a significant effect for certain firms.\(^{25}\)

Firms with CEOs that receive low equity ownership and high bonus are less aligned with shareholders and choose a high level of investment under both the worldwide and territorial systems in order to increase bonus compensation. The model predicts that tax reform leads to approximately no change in the capital stock for firms with this low equity/high bonus compensation contract relative to the $9.7\%$ decline for

\(^{25}\)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. See Appendix C for details on variable construction. Low equity/high bonus corresponds to ($\theta = 0.003, b = 0.15$), and high equity/low bonus is ($\theta = 0.037, b = 0.00$).
the benchmark contract. CEOs with high equity, low bonus compensation contracts behave closer to the benchmark case, with a decline in capital stock of 11.7% following reform; the benchmark level of equity ownership does well in aligning incentives.

Panel B of Table VI shows how agency conflicts distort 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 caused higher investment by 1.8%, while resource diversion reduced investment by 2.0%. 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, with these CEOs choosing capital stock 7.5% higher than the average firm. Taken together, these results suggest that a manager’s contract incentives can play an important role in shaping their optimal response to the tax reform.

4.4. 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.

4.4.1. Tax rates and parent financial constraints

Panel A of Table VII reports the changes, in percent, from territorial tax reform for alternative US and foreign corporate tax rates ($\tau_{US}$ and $\tau_{F}$). As shown in the second column,
for firms facing a lower, 21\%, US tax rate, the effect of tax reform results in only a small 1.7\% decline in the capital stock. Firms facing the top US statutory rate of 35\% reduce their capital stock by 12.3\% following reform. As shown in the final row, the managers find it optimal to defer repatriating foreign earnings until tax reform only in the case with a higher US tax 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.

The last two columns of Panel A shows the effect of varying the foreign tax rate. Both before and after reform, the level of capital stock is decreasing in the foreign tax rate. These two columns, along with the benchmark value, reveals that the capital response to reform is non-monotonic in the foreign tax rate.

4.4.2. 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 \((\tau_{R}^{c})\) and capital \((\tau_{R,K}^{c})\), as well as the likelihood that tax reform occurs \((\lambda)\). The second and third columns show that the response to capital investment following reform is increasing in magnitude with the tax rate on cash \((\tau_{R}^{c})\), while decreasing in magnitude with the tax rate on capital \((\tau_{R,K}^{c})\). 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 substantial 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, $\lambda$. 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 0.4%. However, the value of this reform is very high and the firm’s non-cash assets increase in value by 13.3%, much more than the 3.7% return in the benchmark case. As $\lambda$ 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, $\lambda$ 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 $\lambda$ 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.

4.4.3. 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 cheap, 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, as is the case for $r = 0.08$ shown in the third column.

The final six columns of Panel C show the effect of the persistence and volatility in profitability ($\rho$ and $\sigma$), and returns to scale ($\alpha$) 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.

5. Conclusion

Using an investment model of US multinationals’ foreign operations calibrated to confidential BEA data, we find that the incentive to invest overseas is significantly reduced under the territorial tax system enacted under the TCJA. We show that the worldwide tax system used for decades by the US, combined with a high corporate tax rate, may have had the unintended consequence of increasing foreign investment, and, as a consequence, possibly encouraged the offshoring of US production. We find the incentive to overinvest in foreign operations is primarily driven by tax incentives rather than agency conflicts, and holds even when the manager is perfectly aligned with shareholders.

Our analysis casts doubt on the view that bringing back the foreign “trapped cash” will lead to increased US investment. We find that a vast majority of US multinationals are financially unconstrained, meaning their US investment decisions are unlikely to be significantly affected by repatriation costs. Moreover, we show that the firms that are least financially constrained are most likely to have previously deferred repatriation and have significant foreign cash holdings.

The TCJA was the most significant corporate tax change since 1986, changing incentives in ways that are only beginning to be understood. This dramatic shift in the tax code will be a fruitful laboratory for future empirical work, and our study provides predictions and testable implications for corporate investment, agency conflicts, and taxation.
References


Schiller, A., 2016. Corporate taxation and the cross-section of stock returns.


Zhao, J., 2017. Accounting for the corporate cash increase. Available at SSRN 2492339.
Table I: **Descriptive statistics**

**Panel A: Parent companies**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Quasi-median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets</td>
<td>8,603.8</td>
<td>27,527.8</td>
<td>2,015.5</td>
</tr>
<tr>
<td>Employees</td>
<td>14,845.4</td>
<td>27,564.9</td>
<td>4,828.2</td>
</tr>
<tr>
<td>Sales</td>
<td>5,862.5</td>
<td>14,959.0</td>
<td>1,594.4</td>
</tr>
<tr>
<td>Net income</td>
<td>514.8</td>
<td>1,955.8</td>
<td>82.9</td>
</tr>
<tr>
<td>Dividends (to shareholders)</td>
<td>187.3</td>
<td>745.8</td>
<td>9.3</td>
</tr>
<tr>
<td>Subsidiary count</td>
<td>12.2</td>
<td>23.6</td>
<td>5.0</td>
</tr>
<tr>
<td>Country count</td>
<td>8.0</td>
<td>10.2</td>
<td>4.0</td>
</tr>
</tbody>
</table>

**Panel B: Subsidiaries**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Quasi-median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets</td>
<td>213.4</td>
<td>399.8</td>
<td>67.3</td>
</tr>
<tr>
<td>Employees</td>
<td>432.4</td>
<td>749.1</td>
<td>150.0</td>
</tr>
<tr>
<td>Sales</td>
<td>209.9</td>
<td>383.1</td>
<td>72.9</td>
</tr>
<tr>
<td>Net income</td>
<td>12.1</td>
<td>34.1</td>
<td>2.7</td>
</tr>
<tr>
<td>Dividends (to parent)</td>
<td>3.5</td>
<td>14.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

This table presents descriptive statistics. Panels A and B correspond to the sample parent companies and foreign subsidiaries, respectively. “Quasi-median,” which equals the average of the inner five observations, is used instead of the true median to satisfy confidentiality requirements. Assets is total assets. Employees is employee count. Sales is total sales. In Panel A, dividends are payments from a parent company to its shareholders, while in Panel B they are from a foreign subsidiary to its parent company. Subsidiary count is the number of a parent’s foreign subsidiaries. Country count is the number of unique countries in which a parent has foreign subsidiaries. Financial variables are recorded in 2009 US dollars. All variables are winsorized at the 2.5% and 97.5% thresholds of their empirical distributions. Panels A and B represent 5,258 parent-years and 63,272 subsidiary-years, respectively.
Table II: **Benchmark model parameters**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho$</td>
<td>Persistence in productivity</td>
<td>0.72</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Volatility of productivity</td>
<td>0.34</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Returns to scale</td>
<td>0.48</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Depreciation rate</td>
<td>0.12</td>
</tr>
<tr>
<td>$f$</td>
<td>Fixed costs</td>
<td>0.035</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Adjustment costs</td>
<td>0.06</td>
</tr>
</tbody>
</table>

*Calibrated to production moments:*

| $\rho$ | Persistence in productivity | 0.72 |
| $\sigma$ | Volatility of productivity | 0.34 |
| $\alpha$ | Returns to scale | 0.48 |
| $\delta$ | Depreciation rate | 0.12 |
| $f$ | Fixed costs | 0.035 |
| $\phi$ | Adjustment costs | 0.06 |

*Set to empirical counterpart:*

| $\tau_F$ | Foreign tax rate | 0.138 |
| $\tau_{US}$ | US tax rate on domestic earnings | 0.275 |
| $\tau_R$ | One-time tax rate on cash, before FTC | 0.155 |
| $\tau_R^*$ | One-time tax rate on cash, after FTC | 0.109 |
| $\tau_{R,K}$ | One-time tax rate on illiquid assets, before FTC | 0.08 |
| $\tau_{R,K}^*$ | One-time tax rate on illiquid assets, after FTC | 0.056 |
| $\theta$ | Manager equity ownership | 0.02 |
| $100 \times b$ | Bonus to operating income ratio | 0.1 |
| $1000 \times s$ | Manager resource diversion | 0.04 |

*Pre-selected:*

| $r$ | Discount rate | 0.04 |
| $\lambda$ | Tax reform arrival probability | 0.1 |

The table presents benchmark parameter values used in the quantitative model. Values are reported at an annual frequency, where applicable. FTC stands for foreign tax credits. For more details on the calibration, see Section 3.
Table III: Model targeted moments

<table>
<thead>
<tr>
<th>Moment</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profitability, mean</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Profitability, standard deviation</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Profitability, serial correlation</td>
<td>0.58</td>
<td>0.59</td>
</tr>
<tr>
<td>Investment rate, mean</td>
<td>0.13</td>
<td>0.14</td>
</tr>
<tr>
<td>Investment rate, standard deviation</td>
<td>0.19</td>
<td>0.18</td>
</tr>
<tr>
<td>Investment rate, serial correlation</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td>Frequency of negative earnings</td>
<td>0.19</td>
<td>0.20</td>
</tr>
</tbody>
</table>

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 3 for a description of the data and the calibration approach. See Appendix C for variable definitions.
Table IV: **Response to enacted TCJA and alternative tax reforms**

<table>
<thead>
<tr>
<th></th>
<th>Enacted (TCJA)</th>
<th>Alternative reforms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Territorial reform</td>
<td>Lower US rate ($\tau_{US} = 21%$), maintain worldwide tax</td>
</tr>
<tr>
<td>Capital stock (K)</td>
<td>-9.66</td>
<td>-10.33</td>
</tr>
<tr>
<td>MPK</td>
<td>5.18</td>
<td>5.75</td>
</tr>
<tr>
<td>Revenue</td>
<td>-4.35</td>
<td>-4.67</td>
</tr>
<tr>
<td>Earnings before taxes</td>
<td>-2.22</td>
<td>-2.40</td>
</tr>
<tr>
<td>Enterprise value</td>
<td>-0.37</td>
<td>-6.95</td>
</tr>
<tr>
<td>Foreign tax revenue</td>
<td>-2.17</td>
<td>-3.62</td>
</tr>
<tr>
<td>Global tax revenue</td>
<td>-49.97</td>
<td>-25.12</td>
</tr>
</tbody>
</table>

The table presents the model-computed response of various firm outcomes under the enacted TCJA territorial tax reform as well as two alternative reforms. The first column of Table IV reports, in percent, the 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), and the foreign and global tax revenues collected from the foreign operations of US multinationals 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 decline in the variable following the reform. The last two columns explore alternative 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 unchanged worldwide system. In both cases, as with the first column, we assume that agents do not expect subsequent tax changes to occur.
Table V: **Response to enacted TCJA reform for goods producers and service firms**

**Panel A: Effect of moving to a territorial system (percent)**

<table>
<thead>
<tr>
<th></th>
<th>Goods producers</th>
<th>Service firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital stock ($K$)</td>
<td>-8.33</td>
<td>-6.26</td>
</tr>
<tr>
<td>MPK</td>
<td>4.30</td>
<td>3.10</td>
</tr>
<tr>
<td>Revenue</td>
<td>-3.57</td>
<td>-1.96</td>
</tr>
<tr>
<td>Earnings before taxes</td>
<td>-0.85</td>
<td>1.67</td>
</tr>
<tr>
<td>Firm size</td>
<td>0.48</td>
<td>5.68</td>
</tr>
<tr>
<td>Foreign tax revenue</td>
<td>-0.77</td>
<td>1.76</td>
</tr>
<tr>
<td>Global tax revenue</td>
<td>-47.29</td>
<td>-85.79</td>
</tr>
</tbody>
</table>

**Panel B: Parameters**

<table>
<thead>
<tr>
<th></th>
<th>$\tau_{US}$</th>
<th>$\tau_F$</th>
<th>$\tau^*_R$</th>
<th>$\tau^*_{R,K}$</th>
<th>$\rho$</th>
<th>$\sigma$</th>
<th>$\alpha$</th>
<th>$f$</th>
<th>$\phi$</th>
<th>$\theta$</th>
<th>$b \times 100$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goods producers</td>
<td>0.283</td>
<td>0.148</td>
<td>0.105</td>
<td>0.054</td>
<td>0.70</td>
<td>0.38</td>
<td>0.52</td>
<td>0.033</td>
<td>0.053</td>
<td>0.019</td>
<td>0.14</td>
</tr>
<tr>
<td>Service firms</td>
<td>0.247</td>
<td>0.027</td>
<td>0.147</td>
<td>0.076</td>
<td>0.64</td>
<td>0.50</td>
<td>0.58</td>
<td>0.020</td>
<td>0.047</td>
<td>0.025</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Panel C: Calibrated moments**

<table>
<thead>
<tr>
<th></th>
<th>Goods producers</th>
<th>Service firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data</td>
<td>Model</td>
</tr>
<tr>
<td>Profitability, mean</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>Profitability, standard deviation</td>
<td>0.18</td>
<td>0.15</td>
</tr>
<tr>
<td>Profitability, serial correlation</td>
<td>0.58</td>
<td>0.57</td>
</tr>
<tr>
<td>Investment rate, mean</td>
<td>0.12</td>
<td>0.14</td>
</tr>
<tr>
<td>Investment rate, standard deviation</td>
<td>0.19</td>
<td>0.19</td>
</tr>
<tr>
<td>Investment rate, serial correlation</td>
<td>0.27</td>
<td>0.29</td>
</tr>
<tr>
<td>Frequency of negative earnings</td>
<td>0.24</td>
<td>0.22</td>
</tr>
</tbody>
</table>

The table reports the response to the territorial reform (TCJA) separately for goods producers and service firms. The responses, computed from the model, 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 3. The model-simulated and BEA data moments are reported in Panel C.
Table VI: Effect of managerial incentives on response to tax reform

**Panel A: Response to territorial tax reform (percent)**

<table>
<thead>
<tr>
<th></th>
<th>Benchmark (with agency)</th>
<th>No agency (b = 0)</th>
<th>No bonus (s = 0)</th>
<th>No resource diversion</th>
<th>Low equity, high bonus</th>
<th>High equity, low bonus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital stock (K)</td>
<td>-9.66</td>
<td>-12.20</td>
<td>-10.60</td>
<td>-10.90</td>
<td>0.01</td>
<td>-11.65</td>
</tr>
<tr>
<td>MPK</td>
<td>5.18</td>
<td>6.59</td>
<td>5.60</td>
<td>6.02</td>
<td>0.13</td>
<td>6.24</td>
</tr>
<tr>
<td>Revenue</td>
<td>-4.35</td>
<td>-5.63</td>
<td>-4.85</td>
<td>-4.95</td>
<td>0.37</td>
<td>-5.37</td>
</tr>
<tr>
<td>Earnings before taxes</td>
<td>-2.22</td>
<td>-3.14</td>
<td>-2.70</td>
<td>-2.52</td>
<td>0.95</td>
<td>-3.03</td>
</tr>
<tr>
<td>Enterprise value</td>
<td>-0.37</td>
<td>-1.06</td>
<td>-0.75</td>
<td>-0.65</td>
<td>7.23</td>
<td>-1.10</td>
</tr>
<tr>
<td>Foreign tax revenue</td>
<td>-2.17</td>
<td>-3.08</td>
<td>-2.64</td>
<td>-2.47</td>
<td>0.93</td>
<td>-2.96</td>
</tr>
<tr>
<td>Global tax revenue</td>
<td>-49.97</td>
<td>-50.38</td>
<td>-50.21</td>
<td>-50.07</td>
<td>-49.32</td>
<td>-50.37</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>No agency (b = 0)</th>
<th>No bonus (s = 0)</th>
<th>No resource diversion</th>
<th>Low equity, high bonus</th>
<th>High equity, low bonus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital stock (K)</td>
<td>0.15</td>
<td>-1.82</td>
<td>2.00</td>
<td>7.53</td>
<td>-1.10</td>
</tr>
<tr>
<td>MPK</td>
<td>0.27</td>
<td>1.24</td>
<td>-0.66</td>
<td>-3.20</td>
<td>0.50</td>
</tr>
<tr>
<td>Revenue</td>
<td>0.23</td>
<td>-0.65</td>
<td>1.31</td>
<td>4.45</td>
<td>-0.74</td>
</tr>
<tr>
<td>Earnings before taxes</td>
<td>0.46</td>
<td>0.01</td>
<td>1.50</td>
<td>4.41</td>
<td>-0.86</td>
</tr>
<tr>
<td>Enterprise value</td>
<td>0.25</td>
<td>-0.41</td>
<td>0.79</td>
<td>0.91</td>
<td>-0.30</td>
</tr>
<tr>
<td>Foreign tax revenue</td>
<td>0.25</td>
<td>0.04</td>
<td>1.36</td>
<td>4.16</td>
<td>-0.85</td>
</tr>
<tr>
<td>Global tax revenue</td>
<td>0.15</td>
<td>0.05</td>
<td>1.22</td>
<td>6.57</td>
<td>-0.85</td>
</tr>
</tbody>
</table>

The table reports, in percent, the 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, computed from the model. The construction follows the same approach as in Table IV, and the benchmark results 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 changes 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 θ = 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 Appendix C.
Table VII: Sensitivity analysis

**Panel A: Pre-reform tax rates**

<table>
<thead>
<tr>
<th></th>
<th>Benchmark</th>
<th>$\tau^{*}_{US}$</th>
<th>$\tau^{*}_{F}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital stock (K)</td>
<td>-9.66</td>
<td>-1.69</td>
<td>-12.34</td>
</tr>
<tr>
<td>MPK</td>
<td>5.18</td>
<td>0.84</td>
<td>6.81</td>
</tr>
<tr>
<td>Revenue</td>
<td>-4.35</td>
<td>-0.45</td>
<td>-5.69</td>
</tr>
<tr>
<td>Earnings before taxes</td>
<td>-2.22</td>
<td>0.34</td>
<td>-3.01</td>
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<tr>
<td>Enterprise value</td>
<td>-0.37</td>
<td>2.60</td>
<td>-0.83</td>
</tr>
<tr>
<td>Foreign tax revenue</td>
<td>-2.17</td>
<td>0.34</td>
<td>-2.94</td>
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<tr>
<td>Global tax revenue</td>
<td>-49.97</td>
<td>-34.03</td>
<td>-54.43</td>
</tr>
<tr>
<td>Return from reform</td>
<td>3.64</td>
<td>1.74</td>
<td>4.22</td>
</tr>
<tr>
<td>Defer</td>
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<td>No</td>
<td>Yes</td>
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<table>
<thead>
<tr>
<th></th>
<th>$\tau^{*}_{R,K}$</th>
<th>$\lambda$</th>
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<td>Revenue</td>
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<td>-1.12</td>
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<tr>
<td>Earnings before taxes</td>
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<tr>
<td>Enterprise value</td>
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</tr>
<tr>
<td>Foreign tax revenue</td>
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<td>-0.12</td>
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<tr>
<td>Global tax revenue</td>
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<td>-48.97</td>
</tr>
<tr>
<td>Return from reform</td>
<td>4.18</td>
<td>3.22</td>
</tr>
<tr>
<td>Defer</td>
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<td>Yes</td>
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**Panel B: Tax reform expectations**

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<tr>
<td>Revenue</td>
<td>-4.35</td>
<td>-1.55</td>
<td>-5.38</td>
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</tr>
<tr>
<td>Earnings before taxes</td>
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<td>-0.51</td>
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<td>-4.12</td>
</tr>
<tr>
<td>Enterprise value</td>
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<td>0.49</td>
<td>0.35</td>
<td>-4.43</td>
</tr>
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<td>3.74</td>
<td>4.18</td>
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<tr>
<td>Defer</td>
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**Panel C: Technology and discount parameters**

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<th>$\rho$</th>
<th>$0.08$</th>
<th>$\sigma$</th>
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<tr>
<td>MPK</td>
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<td>6.69</td>
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<td>6.69</td>
<td>3.21</td>
</tr>
<tr>
<td>Revenue</td>
<td>-4.35</td>
<td>-3.08</td>
<td>-4.89</td>
<td>-5.66</td>
<td>-1.30</td>
<td>-5.31</td>
<td>-3.06</td>
<td>-3.60</td>
<td>-2.94</td>
<td>-3.60</td>
<td>-2.94</td>
</tr>
<tr>
<td>Earnings before taxes</td>
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<td>-0.22</td>
<td>-4.58</td>
<td>-3.94</td>
<td>0.72</td>
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<td>-0.69</td>
<td>-1.89</td>
<td>0.70</td>
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<tr>
<td>Enterprise value</td>
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<td>0.43</td>
<td>0.84</td>
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<td>3.62</td>
<td>-2.13</td>
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<td>0.81</td>
<td>0.17</td>
<td>0.81</td>
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<tr>
<td>Foreign tax revenue</td>
<td>-2.17</td>
<td>-0.22</td>
<td>-4.50</td>
<td>-3.82</td>
<td>0.72</td>
<td>-3.39</td>
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<td>0.68</td>
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<tr>
<td>Global tax revenue</td>
<td>-49.97</td>
<td>-45.78</td>
<td>-51.82</td>
<td>-50.73</td>
<td>-49.57</td>
<td>-50.53</td>
<td>-49.20</td>
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<td>-49.81</td>
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<td>Return from reform</td>
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<tr>
<td>Defer</td>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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</tr>
</tbody>
</table>

The table reports the response to a territorial reform (TCJA) for various alternative parameter values. The responses, computed from the model, 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 values are reproduced in the first column of each panel. For each parameter, the response to territorial reform is calculated for the alternative parameter value while holding all other parameters at 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. Marginal value of residual earnings in the case without agency conflicts. Panel A plots the marginal value of immediate repatriation (solid line) and the marginal value of residual earnings held as cash, $\eta$, (dashed line) as a function of the US tax rate $\tau_{US}$. Panels B–F plot the marginal value of residual earnings conditional on the optimal repatriation decision given in Eq. (19) as a function of the US tax rate ($\tau_{US}$), the repatriation tax rate ($\tau^*_R$), the interest rate ($r$), the probability of reform ($\lambda$), and the foreign tax rate ($\tau_F$), respectively. In each panel, all other parameters are held at their benchmark values, and agency conflicts are shut down ($\theta = 1$, $b = 0$, $s = 0$). The vertical dotted lines separate the regions for which the deferral condition given in Eq. (19) is satisfied, labeled “Defer”, and not satisfied, labeled “Repatriate.”
**Fig. 2. Worldwide system: capital investment and effective tax rates in the case without agency conflicts.** Panel A plots the average capital stock under the worldwide tax system relative to its value in a territorial tax system as a function of the US tax rate ($\tau_{US}$), expressed as a percent. Panel B plots the average effective total tax rate rate constructed as the total expected present value of all tax costs in both the US and foreign country, as a fraction of pre-tax earnings. Panels C and D repeat the exercise but set the repatriation tax rates, $\tau_{R}^{*}$ and $\tau_{R,K}^{*}$, proportionally to the US tax rate. (See Footnote 15 for details.) In each panel, all other parameters are held at their benchmark values, and agency conflicts are shut down ($\theta = 1$, $b = 0$, $s = 0$). The vertical dotted lines separate the regions for which the deferral condition given in Eq. (19) is satisfied, labeled “Defer”, and not satisfied, labeled “Repatriate.”
Fig. 3. **Territorial system: capital investment and effective tax rates.** Panel A plots the capital stock under the territorial tax system as a function of the tax rate on those earnings, $\tau_F$. The values are reported as a percent relative to the case of zero taxes. Panel B plots the average effective tax rate on earnings as a function of the tax rate, $\tau_F$. 
**Fig. 4. Marginal value of residual earnings with agency conflicts.** Panel A plots the marginal value of immediate repatriation (solid line) and the marginal value of residual earnings held as cash, $\eta$, (dashed line) as a function of the US tax rate $\tau_{US}$ under the benchmark parameters. Panels B–D plot the marginal value of residual earnings conditional on the manager’s repatriation decision given in Eq. (21) for three sets of agency parameters, respectively: benchmark, high resource diversion ($s = 0.2/1000$), and low equity ownership ($\theta = 0.005$). In each panel, all other parameters are held at their benchmark values. The vertical dotted lines separate the regions for which the deferral condition given in Eq. (21) is satisfied, labeled “Defer”, and not satisfied, labeled “Repatriate.”
Fig. 5. **Capital investment under the worldwide tax system with agency conflicts.** This figure plots the average level of capital under the worldwide tax system, shown with solid lines. For reference, the case without agency conflicts is shown with dashed lines. In both cases, capital is scaled by the level of capital in the territorial, no agency benchmark (a constant across values of \( \tau_{US} \)) and reported as a percent. Panels A–D show the plots for agency parameters at their benchmark, with high resource diversion \( (s = 0.2/1000) \), low equity ownership \( (\theta = 0.005) \), and high bonus compensation \( (b = 0.01) \), respectively. The vertical dotted lines separate the regions for which the deferral condition given in Eq. (21) is satisfied, labeled “Defer”, and not satisfied, labeled “Repatriate.”
Fig. 6. The investment distortion from agency conflicts. The 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 $\theta$ (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.
Appendix A. The value of foreign earnings

In this section, we derive the expected present value of residual earnings held as cash inside the foreign subsidiary until tax reform occurs, as well as the expected present value of the manager’s resource diversion associated with those cash holdings.

A.1. The expected present value of foreign cash

Define \( \eta \) 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,

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

where

\[
X \equiv (1 - \tau_R^*)[1 + (1 - \tau_F)r], \\
Y \equiv (1 - \tau_{US})r.
\]

This gives Eq. (18).

The marginal value of residual earnings, \( \omega(Z_t, K_t, C_t) \), will exceed \( \eta \) only if there is an opportunity cost to “locking up” this dollar as cash until reform. An opportunity cost would arise only if the subsidiary has investment opportunities that exceed internal cash flows and it is costly for the subsidiary to use financing from the parent (a negative dividend in the model). With frictionless financing from the parent, there is no opportunity cost and \( \omega(Z_t, K_t, C_t) = \eta \). In our model, financing is frictionless, but \( \omega(Z_t, K_t, C_t) \) may exceed \( \eta \) for technical reasons. Specifically, in the model there is a tax cost to using financing from the parent because upon the realization of a bad shock and disinvestment, the foreign
subsidiary would incur a repatriation tax on the return of that contributed capital. We choose this simplification for tractability and convenience: allowing for tax-free return of capital in the model would add a state variable. We find in the model that $\omega(Z_t, K_t, C_t)$ closely approximates $\eta$ at moderate levels of cash holdings.

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

Define $\gamma$ 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,

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

This gives Eq. (20).

Appendix B. Computational approach

The model does not admit an analytic solution and must be solved numerically. The problem includes four Bellman equations: the manager and shareholder values under both the territorial and worldwide regimes (i.e., $U^{\text{terr}}(\cdot)$, $V^{\text{terr}}(\cdot)$, $U(\cdot)$, and $V(\cdot)$). The solution approach proceeds sequentially from the innermost to the outermost Bellman equation, and uses value function iteration (VFI) at each step:

1. Use VFI to solve for the manager’s total utility $U^{\text{terr}}(Z_t, K_t, C_t)$ given in Eq. (12) and obtain the manager’s policy functions, $K^{\ast,\text{terr}}(Z_t, K_t, C_t)$ and $C^{\ast,\text{terr}}(Z_t, K_t, C_t)$, under
the post-reform, territorial tax system.

2. For the fixed policy functions $K^{*,\text{terr}}(Z_t, K_t, C_t)$ and $C^{*,\text{terr}}(Z_t, K_t, C_t)$ found in Step 1, use VFI to solve for the market value $V^{\text{terr}}(Z_t, K_t, C_t)$ given in Eq. (13) under the post-reform, territorial tax system.

3. Use VFI to solve for the manager’s total utility $U(Z_t, K_t, C_t)$ given in Eq. (14) and obtain the manager’s policy functions $K^*(Z_t, K_t, C_t)$ and $C^*(Z_t, K_t, C_t)$, under the pre-reform, worldwide tax system.

4. For fixed policy functions $K^*(Z_t, K_t, C_t)$ and $C^*(Z_t, K_t, C_t)$ found in Step 3, use VFI to solve for the market value $V(Z_t, K_t, C_t)$ given in Eq. (15) under the post-reform, territorial tax system.

This approach is similar to that used in Nikolov and Whited (2014) with an additional layer for pre- and post-reform tax regimes.

The solution approach relies on one additional strategy to address the fact that optimal cash holdings may accumulate prior to reform. Under many reasonable parameterizations, the foreign subsidiary’s optimal policy is to defer repatriation on all residual earnings. For these firms, the cash variable $C_t$ will tend to have positive drift until the tax reform occurs, requiring a large solution grid.

To improve model tractability, we use analytic expressions for the expected value of deferred cash in order to transform the problem. Specifically, we rewrite the firm’s problem such that it has the option to convert residual earnings held as cash into the expected present value of holding a dollar of cash until reform occurs. This expected present value of holding cash until reform is $\eta$, defined in Eq. (18). This option to convert residual cash into its present value is achieved by setting the tax rate on earnings repatriated prior to reform to

$$\tilde{\tau} \equiv \min \left\{ \frac{\tau_{US} - \tau_F}{1 - \tau_F}, 1 - \eta \right\}.$$  \hspace{1cm} (A-1)

where $\eta$ is equal to $\eta$ when the deferral condition in Eq. (22) holds, and zero otherwise. This adjusted repatriation tax rate is applied to the after-tax dividend, and the dividend
originally specified in Eq. (8) is replaced by

\[ d_t = \tilde{d}_t - \tilde{\tau} \max \{ 0, \tilde{d}_t - F_t \} \]  \hspace{1cm} (A-2)

This specification differs from Eq. (8) only when the repatriation rate (after accounting for foreign tax credits) is greater than \((1 - \eta)\). 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.

The manager’s problem must also be transformed to account for the per-period resource diversion the manager can achieve on cash held until reform. The present value of the future resource diversion from cash holdings is given by \(\gamma\), defined in Eq. (20). The manager’s per-period utility, originally specified in Eq. (9), is replaced by

\[ u(Z_t, K_t, C_t, K_{t+1}, C_{t+1}) = \theta d_t + (b + s)(1 - \tau_F)E_t + s(1 + (1 - \tau_{US})r)C_t + \tilde{\gamma} \max \{ 0, \tilde{d}_t - F_t \} \]  \hspace{1cm} (A-3)

where \(\tilde{\gamma}\) is equal to \(\gamma\) when the deferral condition in Eq. (22) holds, and zero otherwise.

The transformation only requires the modification of the after-tax value of the dividend, Eq. (8), and the manager’s utility function, Eq. (9). The rest of the model specification remains unchanged. The transformation we have specified allows us to add a constraint on the maximum cash holdings, i.e. \(C_t < \bar{C}\), without substantially affecting the solution because the marginal value of cash holdings converges to \(\eta\) for moderate levels of \(C_t\). See Appendix A.1 for a discussion. We verify the chosen \(\bar{C}\) is sufficiently large by testing that increasing this upper bound does not substantially change the solution.

Appendix C. Variable definitions

We winsorize each variable at the 2.5% and 97.5% thresholds of its empirical distribution to mitigate the influence of outliers. All financial variables are denominated in millions of 2009 US dollars.

- **Investment rate**: Investment is the ratio of capital expenditures to lagged gross
property, plant, and equipment. It is calculated at the subsidiary-year level.

- **Profitability**: Profitability is the ratio of taxable income to assets. Taxable income is the sum of net income and taxes paid. It is calculated at the subsidiary-year level.

- **Frequency of negative earnings**: We create an indicator variable that equals one in years when taxable income is negative and zero in years when taxable income is weakly positive. Taxable income is the sum of net income and taxes paid. The reported statistic is the ratio of this indicator variable to the total number of subsidiary-years for which the indicator is nonmissing.

- **Foreign tax rate**: For each foreign subsidiary-year, we calculate the ratio of taxes paid to taxable income, where taxable income is the sum of taxes paid and net income. To satisfy confidentiality requirements, we report the pseudo-median value of this ratio by taking the average of the inner 5 observations.

- **US tax rate**: Following Foley, Hartzell, Titman, and Twite (2007), we rely on marginal taxes rates from Graham (1996a) and Graham (1996b). To satisfy confidentiality requirements, we report the pseudo-median marginal tax rate by taking the average of the inner 5 observations.

- **Manager equity ownership**: This is calculated as the sum of the CEO’s equity shares and options, both vested and unvested, divided by the common equity shares outstanding. The compensation data are from ExecuComp.

- **Bonus to operating income**: This is calculated as the CEO’s bonus, as reported in Execucomp, normalized by the company’s operating income before depreciation, as reported in Compustat.

- **Financially constrained**: We use the financial constraints metric defined in Whited and Wu (2006). Firms are stratified relative to Compustat.

### Appendix D. An illustrative, two-period model

This section presents a simplified, two-period model of the foreign subsidiary of a US multinational with a single investment and cash holding decision. The subsidiary operates under a worldwide tax system where reform occurs with some probability. The model differs from the full, quantitative model of Section 1 in that it assumes a single repatriation tax rate on reform which is stochastic and the shareholder makes decisions to maximize firm

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26Hartman (1985) develops a static model of the foreign investment-repatriation tradeoff for a firm in a worldwide system but without the possibility of tax reform.
value (i.e., there are no agency conflicts). The simplified model allows for analytic solutions for the investment, cash holdings, and repatriation decisions while retaining the economic trade-offs regarding taxes that are present in the full model. We show that foreign investment is declining in the US tax rate, and that investment is higher under the worldwide system with only mild parameter restrictions.

\textit{D.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 in which 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 $\tau_F$. Time-0 repatriation is taxed at a rate $\tau_{US}$ 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). Conditional on the firm’s chosen investment and cash holdings decisions, the after-tax value of the dividend in the first period is

\[
\frac{1 - \tau_{US}}{1 - \tau_F} [(1 - \tau_F)E_0 - K - C].
\] (A-4)

All decisions—investment, cash holding, and repatriation/deferral—are made at time 0 in order to maximize shareholder value. 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 $\tau_R$, before foreign tax credits, and the model ends. We assume that there is some likelihood of tax reform that occurs at time $T$ such that $\mathbb{E}[\tau_R] < \tau_{US}$. 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:

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

\[ \Pi(K) = \frac{1 - \tau_R}{1 - \tau_F} [(1 - \tau_F)(AK^\alpha - \delta K) + K], \] (A-5)

where \( 0 < \alpha < 1 \) is the returns to scale, and \( 0 < \delta \leq 1 \) is depreciation. Without loss of generality, productivity \( A \) is assumed to be deterministic.

Any cash \( C \) is held by the firm in financial assets that generate a pre-tax one-period return of \( r \). The return on financial assets is considered passive income (Subpart F income) and is therefore subject to immediate US taxation at rate \( \tau_{US} \). 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 that defer repatriation.\(^{27}\)

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:

\[
V = \max_{K \geq 0, C \geq 0} \left\{ \frac{1 - \tau_{US}}{1 - \tau_F} \left[ (1 - \tau_F)E_0 - K - C \right] \right. \\
+ \frac{1 - \tau_R}{1 - \tau_F} [(1 - \tau_F)\hat{r}C + \frac{1 - \tau_R}{1 - \tau_F} C + \frac{1 - \tau_R}{1 - \tau_F} [(1 - \tau_F)(AK^\alpha - \delta K) + K] \right. \\
\left. \ \left. \text{Immediate repatriation} \quad \text{After-tax interest} \quad \text{After-tax value of cash principal} \quad \text{Output and non-cash assets} \right) \right\}, \] (A-7)

where \( \hat{r} \equiv (1 + r)^T - 1 \) represents the \( T \)-period discount rate and pre-tax return on financial assets (cash holdings). The expectation operator is over \( \tau_R \), the only random variable.

\(^{27}\)In addition to deferral, several firms underwent corporate inversion (reincorporating in a foreign country for tax purposes) as a way to avoid the worldwide reach of the US tax system. See, for example, Desai and Hines (2002) and Babkin, Glover, and Levine (2017).
D.2. Repatriation decision

At time 0, the firm decides how much, if any, of their earnings to repatriate. Because both the benefit and cost 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. That is, the optimal repatriation amount is a corner solution. From Eq. (A-7), the marginal value of immediate repatriation is

$$\frac{1 - \tau_{US}}{1 - \tau_F}$$

(A-8)

while the expected marginal value of deferral is

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

(A-9)

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

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

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

(A-10)

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

Case 2 (deferred repatriation): If condition (A-10) is not satisfied, the firm defers repatriation and 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 on foreign investment opportunities or production parameters.

D.3. Investment decision

Investment in physical capital has diminishing marginal returns. For a firm that optimally chooses 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 a firm that optimally chooses 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 of these two cases.

**D.3.1. Case 1: immediate repatriation**

When condition (A-10) holds, the firm immediately repatriates any time-0 earnings not used for investment, i.e. $C = 0$. The value of the subsidiary becomes

$$V = \max_{K \geq 0} \left\{ \frac{1 - \tau_{US}}{1 - \tau_F} [(1 - \tau_F)E_0 - K] + \frac{1}{1 + \hat{r}} \frac{1 - \mathbb{E}[\tau_R]}{1 - \tau_F} [(1 - \tau_F)(AK^\alpha - \delta K) + K] \right\}. \quad (A-11)$$

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

$$K^*,\text{rep} = \left( \alpha A \frac{(1 - \tau_F)(1 - \mathbb{E}[\tau_R])}{(1 + \hat{r})(1 - \tau_{US}) - [1 - \delta(1 - \tau_F)](1 - \mathbb{E}[\tau_R])} \right)^{\frac{1}{1 - \alpha}}. \quad (A-12)$$

**D.3.2. Case 2: deferred repatriation**

When condition (A-10) does not hold, the firm defers repatriation and holds as cash all time-0 earnings not used for investment, i.e. $C = (1 - \tau_F)E_0 - K$. The value of the subsidiary becomes

$$V = \max_{K \geq 0} \frac{1}{1 + \hat{r}} \left\{ \left( \frac{1 - \tau_{US}}{1 - \tau_F} \right)^{\tau_F} \left[ (1 - \tau_F)E_0 - K \right] + \frac{1 - \mathbb{E}[\tau_R]}{1 - \tau_F} [(1 - \tau_F)(AK^\alpha - \delta K) + K] \right\}. \quad (A-13)$$

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

$$K^*,\text{defer} = \left( \alpha A \frac{(1 - \mathbb{E}[\tau_R])}{(1 - \tau_{US})\hat{r} + (1 - \mathbb{E}[\tau_R])\delta} \right)^{\frac{1}{1 - \alpha}}. \quad (A-14)$$

**D.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 $K^*,\text{rep}$ or $K^*,\text{defer}$ corresponding to this optimal repatriation timing.
decision. Formally, let \( \varphi \) be the indicator function that is equal to one when condition (A-10) is satisfied, i.e. the firm chooses to immediately repatriate, and zero otherwise. Optimal investment is then given by

\[
K^* = \varphi K^{*,\text{repat}} + (1 - \varphi) K^{*,\text{def}}.
\] (A-15)

D.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

\[
K^{*,\text{terr}} = \left( \frac{\alpha A}{\hat{r}} + (1 - \tau_F)\delta \right)^{\frac{1}{1-\alpha}}.
\] (A-16)

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.

The above expressions allow us to compare investment under the worldwide and territorial systems in the following proposition.

**Proposition 2.** If \( \tau_F < \mathbb{E}[\tau_R] < \tau_{US} \), then investment is higher under worldwide taxation, \( K^* \), than under territorial, \( K^{*,\text{terr}} \), i.e. \( K^{*,\text{terr}} < K^* \).

From Eqs. (A-12), (A-14), and (A-16), it is straightforward to show that \( K^{*,\text{terr}} < K^{*,\text{repat}} \) if \( \mathbb{E}[\tau_R] < \tau_{US} \) and \( K^{*,\text{terr}} < K^{*,\text{def}} \) if \( \tau_F < \mathbb{E}[\tau_R] < \tau_{US} \).

D.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, as well as other parameters of interest, and firm policies. We report these comparative statics in Table A.1. 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 D.3.4.

The first row of Table A.1 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 repatriate 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 a lower expected 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 increases the tax holding cost of cash, making capital investment look relatively more attractive. In both cases, a higher US tax rate creates an incentive for the firm to invest more in the foreign subsidiary.  

For a similar reason, the region of deferred repatriation and investment choice are 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.

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28This positive 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 $a < 1$.  

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Table A.1: Comparative statics for the two-period model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Region of deferred repatriation</td>
<td>Worldwide Case 1: $K^{*,\text{rep}}$</td>
<td>Case 2: $K^{*,\text{defer}}$</td>
<td>Territorial $K^{*,\text{terr}}$</td>
</tr>
<tr>
<td>US tax rate</td>
<td>$\tau_{US}$</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Future repatriation tax rate</td>
<td>$E[\tau_R]$</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Foreign tax rate</td>
<td>$\tau_F$</td>
<td>~</td>
<td>~</td>
<td>0</td>
</tr>
<tr>
<td>Discount/interest rate</td>
<td>$r$</td>
<td>+</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Decreasing returns to scale</td>
<td>$\alpha$</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Productivity</td>
<td>$A$</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

The table presents qualitative comparative statics for various parameters in the illustrative model defined in Section D. 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, $\tau_F < E[\tau_R] < \tau_{US}$. Finally, column (4) reports the sign of the comparative static on the capital choice under the territorial system defined in Section D.3.4.