Profit Shifting and Multinational Investment

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Abstract

How does profit shifting impact cross-border investment by multinational firms? Using a joint model of profit shifting and investment, I show that profit shifting increases investment in both high-tax and low-tax countries by reducing the distortive effects of corporate income taxes. This interaction induces endogenous patterns of complementarities between investment in different countries, increasing business cycle correlations between high-tax and low-tax countries and decreasing correlations between high-tax (low-tax) and other high-tax (low-tax) countries. I find supportive evidence for the interaction between profit shifting and investment using a heterogeneous firm, mixed effects regression analysis, and I provide causal evidence supporting the business cycle effects using an event study around the enactment of the check-the-box regulation. In equilibrium, eliminating profit shifting would increase U.S. corporate tax revenue by 5.9% but decrease it in tax havens and the rest of the world; the investment response to this would decrease investment in the U.S. and in tax havens, and U.S. consumption would fall by 0.2%.

The analysis and conclusions are those of the author and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System.

1 Introduction

The governments of high-tax countries have long lamented profit shifting by multinational enterprises (MNEs), in which these firms manipulate the location of where their profits are reported and taxed relative to the location of the activities that generated those profits. But how does profit shifting affect the real investment decisions of multinationals?

As an example, Germany is far larger, more prosperous and more productive than Ireland, whereas Ireland is a tax haven, with U.S.-headquartered multinationals reporting far more profits in Ireland than Germany (IRS Statistics of Income Division 2019). Yet Ireland's role as a tax haven results in more than just high profits shifted to the country—they also benefit from disproportionately high investment in physical capital, research and development, and payroll employment from U.S. multinationals.

While this anecdote suggests that low-tax countries can benefit from profit shifting, this is not only true of tax havens, as recent empirical research has identified impacts of profit shifting on investment in high-tax countries as well. Albertus (2018), Buettner et al. (2018), and Suárez Serrato (2019) found that policy changes that reduced profit shifting by multinationals also reduced their investment and employment in high-tax countries. These papers fit within a small but growing body of research that considers potential interactions between profit shifting and foreign direct investment, each of which have extensive but separate literatures.[1]

This paper explores how profit shifting and investment *jointly* respond to tax incentives—as well as the aggregate implications of these responses. I construct a model of profit shifting and investment with heterogeneous multinational corporations. Within this theoretical framework, profit shifting facilitates higher investment in both low-tax and high-tax countries by reducing the corporate income tax distortion on investment. For a multinational operating in both Germany and Ireland, the income generated in Germany is not fully subject to the high German tax rate, but rather to a combination of the high German rate and the low Irish rate, reducing the corporate income tax distortion on its German investment. On the other side, more production activity in low-tax countries facilitates the shifting of more profits into those countries and out of higher-tax countries, creating an extra incentive to invest in low-tax countries.

The intuition above applies to intensive-margin investment (conditional on operating in a country), but this effect of profit shifting on investment also operates on the extensive margin (whether to invest in a country). A new investment in a low-tax country allows the firm to begin shifting profits there. For a new investment in a high-tax country, the ability to shift profits out reduces the effective average tax rate on that new investment.

To test for this interaction, I conduct a heterogeneous-firm empirical analysis, using a mixed effects model to estimate firm-specific profit shifting semi-elasticities. The empirical analysis provides evidence in support of the facilitation effect identified in the theoretical framework: firms with lower estimated costs of profit shifting invest more in low-tax and in high-tax countries.

This effect of profit shifting on investment incentives has further implications not previously considered in the extant literature. The interaction between profit shifting and investment induces endogenous patterns of complementarity and substitutability of investment in different countries. Specifically, profit shifting makes investment in high-tax countries complementary to investment in low-tax countries and a substitute for investment in other high-tax countries. Similarly, investment in low-tax countries is a complement to investment in high-tax countries and a substitute for investment in other low-tax countries. These patterns of complementarity and substitutability have novel implications for the transmission of aggregate shocks across countries; through this

[1] See Heckemeyer and Overesch (2017) and Feld and Heckemeyer (2011) for reviews of the literatures on profit shifting and on foreign direct investment.

channel, multinationals amplify the transmission of shocks between high-tax and low-tax countries, and they attenuate shock transmission between high-tax and other high-tax countries or between low-tax and other low-tax countries.

I test for this international shock transmission channel using an event study around the check-the-box regulation in the U.S., which unintentionally removed a key barrier to profit shifting. Using a difference-in-differences estimation around this natural experiment and an interaction term constructed from the theoretical framework, I provide robust causal evidence for this new theoretical transmission channel, which has explanatory power comparable to bilateral trade between countries.

Finally, I consider the equilibrium implications of profit shifting. I embed the theoretical framework in a dynamic multi-country general equilibrium model, calibrated to match moments of the decisions of U.S. multinationals. In equilibrium, eliminating profit shifting reduces worldwide GDP and consumption. It also reduces capital, consumption, and output in the U.S., although it increases U.S. corporate tax revenue.

Section 2 provides background on international taxation, profit shifting, foreign direct investment, and business cycle correlations. Section 3 develops a theoretical model of multinationals featuring profit shifting and investment, and characterizes the key theoretical implications of their interaction. Section 4 presents empirical analyses testing the theoretical predictions. Section 5 sets up the structural dynamic multi-country general equilibrium model and presents the quantitative results, and section 6 concludes.

2 Background and Related Literature

2.1 International Tax System

A multinational enterprise (MNE) is a business with affiliates operating in multiple countries. A MNE can own controlled foreign corporations (CFCs); each CFC is treated as a separate entity for tax and accounting purposes, under certain conditions. The income of a CFC is taxed in the country in which it is located, but the home country of the multinational may also tax foreign activities of the multinational. If the home country uses an exemption (territorial) system, it does not count income from foreign sources in the taxable income of the parent company. Alternatively, the home country may use a worldwide system, which includes income from foreign sources but provides a credit for foreign taxes paid.

Prior to the Tax Cuts and Jobs Act of 2017 (TCJA), the income from CFCs would be included in U.S. taxable income when repatriated to the parent company, but not if the profits were retained in the CFC. This was accompanied by the subpart F rules, which treated certain passive investment income in CFCs as immediately subject to tax in the U.S. This system was intended to eventually subject profits of multinationals to U.S. tax, while allowing deferral to keep these firms competitive in foreign markets. With no tax advantage to deferral over a finite time horizon (Hartman 1985), there would be no advantage to profit-shifting, as the tax shield from shifting profits out of the U.S. would eventually be negated by the repatriation tax penalty.

However, this intent did not hold in practice. A long literature has documented profit-shifting by U.S. multinationals, and that the repatriation tax penalty resulted in the accumulation of profits "trapped" abroad. Firms unable to take advantage of deferral faced a high U.S. tax rate that put them at a competitive disadvantage in foreign markets. These pressures drove a wave of corporate inversions, in which U.S. MNEs merged with foreign firms to shield their foreign profits from the high U.S. tax rate (Bloomberg 2017).

The TCJA attempted to address issues of profit shifting and this competitive disadvantage. First, it reduced statutory corporate tax rates from a top rate of 35 percent to 21 percent, mitigating

many other adverse incentives. Second, it exempted dividends from CFCs from taxable income, ending the repatriation tax penalty. This shifted the U.S. tax system toward a territorial system, which alone would increase profit shifting incentives for U.S. MNEs (Markle 2016). To counter these incentives, the TCJA added two provisions: the minimum tax on Global Intantible Low Taxed Income (GILTI) and a deduction for Foreign-Derived Intangible Income (FDII). The GILTI minimum tax required that half of foreign income in excess of 10 percent of foreign tangible assets would be automatically included in U.S. taxable income, creating a 10.5 percent tax on this income, with a credit for 80% of foreign taxes paid, resulting in an effective minimum tax between 10.5 and 13.125%. The FDII provision allows a 37.5% deduction on domestically reported income from foreign sources in excess of 10% of tangible assets, creating an effective 13.125 percent marginal tax rate on this income. The GILTI and FDII deductions are set to become less generous in 2026, with the effective rates rising to 13.125 and 16.4% respectively. The TCJA also created the Base Erosion and Anti-abuse Tax (BEAT), intended to target intracompany transactions by foreign multinationals shifting profits out of their U.S. operations, but this provision has had limited effectiveness in practice (JCT 2021).

Additionally, the OECD, through its Base Erosion and Profit Shifting (BEPS) project, has advanced the Pillar 1 and Pillar 2 proposals to raise taxes on the profits of large, highly profitable multinationals (OECD/G20 2021). Pillar 1 would subject a portion of multinationals' foreign profits to tax based on the location of its customers. This would create an explicit connection between the location of profits and the location of sales. Pillar 2 would have countries impose a set of overlapping minimum taxes to subject multinationals' profits to tax rates of at least 15 percent and to incentivize low-tax countries to raise their tax rates by limiting the ability of tax havens to actually shield foreign corporate income from tax.

2.2 Profit Shifting

The literature on profit shifting has identified three main channels by which firms shift profits from high-tax to low-tax countries: transfer mispricing, the location of intangible assets, and financial structure.

MNEs engage in substantial intrafirm trade between affiliates in different countries. In principle, these transactions between affiliates of a multinational group must satisfy the Arm's Length Principle (ALP), which requires they be priced similarly to transactions between unrelated parties. In practice, however, firms have some latitude to structure and misprice these transactions to reduce their worldwide tax liabilities. Clausing (2009), Bartelsman and Beetsma (2003), and Liu et al. (2020) find evidence of substantial mispricing by multinationals, as well as evidence of trade creation to facilitate this.

Intangible assets play a particularly important role in profit shifting for two reasons. First, because these assets are intangible, their location only matters for legal and tax purposes, unlike the location of physical capital and employees. Second, royalties and license fees for intangible assets often lack comparable unrelated party transactions to apply the ALP; accordingly, MNEs have greater flexibility in determining these payments without constraint from the ALP. Grubert (2003) finds that half of profit-shifting is attributable to income from R&D, and more R&D-intensive affiliates and parents engage in more intracompany transactions. Griffith et al. (2014) find that lower tax rates substantially increase the probability of patents being booked in a country, although the effects are heterogeneous across firms. Karkinsky and Riedel (2012) find analogous results for the number of patents located in each country.

Firms can also reduce their global tax liabilities through the financial structure of the MNE. Borrowing in high-tax countries provides a larger tax shield than borrowing in low-tax countries,

and lending by affiliates in low-tax countries to affiliates in high-tax countries shifts income from the high-tax country to the low-tax country. Early work by Hines and Hubbard (1990) found higher average tax rates for affiliates making interest payments to the parent company than for affiliates that did not. Desai et al. (2004b) find that 10% higher local tax rates are associated with 2.8% higher debt/asset ratios, and that MNEs use internal capital markets to overcome local capital market imperfections. Huizinga et al. (2008) estimate that this international debt shifting raises the responsiveness of debt to tax rates by about a third. Policy changes to restrict the tax benefit from strategic overborrowing in high-tax countries—such as thin capitaliation rules in many countries or interest expense apportionment in the U.S.—reduce the use of internal debt for profit shifting but may increase the use of external debt (Buettner et al. 2012; Froot and Hines 1995).

Much of the literature on profit shifting attempts to abstract from the method and instead quantify the overall magnitude, relying on the log-linear semi-elasticity estimation developed in the seminal work by Hines and Rice (1994).[2] In a metastudy, Heckemeyer and Overesch (2017) find an overall semi-elasticity of reported profits of 0.8 with respect to the corporate tax rate (in absolute value). Newer work by Dowd et al. (2017) and Bratta et al. (2024) find a larger responsiveness to corporate tax rates in low-tax countries and tax havens, and a recent metastudy by Beer et al. (2020) suggests that the semi-elasticity has risen to 1. Moreover, Heckemeyer and Overesch (2017) and Dharmapala (2014) identify the importance of the data source, with studies relying on aggregated country data estimating larger elasticities (around 2 or 3) than studies using microdata (often less than 1).

The elasticities estimated by these papers typically are common across firms, ignoring potential sources of heterogeneity. Markle (2016) finds that firms headquartered in countries with territorial tax systems shift more income compared to those headquartered in countries with worldwide tax systems; this effect only applies to income shifted between the parent company and its foreign affiliates, but not between foreign affiliates. Klassen and Laplante (2012) find that U.S. multinationals increased their profit shifting over time due to changing regulatory costs of profit shifting.

This paper contributes to the profit shifting literature through the novel use of a heterogeneous firm analysis. Instead of the standard approach of estimating a single profit shifting elasticity or parameter, I use a mixed effects regression analysis to estimate firm- and time-specific profit shifting semi-elasticities. Overall, firms that are better at profit shifting have higher measured productivity (profitability relative to physical capital and labor inputs), conduct more R&D, and hold more cash. These first two factors strongly suggest the importance of intangible capital and intellectual property in profit shifting.

2.3 Taxes and Foreign Direct Investment

In addition to this research on profit shifting, a separate literature has focused on the responses of foreign direct investment (FDI) to tax incentives. This literature has found that FDI is highly responsive to tax rates; metastudies by Feld and Heckemeyer (2011) and de Mooij and Ederveen (2003) have found overall mean semi-elasticities of FDI with respect to tax rates of 2.55 and 3.3 in magnitude.

FDI responses to tax rates generally operate through three channels. One of these channels consists of financial investment and M&A, as taxes may distort multinationals' decisions to purchase assets and businesses in other countries. Merz et al. (2017) find that higher taxes reduce the

[2]Accounting papers often use the estimation approach from Collins et al. (1998), which regresses the ratio of foreign pre-tax income to foreign sales on tax measures and control variables. However, Laffitte and Toubal (2022) find substantial mischaracterization of the location of reported sales, so this profitability-based approach likely underestimates the shifting of profits.

probability of establishment by financial services entities. Arulampalam et al. (2019) find that a higher statutory tax rate reduces the probability of being acquired, depending on whether the acquirer is also domestic or is multinational, whether the acquisition is cross-border, and whether the acquirer's country has a worldwide or territorial system.

The remaining two channels consist of the standard intensive margin investment response and an extensive margin response. The intensive margin investment response describes how firms change their marginal investment in existing projects in response to corporate tax policies. The extensive margin response describes how firms choose a location for a discrete mutually exclusive project with supernormal returns, such as a single production site in a European country that would produce for the entire European Union. Devereux and Griffith (2003) provided the seminal paper on this discrete choice of location, in which they developed a new project-level effective average tax rate (EATR). Subsequent assessments of the relative importance of the intensive and extensive margins by Davies et al. (2021) and others have found that the extensive margin is more important for FDI than the intensive margin.

In addition to these empirical papers on FDI, a few papers have developed structural models of FDI by multinationals and how taxes distort these incentives. Gu (2017) models physical and intangible investment across borders and cash accumulation domestically and in foreign affiliates due to repatriation tax penalties. She finds that eliminating the repatriation tax penalty would reduce the cash differential between foreign and domestic affiliates of MNEs. Albertus et al. (2022) model foreign investment by U.S. multinationals due to the build-up of cash in foreign affiliates in the context of moral hazard. They find that the repatriation tax penalty increased foreign investment by U.S. multinationals by depressing the opportunity cost of capital, and switching to a 21% tax rate in a territorial system would reduce foreign investment by 10.2%.

This paper contributes to the literature on taxation and FDI by identifying, testing for, and quantifying a different channel through which profit shifting impacts international investment decisions, namely by reducing the distortion of the corporate income tax. I also identify that profit shifting induces endogenous patterns of complementarity and substitutability of investment across countries.

2.4 Profit Shifting and Foreign Direct Investment

Although many papers have studied the reponses of profit shifting and of FDI to tax incentives, few papers have studied these jointly. The idea of a potential link between these is not new. In their original paper on profit shifting, Hines and Rice (1994) also found that lower tax rates were associated with higher real activity. Clausing (2009) and Azémar (2010) explored responses to taxes through profit shifting and investment, but these papers treated these as simultaneous responses, not as integrated or interacting effects.

Other research has explored the concept of profit shifting affecting investment into low-tax countries. Grubert and Slemrod (1998) consider a simple model in which a firm chooses whether to invest in Puerto Rico and the profitability rate to report, finding that income shifting opportunities were the main reason for investing in Puerto Rico. Consistent with this result for Puerto Rico, Dharmapala and Hines (2009) find that small countries with better governance are more likely to become tax havens, as doing so attracts foreign investment.

Finally, profit shifting to low-tax countries can also facilitate domestic investment in high-tax countries. Hines (2010) argues that tax havens can positively benefit other countries' real activities by increasing financial market competition and encouraging investment in high-tax countries. Hong and Smart (2010) suggest in a theoretical model that citizens of high-tax countries can benefit from some profit shifting. As part of his analysis of intangibles and intercompany transactions, Grubert

(2003) found evidence that firms with more R&D-intensive parent companies (a proxy for ability to shift profits) are more likely to have affiliates in both low- and high-tax countries.

More recent research has found empirical evidence of direct interactions between profit shifting and investment, and that efforts to restrict profit shifting also reduce multinationals' economic activity. Albertus (2018) finds that when foreign multinationals are restricted from shifting income out of the U.S., they scale back their U.S. activity and are less likely to establish U.S. operations. Egger and Wamser (2015) find a similar result looking at German multinationals. Analyzing thin-capitalization rules, which restrict the debt channel of profit shifting, Buettner et al. (2018) and de Mooij and Liu (2021) find that these policies cause multinationals to reduce investment in high-tax countries and may increase the tax rate sensitivity of FDI. Suárez Serrato (2019) found that ending Puerto Rico's corporate tax loophole (section 936) cause the affected multinationals to reduce their investment and employment in the U.S. Exploiting the timing of transfer pricing rules, Mooij and Liu (2020) show that the staggered introduction of transfer pricing rules causes multinationals to reduce their investment in affected countries by 11%, although they argue that these investments are most likely shifted to other countries. Recent work by De Simone et al. (2022) estimates firm-specific measures of income shifting aggressiveness, finding that firms that shift income more aggressively exhibit decreased overall responsiveness of investment to taxes.

This paper contributes to this smaller joint literature on profit shifting and FDI by providing a multi-country theoretical model of their interactions, identifying that profit shifting facilitates higher investment in high-tax and low-tax countries, makes investment complementary between high-tax and low-tax countries, and makes investment in high-tax (low-tax) and other high-tax (low-tax) countries endogenous substitutes. This provides a microfoundation for the results of Albertus (2018), Buettner et al. (2018), and Suárez Serrato (2019); within the model, restricting the ability of firms to shift profits causes them to reduce their investment in high-tax countries. The model also predicts (and the data validate) that firms that are better at profit shifting should exhibit reduced sensitivity to marginal changes in tax rates in high-tax countries, as in De Simone et al. (2022), but that they exhibit *greater* sensitivity to tax rates in high-tax countries.

2.5 International Business Cycle Correlations

Finally, this paper also contributes to the literature on international business cycle correlations. Much of this literature has focused on determinants of business cycle correlations between countries, such as Frankel and Rose (1998), who find that countries with closer trade links have more correlated business cycles. Additional work has explored the implications of financial integration (Schiavo 2008; Artis et al. 2008), specialization (Imbs 2004; Kalemli-Ozcan et al. 2003; Inklaar et al. 2008), and currency unions (Rose and Engel 2002).

However, some theoretical and structural work has emphasized the role of multinational firms in transmitting shocks between countries, either through vertically integrated production networks (Burstein et al. 2008; Zlate 2016), through FDI channels (Menno 2014), through exports (Contessi 2010), or through productivity spillovers (Cravino and Levchenko 2016). Meanwhile, empirical work has found strong evidence of spillovers of shocks operating through multinationals (Budd et al. 2005; Boehm et al. 2019; Desai et al. 2004a; Desai et al. 2009; Kleinert et al. 2015). These papers have exclusively focused on the role of multinationals in increasing business cycle correlations.

This paper identifies a novel channel for how multinationals can affect business cycle correlations through the effects of profit shifting. Profit shifting creates endogenous patterns of complementarity and substitutability of investment across countries, which exacerbates the transmission of shocks between high-tax and low-tax countries but attentuates transmission between high-tax and other high-tax countries or between low-tax and other low-tax countries. I find robust, causal evidence

of this channel.

3 Theoretical Analysis

This paper's theoretical analysis adapts the profit shifting framework developed by Hines and Rice (1994) to include firm heterogeneity, endogenous investment, and more corporate tax policy detail. A firm indexed j operates in a set of countries I indexed by i. It chooses its capital k_{ij} and labor ℓ_{ij} inputs in each country. It produces output by the Cobb-Douglas aggregator with decreasing returns to scale, $A_i z_j k_{ij}^{\alpha} \ell_{ij}^{\beta}$, where $\alpha + \beta < 1$, A_i is country productivity, and z_j is the firm's measured productivity (output relative to the capital and labor inputs). It pays wages at rate w_i and rents capital at price r_i; capital also depreciates at rate δ.

In the absence of taxation, the firm's economic income in country i is $A_i z_j k_{ij}^{\alpha} \ell_{ij}^{\beta} - w_i \ell_{ij} - (r_i + \delta) k_{ij}$. However, economic income is not defined identically to taxable income. A firm's taxable income before profit shifting—y_{ij}, which we will refer to as "production income"—is defined as

$$y_{ij} \equiv z_j A_i k_{ij}^{\alpha} \ell_{ij}^{\beta} - w_i \ell_{ij} - \delta k_{ij} - \theta_i r_i k_{ij}.$$

The distinction between economic and production income comes from the extent to which the tax system provides a shield on the normal rate of return; the deductible share in country i is given by θ_i. In a static environment, this operates as a deduction for the normal return on capital; in a dynamic environment, this could operate through combinations of accelerated depreciation, interest deductibility, allowances for corporate equity, or cash flow taxes.

The firm also shifts profits s_{ij} into or out of country i, although it faces a convex cost of profit shifting. This introduces a discrepancy between income produced (y_{ij}) in a country and income reported (ρ_{ij}) in that country. Reported profits are given by

$$\rho_{ij} = y_{ij} + s_{ij} - \frac{\gamma_j s_{ij}^2}{2 y_{ij}}.$$

Positive values of s_{ij} denote profits shifted in, and negative values denote profits shifted out. Hines and Rice (1994) justify this quadratic cost of profit shifting by arguing that the marginal costs of profit shifting are increasing in the ratio of shifted profits to income produced in the country.

In principle, the connection between the costs of profit shifting and economic substance (through y_{ij}) operates through auditing risk. A firm that reports high profits in a tax haven but no capital or labor there would trigger more frequent and aggressive audits from governments than if it was also producing there. In Appendix A, I consider a microfoundation for this connection based on auditing risk and the use of tax planning services, in which a tax collection agency observes reported taxable income and a noisy signal of production income. The agency chooses its auditing effort to attempt to catch the firm engaging in illegal forms of profit shifting, and the firm pays for tax planning services to defend against this. This game generates a convex cost of profit shifting closely approximated by this reduced form quadratic cost.

The key features of this cost of profit shifting are heterogeneity in γ_j, which governs the cost of profit shifting, and the connection to economic substance (decreasing in y_{ij}). Not all firms are equally good at profit shifting. In particular, those with more intellectual property and other intangible capital can more easily shift profits by locating these assets in low-tax countries and having their other affiliates pay royalties for the use of these assets. Moreover, it is difficult to identify mispricing in the royalties paid for its use by different affiliates. Therefore, firms with more IP and other intangible assets should face lower costs of profit shifting. Section 4.1.2 investigates empirically what firm characteristics correlate with being better at profit shifting. Appendix A also considers alternative and generalized functional forms for the costs of profit shifting.

3.1 Profit Shifting and Investment

The firm maximizes total after-tax economic profits, subject to the definition of production income and an accounting identity that net shifted profits must be zero—profits shifted into a country must come from other countries, and profits shifted out of a country must be shifted to others. λ_j denotes the Lagrange multiplier on the accounting constraint for shifted profits, and η_{ij} denotes the multipliers on the constraints for the definitions of production income.

$$\Pi(I, z_j, \gamma_j) = \max_{k_{ij}, \ell_{ij}, s_{ij}, y_{ij}} \sum_{i \in I} (1 - \tau_i) \left(y_{ij} + s_{ij} - \frac{\gamma_j s_{ij}^2}{2 y_{ij}} \right) - \sum_{i \in I} (1 - \theta_i) r_i k_{ij}$$

s.t.

$$\sum_{i \in I} s_{ij} = 0$$

$$y_{ij} = A_i z_j k_{ij}^{\alpha} \ell_{ij}^{\beta} - w_i \ell_{ij} - \delta k_{ij} - \theta_i r_i k_{ij}$$

The following equations identify the solutions to this problem. Optimal profits shifted are proportional to production income, decreasing in the cost parameter γ_j, and increasing in the difference between the net-of-tax rate $1 - \tau_i$ and λ_j. The value of λ_j at the optimum is a harmonic mean net-of-tax rate, weighted by production income in each country. Capital and labor demand depend on the user cost of capital, which in turn depends on the deductible share of the normal return and the multiplier η_{ij}.

$$s_{ij}^* = \frac{y_{ij}}{\gamma_j} \left(\frac{1 - \tau_i - \lambda_j}{1 - \tau_i} \right)$$

$$\lambda_j = \left(\frac{\sum_i y_{ij} (1 - \tau_i)^{-1}}{\sum_i y_{ij}} \right)^{-1}$$

$$\eta_{ij} = (1 - \tau_i) \left(1 + \frac{1}{2 \gamma_j} \left(\frac{1 - \tau_i - \lambda_j}{1 - \tau_i} \right)^2 \right)$$

$$k_{ij}^* = (A_i z_j)^{\frac{1}{1-\alpha-\beta}} \left(\frac{\alpha}{\theta_i r_i + (1 - \theta_i) r_i / \eta_{ij} + \delta} \right)^{\frac{1-\beta}{1-\alpha-\beta}} \left(\frac{\beta}{w_i} \right)^{\frac{\beta}{1-\alpha-\beta}}$$

$$\ell_{ij}^* = (A_i z_j)^{\frac{1}{1-\alpha-\beta}} \left(\frac{\alpha}{\theta_i r_i + (1 - \theta_i) r_i / \eta_{ij} + \delta} \right)^{\frac{\alpha}{1-\alpha-\beta}} \left(\frac{\beta}{w_i} \right)^{\frac{1-\alpha}{1-\alpha-\beta}}$$

Define a new tax rate $\bar{\tau}_j$ as $1 - \bar{\tau}_j \equiv \lambda_j$; we can interpret this as the firm's worldwide effective tax rate before it shifts profits.[3] This allows us to rewrite the profit shifting and η_{ij} results as follows.

$$s_{ij} = \frac{y_{ij}}{\gamma_j} \left(\frac{\bar{\tau}_j - \tau_i}{1 - \tau_i} \right)$$

$$\eta_{ij} = 1 - \tau_i + \frac{1}{2} (\bar{\tau}_j - \tau_i) \frac{s_i}{y_i} \geq 1 - \tau_i$$

From this first equation, the firm shifts profits into country i if i is a low-tax country ($\tau_i < \bar{\tau}_j$) and out if i is a high-tax country ($\tau_i > \bar{\tau}_j$). The multiplier η_{ij} is the net-of-tax rate on the production income generated in country i. If $\tau_i > \bar{\tau}_j$, a portion of this income is shifted out, and taxed at the

[3] Because λ_j is a harmonic-mean net-of-tax rate, $\bar{\tau}_j$ effectively overweights the high-tax countries.

lower rate $\bar{\tau}_j$ on average. If $\tau_i < \bar{\tau}_j$, a proportional amount of income is shifted in, being taxed at the lower rate of τ_i instead of $\bar{\tau}_j$ on average.

For an example of this, consider a firm with operations in Germany and Ireland, shifting profits from Germany to Ireland. Its income produced in Germany is not entirely subject to the high German tax rate; part of it is taxed in Ireland instead. Consequently, income produced in Germany faces a blended tax rate, a weighted average of the German and Irish tax rates, with weights determined by the share of German income being shifted to Ireland. If income produced in Germany faces a lower blended tax rate because of profit shifting, the corporate income tax distortion on investment is also smaller, resulting in higher investment in Germany than without profit shifting.

To understand the effect in Ireland, consider a marginal investment in Ireland, producing some marginal income. Because an optimizing firm shifts profits in proportion to its production income, this marginal increase in production income in Ireland also increases profits shifted into Ireland. For this firm, profits shifted into Ireland come out of Germany;. With a larger share of German income being shifted out, the blended tax rate on German production income places a higher weight on the Irish tax rate, reducing the blended tax rate faced by German production income, which in turn reduces the corporate income tax distortion in Germany.

Note that the intuition above depends on a distortionary corporate income tax. If the design of the corporate income tax is nondistortionary ($\theta_i = 1$), there is no corporate income tax distortion and no interaction between profit shifting and investment on the intensive margin; however, this result still applies on the extensive margin, as discussed in section 3.3.

The intuition above describes a "facilitation" role for profit shifting, in which profit shifting facilitates higher investment by reducing the corporate income tax distortion. Formally, consider the derivative of the optimal capital decision with respect to a firm's ability to shift profits, summarized by $1/\gamma_j$, in equation (1). This derivative is nonnegative; firms that are better at shifting profits invest more in low-tax countries ($\tau_i < \bar{\tau}_j$) and in high-tax countries ($\tau_i > \bar{\tau}_j$).

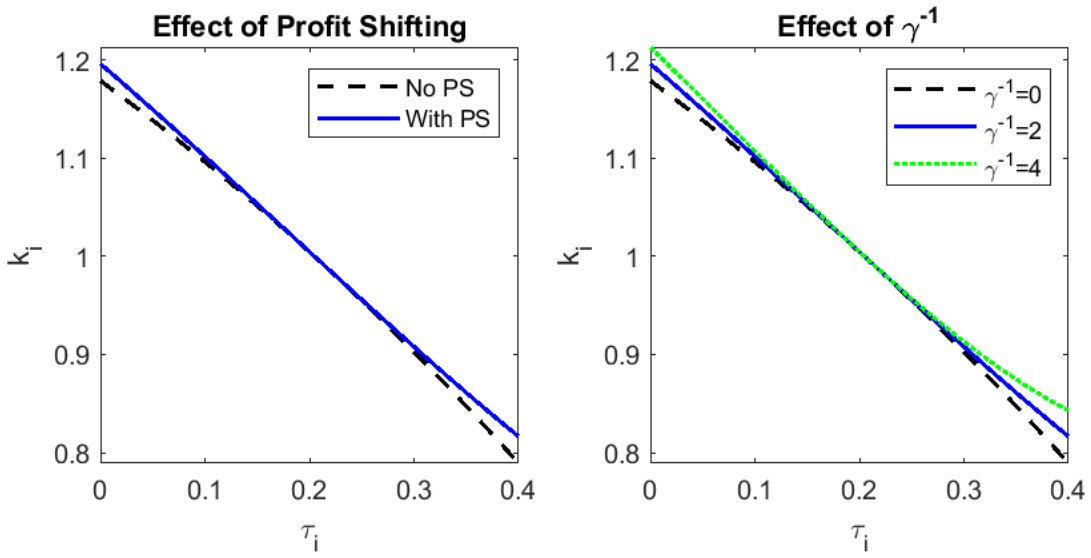
$$\frac{\partial \log k_{ij}^*}{\partial \gamma_j^{-1}} = \frac{1}{2}\left(\frac{1-\beta}{1-\alpha-\beta}\right)\left(\frac{(1-\theta_i)r_i/\eta_{ij}}{\theta_i r_i + (1-\theta_i)r_i/\eta_{ij} + \delta}\right)\frac{\left(\frac{\bar{\tau}_j-\tau_i}{1-\tau_i}\right)^2}{1+\frac{1}{2\gamma_j}\left(\frac{\bar{\tau}_j-\tau_i}{1-\tau_i}\right)^2} \geq 0 \tag{1}$$

This result is consistent with the empirical results of Grubert (2003), which found that multinationals with more R&D-intensive parents (as a proxy for ability to shift profits) are more likely to have affiliates in very high-tax countries and in very low-tax countries than less R&D-intensive firms. It also rationalizes the empirical results of Albertus (2018), Buettner et al. (2018), and Suárez Serrato (2019). All of these papers found that policy changes that restricted profit shifting caused affected multinationals to reduce their investment and employment in high-tax countries.

To illustrate this, consider an example of a firm operating in three countries: a high-tax country (H), with a 30% tax rate; a low-tax country (L), with a 10% tax rate; and country i. Figure 1 plots the firm's optimal investment in country i as a function of that country's tax rate τ_i. The dashed black line displays its optimal investment without profit shifting ($\gamma_j^{-1} = 0$), and the solid blue line display investment with profit shifting. The firm's optimal investment is higher due to profit shifting if τ_i is either high or low.

The second plot in Figure 1 adds another line with a firm that is better at profit shifting (larger γ^{-1}). This second plot displays the first testable prediction of the model: firms that are better at profit shifting should invest more in high-tax and in low-tax countries.

Figure 1: Effect of Profit Shifting on Investment



3.2 Spillovers Across Countries

The results above demonstrate that profit shifting increases investment. However, it also induces patterns of complementarity and substitutability of investment across countries. Equation (2) presents the derivative of optimal investment in country i with respect to the price of capital in country m.

$$\frac{\partial \log k_{ij}^*}{\partial r_m} = X\big(\alpha, \beta, \delta, r_i, r_m, \theta_i, \theta_m, \tau_i, \tau_m, \eta_{ij}, \eta_{mj}, \lambda_j\big) \frac{1}{\gamma_j} \left(\frac{y_{mj}}{\sum_\iota y_{\iota j}} \right) (\bar{\tau}_j - \tau_i)(\bar{\tau}_j - \tau_m) \tag{2}$$

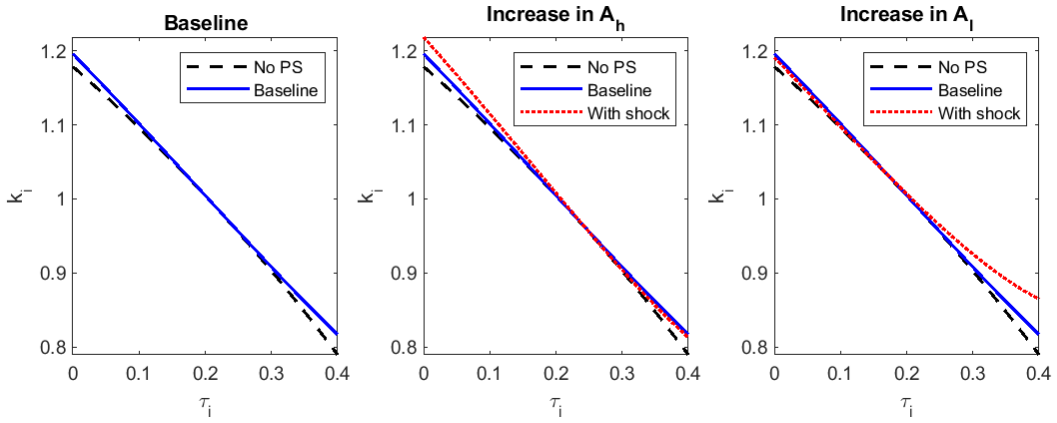
The sign of this derivative identifies whether capital investment in country i is a complement (negative) to investment in country m or a substitute (positive). The first term in the derivative in equation (2) is a multiplier that depends on the parameters and tax wedges for the two countries. If the corporate income tax is distortionary in country i ($\theta_i < 1$), this term is strictly positive. The derivative is decreasing in γ_j; as profit shifting diminishes, the magnitude of this interaction shrinks. The derivative also depends on the importance of country m to the firm, measured as the share of the firm's worldwide production income attributable to country m. A shock to Monaco has negligible implications for Apple's worldwide activities, whereas a shock to the U.S. has larger effects. Finally, the sign depends on the tax rate differentials in each country. If both countries are high-tax ($\bar{\tau}_j < \tau_i, \tau_m$) or both countries are low-tax ($\bar{\tau}_j > \tau_i, \tau_m$), the product of the tax rate differentials is positive, and investments in these countries are substitutes. On the other hand, if one of these countries is high-tax and the other is low-tax, this product is negative, and so investments in these countries are complementary.

These endogenous patterns of complementarity and substitutability of investment have implications for international shock spillovers. Equation (3) presents the effect of a TFP shock in country m on the firm's investment in country i. The coefficient Δ is a nonnegative term depending on parameters and tax wedges. In this expression, a TFP shock in country m affects the firm's investment in country i through conventional spillovers (e.g. through trade links) and through this profit shifting interaction channel.

$$\frac{\partial \log k_{ij}^*}{\partial \log A_m} = -\Delta \left(\frac{y_{mj}}{\sum_\iota y_{\iota j}} \right) \frac{1}{\gamma_j} (\bar{\tau}_j - \tau_i)(\bar{\tau}_j - \tau_m) \tag{3}$$

Figure 2 plots this effect, using the example of a firm operating in a high-tax country (H), a low-tax country (L), and the country of interest (i). The left plot displays investment with and without profit shifting in country i as a function of τ_i, from Figure 1. The middle plot adds an extra line of the firm's optimal investment in i following an increase in productivity in country H; its investment is higher if τ_i is small, and slightly lower if τ_i is large. The right plot adds a line of the firm's investment in i following a positive productivity shock to country L; its investment is higher if τ_i is high and slightly lower if τ_i is low. These demonstrate a positive spillover from a high-tax country to a low tax country or from a low-tax country to a high-tax country, and a negative spillover from a high-tax country to another high-tax country or from a low-tax country to another low-tax country.

Figure 2: Cross-Country Investment Spillovers



Because of these complementarities and substitutabilities induced by profit shifting, this channel amplifies shock transmission from a high-tax country to a low-tax country or vice versa, and it attentuates shock transmission from a high-tax country to other high-tax countries or from low-tax to other low-tax countries.

Note that this result relies on having at least three countries in the model. A two-country version of this model would predict that the interaction between profit shifting and investment increases amplifies business cycle spillovers when countries have different tax rates, in contrast to the more general result with many countries.

3.3 Extensive Margin Effects

The results so far have focused only on intensive margin interactions between profit shifting and investment, taking as given the countries in which the firm operates. Moreover, these interactions operate through alleviating the corporate income tax distortion; a corporate income tax that fully exempts the normal return from the tax base eliminates this interaction.

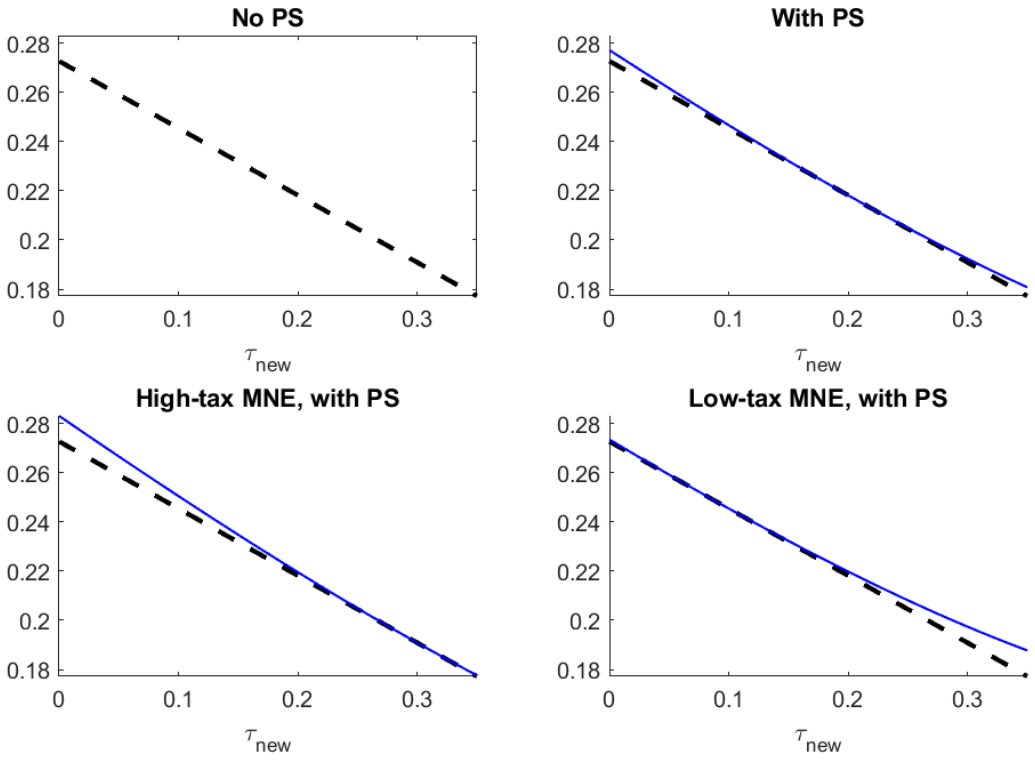
We now consider the effects of profit shifting on extensive margin investment decisions. Suppose a multinational already operates in a set of countries I, and is considering a greenfield investment in a new country (e.g. building a new factory). The relevant metric for how taxes affect this decision is the change in the firm's worldwide (after-tax) profits from investing in this new country, defined

as

$$\Pi_j(I \cup \{new\}; z_j, \gamma_j) - \Pi_j(I; z_j, \gamma_j)$$

Figure 3 plots the change in the firm's worldwide after-tax profits from creating an affiliate in this new country, as a function of the tax rate in the new country. We consider four scenarios: no profit shifting ($\gamma_j = \infty$), in the top left plot; with profit shifting, in the top right plot; with profit shifting and initially operating in high-tax countries, in the bottom left plot; with profit shifting and initially operating in low-tax countries, in the bottom right plot. All plots include the gain without profit shifting for comparison.

Figure 3: Change in Global Profits from Greenfield Investment



For all of these multinationals that engage in profit shifting, the gain in profits from this greenfield investment weakly exceeds the gain for a multinational that does not shift profits. For the top right plot, the gain is strictly positive in high-tax and in low-tax countries, amplifying the intensive margin effect described earlier. For a high-tax multinational (e.g. one operating in Germany and the U.S. pre-2017), the gain from investing in a low-tax country or a tax haven is larger, while the gain from investing in a high-tax country does not substantially differ from the case without profit shifting. On the other hand, for a low-tax multinational (e.g. one operating in Ireland and Switzerland), profit shifting confers no advantage to investing in a new low-tax country, but confers larger advantages to investing in high-tax countries.

Intuitively, under their initial cross-border structures, both the high-tax and the low-tax multinational engage in very little profit shifting, as the benefits of shifting between only high-tax countries or between only low-tax countries is negligible. Consequently, if the high-tax multinational invests in a low-tax country, this opens opportunities for shifting profits out of its existing affiliates

and into the new affiliate. Conversely, if the low-tax multinational invests in a high-tax country, it can shift profits toward its lower-tax affiliates.

Note that the plots in Figure 3 use a nondistortionary tax base in the new country ($\theta_{new} = 1$). The effects of profit shifting on these extensive margin incentives are similar with distortionary taxes. Importantly, this implies that the intensive-margin investment effects of profit shifting—increasing investment in low-tax and in high-tax countries—also apply on the extensive margin, regardless of the design of the corporate income tax (θ).

Moreover, the cross-border shock transmission implications also apply to the extensive margin investment decisions. A positive shock to a high-tax country in which the multinational operates shifts the multinational's gain from a greenfield investment toward the high-tax curve in Figure 3, increasing the incentive to invest in low-tax countries but decreasing the incentive to invest in high-tax countries. The reverse applies to a positive shock to a low-tax country.

4 Empirical Analysis

The theoretical analysis above produces two important, testable predictions about the interaction between profit shifting and investment. First, firms that are better at profit shifting should invest more in high-tax and in low-tax jurisdictions. Second, this interaction amplifies shocks between high-tax and low-tax countries, and it attentuates shock transmission between high-tax and other high-tax countries or between low-tax and other low-tax countries.

We test the first prediction using microdata, by estimating a mixed effects model with firm-specific profit shifting semi-elasticities. Combining these estimated semi-elasticities with the squared tax shields, consistent with the theoretical model, allows us to test the claim that firms with higher values of γ_j^{-1} should invest more in high-tax and in low-tax countries. Section 4.1 contains this analysis.

We test the second prediction using an event study around the check-the-box reform, which reduced barriers to profit shifting by U.S. multinationals. Using differences-in-differences estimation, we can see that an interaction term based on the theoretical channel significantly affected cross-country GDP correlations consistent with the theoretical prediction. This analysis can be found in section 4.2.

4.1 Profit Shifting and Investment

4.1.1 Data and Methodology

This analysis uses Compustat data on firms and on their geographic segments for the period from 1998 to 2023. Appendix B provides detailed descriptions of the data preparation. We first use data on the segments to conduct a profit shifting analysis, to estimate key parameters. We employ the standard empirical specification in the literature, following Hines and Rice (1994).

From the theoretical model, we can express reported profits as

$$\rho_{ij} = y_{ij}\left(1 + \frac{1}{2\gamma_j} - \frac{\lambda_j^2}{2\gamma_j(1-\tau_i)^2}\right).$$

We do not directly observe production income y_{ij} in the data. However, for an optimizing firm with Cobb-Douglas production technology, we should have

$$y_{ij} \propto A_i z_j k_{ij}^{\alpha} \ell_{ij}^{\beta}.$$

To estimate the profit shifting response, we use a first order Taylor expansion around the mean $(1 - \tau_i = \lambda_j)$ to obtain

$$\log \rho_{ij} \approx a_j + \log A_i + \log z_j + \alpha \log k_{ij} + \beta \log \ell_{ij} + \frac{1 - \tau_i}{\gamma_j \lambda_j}$$

where a_j is a firm-specific constant.

When taking this to the data, there are several adjustments to make. First, we use panel data, with time variation. Second, we measure the tax rate as the effective tax rate on affiliate i of firm j in year t.[4] We can thus estimate the profit shifting semi-elasticity $(\gamma_{jt}\lambda_{jt})^{-1}$ using the following estimation equation, where the coefficient estimate on the net-of-tax rate identifies the profit shifting semi-elasticity ε_{jt}.

$$\log \rho_{ijt} = a_j + b_i + c_t + \alpha \log k_{ijt} + \beta \log \ell_{ijt} + \Delta \log z_{jt} + \varepsilon_{jt}(1 - \tau_{ijt}) + \upsilon_{ijt}$$

In this equation, a_j, b_i and c_t are firm-, country- and year-specific fixed (or random) effects, or stand-ins for firm and country control variables. Firm-specific productivity z_{jt} is estimated by regressing the parent company's logged earnings before interest and taxes on the log of PPE and the log of employment. The residual from this regression provides an estimate of firm-specific measured productivity consistent with the model. Capital input k_{ijt} is measured as the segment's net property, plant and equipment (PPE), and labor input ℓ_{ijt} is the segment's employment. We measure the tax rate τ_{ijt} on the segment's income as its total income taxes divided by its pre-tax income. To measure the profit variable, we use reported pre-tax income, although we also use operating profits as a robustness check in the appendix.

Recall that λ_{jt} is the harmonic mean net-of-tax rate, weighted by production income y_{ijt}. Because production income is unobserved, we instead weight by property, plant and equitment capital. We can then back out estimates of the underlying parameters $\gamma_{jt}^{-1} = \varepsilon_{jt}\lambda_{jt}$.

In the model, the relevant variation for testing the theoretical prediction relies on firm heterogeneity in γ, whereas in the data we can potentially allow for time variation as well. In the main empirical exercises, we interact year indicator variables with the net-of-tax rate to obtain time variation, and we apply firm random coefficients using a mixed effects model to identify the firm-specific components of the semi-elasticities. This approach assumes that time variation is orthogonal to cross-sectional variation. As alternatives, we can either eliminate the time variation or allow firm-year specific random effects when estimating profit shifting semi-elasticities. These alternatives are explored in Appendix B, and the results are robust to them.

Table 1 reports the summary statistics of the relevant variables at the segment level. Consistent with standard firm data, pretax income, PPE, employment and productivity are all right-skewed. The average effective tax rate (τ_{ijt}) is 26.8 percent, lower than the average of the harmonic mean rate of 31.3 percent $(\bar{\tau}_{jt} = 1 - \lambda_{jt})$.

Note that this sample is much smaller than the full Compustat sample. Reporting of geographic segment information for firms is voluntary, and consequently, this sample excludes many firms and may suffer from selection bias. However, although selection bias would affect mean coefficient estimates, the identification of the interaction comes from *dispersion* in coefficient estimates across firms. In Appendix B, we also conduct a validation exercise, estimating firm-specific profit shifting

[4]There is some controversy over which tax rate is most appropriate. Ideally, we would know the marginal tax rate on the firm's profits. However, statutory tax rates are often poor proxies for this, due to complex exemption rules and patent boxes, while effective tax rates may reflect deductions and credits not relevant to the actual marginal tax rate and can be quite volatile. Dowd et al. (2017) explore the discrepancies between these. Overall, I consider effective tax rates a more appropriate measure, and Appendix B explores using moving average tax rates instead.

Table 1: Summary Statistics - Compustat

Variable	Obs	Mean	StDev	Min	Median	Max
Pretax income	3512	824.3	1843.7	0	156.2	19852
PPE	3512	1732.9	6877.2	0	191.2	71299.4
Employment	3512	10335	31429.5	0.8	2098.6	321830
Firm productivity	3512	3.7	3.4	0	2.6	18.7
Effective tax rate	3512	0.268	0.197	0	0.255	0.99
$\lambda \quad (= 1 - \bar{\tau})$	3512	0.687	0.223	0.01	0.734	1

Data are from Compustat historical segments, restricted to foreign geographic segments. Pretax income and PPE (net property, plant and equipment) are in millions of USD; their summary statistics are rounded to the nearest integer. Productivity and λ are estimated at the firm level; all other variables are at the segment level. The sample only uses geographic segments. The effective tax rates are constrained to be nonnegative and no greater than 0.99.

semi-elasticities on the full Compustat sample but using only domestic and foreign income; this estimation sacrifices cross-sectional geographic information for each firm but eliminates selection bias. I show that the estimates of γ_{jt}^{-1} have similar properties in the main sample and in the alternative expanded sample.

The literature on profit shifting has focused on estimating an overall profit shifting semi-elasticity common across firms and over time, although recent work has explored time trends (Klassen and Laplante 2012). However, there is no reason to expect this responsiveness to be identical across firms. To estimate firm-specific profit shifting semi-elasticities $\varepsilon_{jt} = (\gamma_{jt}\lambda_{jt})^{-1}$, we estimate a firm-specific component $\hat{\varepsilon}_j$ and a year-specific component $\bar{\varepsilon}_t$, with the variation across firms disciplines using maximum likelihood in a mixed effects regression. We obtain the firm-year-specific semi-elasticity as $\varepsilon_{jt} = \hat{\varepsilon}_j + \bar{\varepsilon}_t$. We then combine the firm-year-specific semi-elasticity with the firm-year-specific estimate for λ_{jt} to estimate γ_{jt}^{-1}. To understand what correlates with γ_{jt}^{-1}, we regress this on a set of firm variables.

Finally, we analyze how γ_{jt} correlates with investment at the parent level and at the segment level. For the segment investment regressions, we construct an interaction term $\gamma_{jt}^{-1}(\bar{\tau}_{jt} - \tau_{ijt})^2$ based on the theoretical term.

A mixed effects regression uses an assumption that $\hat{\varepsilon}_j$ comes from a normal distribution. If this assumption is true, the maximum likelihood estimation better disciplines the resulting estimates than OLS using a large number of firm indicators interacted with the net-of-tax rate; when groups have relatively few observations, the OLS-with-indicators approach has much greater estimation variance. The main analysis' approach of estimating $\varepsilon_{jt} = \hat{\varepsilon}_j + \bar{\varepsilon}_t$ assumes orthogonality to limit the variation, but Appendix B considers alternatives: no time variation, having time variation nested within firm variation, or estimating firm-year specific semi-elasticities with no assumed structure. The results hold under all these approaches, because the key variation for identifying the investment effect comes from variation across firms.

4.1.2 Profit Shifting Analysis

We first conduct a standard profit shifting analysis, with the results reported in Table 2. All of the regressions use year fixed effects and a set of geography indicator variables for regions and major countries (described in Appendix B), but they use different degrees of group fixed effects, to evaluate how these impact the estimates. The first column uses industry fixed effects, the second uses firm fixed effects, and the third uses firm-year fixed effects (which negates the year fixed effects). These

additional fixed effects increase the estimated semi-elasticities. The last two columns use mixed effect estimation, with the coefficients allowed the vary by firm (second column from right) or by firm and year as described in the prior subsection (right column). The table reports the mean coefficients only, with the variation explored below.

Table 2: Profit Shifting Regressions

Dependent variable:	log(Pretax income)				
Elasticity variation:	None	None	None	Firm	Firm+Year
1 - ETR	1.355***	1.455***	1.693***	1.679***	1.263***
	(0.122)	(0.138)	(0.160)	(0.212)	(0.228)
log(Capital)	0.428***	0.408***	0.425***	0.435***	0.430***
	(0.0125)	(0.0243)	(0.0284)	(0.0330)	(0.0327)
log(Employment)	0.398***	0.379***	0.375***	0.361***	0.363***
	(0.0153)	(0.0229)	(0.0277)	(0.0383)	(0.0385)
Firm productivity	0.848***	0.642***		0.808***	0.812***
	(0.0234)	(0.0413)		(0.0489)	(0.0489)
Year FE	Yes	Yes		Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes
Group FE	Industry	Firm	Firm-Year		
Observations	3,512	3,512	3,512	3,512	3,512
R-squared	0.897	0.919	0.951		

These regressions estimate the model parameters using the estimation equation from Hines and Rice (1994). Capital is defined as PPE. The coefficient estimate on 1 - ETR is the estimated semielasticity of profit shifting $\varepsilon = (\gamma\lambda)^{-1}$. All standard errors reported are robust. All columns use year and geographic fixed effects. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels.

Column 1 uses industry fixed effects, column 2 uses firm fixed effects, and column 3 uses firm-year fixed effects. Columns 4 and 5 are estimated using a mixed effects model with heterogeneity by firm, and the regression in column 5 also includes interactions between the net-of-tax rate and year dummy variables. The mixed effects specifications report the overall mean for the coefficient estimate. The estimated variances of the random coefficients are statistically significantly greater than zero.

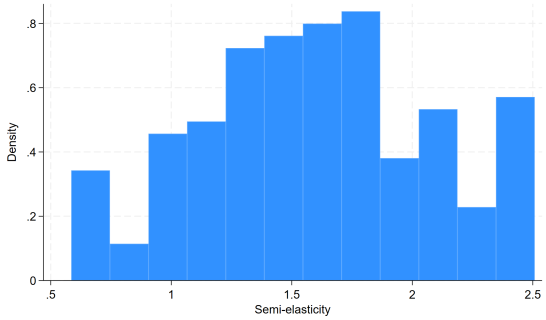
As noted, we conduct a similar exercise using consolidated financial statements, comparing only foreign and domestic income of each firm. Appendix B reports the results of this analysis, which resemble those from Table 2.

We now consider the variation in the coefficients estimated from the last column. Figure 7e plots the (winsorized) distribution of the estimated firm-specific semi-elasticities. Figure 7f plots the annual average semi-elasticities, showing a general upward trend consistent with Klassen and Laplante (2012). For comparison, it also plots the time trends of the semi-elasticities estimates from the full consolidated data. The time-trends from the segment sample and from the consolidated sample closely track. When using moving average tax rates instead of current ones (to control for potential volatility in tax rates), the estimated semi-elasticities are small and less volatile but display the same time trend.

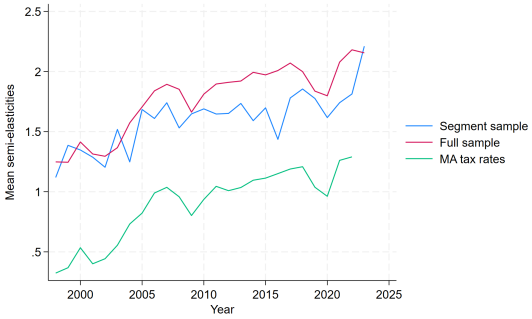
All of these time trends share a general upward slope, a notable increase around 2005, decreases in 2019 and 2020, and increases post-pandemic. The jump in 2005 is likely related to the dividend repatriation holiday in the American Jobs Creation Act of 2004, which created or strengthened expectations that American multinationals would eventually be allowed to repatriate foreign profits without facing large tax penalties. The decrease in 2019 may be related to the Tax Cuts and Jobs

Figure 4: Estimated Firm-Specific Profit Shifting Semi-Elasticities

(a) Firm Distribution



(b) Time Distribution



Plot (a) displays the estimated semi-elasticities from the mixed effects estimation in Table 2, column (5). The semi-elasticities are winsorized at the 5th and 95th percentiles, and averaged over time for each firm. Plot (b) displays the year-specific means of the estimated semi-elasticities. The full sample semi-elasticities are estimated from consolidated financial statements, described in greater detail in Appendix B. We also use this consolidated sample to estimate semi-elasticities using moving average tax rates instead of current tax rates.

Act of 2017 (which was passed in late December, and thus may not have affected 2018's decisions).

Using these estimated semi-elasticities, we then back out estimates for γ_{jt}^{-1} by multiplying these firm-specific semi-elasticities by λ_{jt}. In the segment sample with orthogonal firm and time variation, the firm-year-specific estimates of γ_{jt}^{-1} have mean 1.24 and standard deviation 0.61.

Before using these estimates of γ_{jt}^{-1} to test for the theoretical interaction, we first analyze the correlates of this variable. Table 3 presents these regression results. The even-numbered columns use industry fixed effects. The first two columns use the estimates from the segment sample, and the last two use estimates from the consolidated sample. The second and fourth columns use industry fixed effects.

Note that the analysis in Table 3 is explicitly not causal, but rather to confirm if the estimates are correlated with other variables we would reasonably expect. There is a positive correlation with measured firm productivity and with the ratio of R&D to assets, consistent the role of intangible capital in profit shifting. The tangibility of the firm's assets is not robustly correlated with the estimates of γ_{jt}^{-1}. In the segment sample, which may have selection bias, we find no relationship with firm size or with income volatility, although we find positive relationships in the full sample.

4.1.3 Investment Analysis

We now consider how a firm's ability to shift profits—measured by γ_{jt}^{-1}—relates to its investment decisions. From equation (1), a firm's capital decisions should be increasing in γ_{jt}^{-1}, but only insofar as the firm shifts profits between high-tax and low-tax affiliates. We test for this interaction through both an indirect approach of regressing the MNE's capital investment on its estimated profit shifting ability and a direct test for the interaction at the segment level.

Table 4 presents the consolidated investment regressions, using two different measures of investment, and employing standard control variables. We use the estimates of γ_{jt}^{-1} from the full sample, computed using current and moving average tax rates, and those from the segment sample. The coefficient estimates on γ_{jt}^{-1} are generally positive and significant, although less so for those estimated from the segment sample, with fewer firms and years included. The results suggest that firms that are better at profit shifting also generally have higher investment rates.

Table 3: Correlates of γ_{jt}^{-1}

	Dependent variable: γ_{jt}^{-1}			
Sample source:	Segments	Segments	Full	Full
Firm productivity	0.0448**	0.0881***	0.0779***	0.0661***
	(0.0214)	(0.0247)	(0.00374)	(0.00385)
log(Assets)	0.0110	-0.00145	0.00430**	0.00598***
	(0.00838)	(0.0104)	(0.00167)	(0.00170)
PPE/Assets	0.00654	0.287**	-0.0248	-0.0700***
	(0.0817)	(0.142)	(0.0156)	(0.0189)
Cash/Assets	0.674***	0.876***	0.558***	0.542***
	(0.0989)	(0.104)	(0.0224)	(0.0229)
R&D/Assets	1.593*	0.0196	1.346***	0.855***
	(0.838)	(0.515)	(0.0690)	(0.0761)
Income volatility	0.358	-0.105	0.167***	0.0858*
	(0.261)	(0.361)	(0.0515)	(0.0462)
Year	0.0148***	0.0167***	0.0309***	0.0309***
	(0.00313)	(0.00320)	(0.000259)	(0.000258)
Fixed effects	None	Industry	None	Industry
Observations	721	721	34,103	34,103
R-squared	0.141	0.356	0.411	0.446

The estimates for γ_{jt}^{-1} come from estimating firm- and year-specific profit shifting semi-elasticities $\varepsilon_{jt} = (\gamma_{jt}\lambda_{jt})^{-1}$ and multiplying by the firm-year-specific estimates of λ. γ_{jt}^{-1} may be interpreted as how good a firm is at profit shifting.
Short-term leverage is defined as the ratio of debt in current liabilities to total assets.
The analysis is at the firm level using Compustat data for 1998-2023. All standard errors are robust. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

To test for the interaction directly, we regress the firm's capital investment decisions for each segment on the net-of-tax rate, the estimated cost parameter γ_{jt}^{-1}, and the theoretical interaction term between profit shifting and investment, based on equation (1). Table (5) presents these results.

In these regressions, the key coefficient estimates are on γ_{jt}^{-1} and on the interaction term. If the theory is correct, the coefficient on the interaction term should be positive. Controlling for the interaction term, γ_{jt}^{-1} should have no effect on intensive-margin investment. On the extensive margin, by making high-tax and low-tax countries more favorable, firms that are better at profit shifting would be less likely to make new investments in medium-tax jurisdictions.

In Table (5), the coefficient estimates on the interaction term are positive and broadly significant. The coefficient estimates on γ_{jt}^{-1} alone, however, are negative, consistent with the extensive margin effect rather than just the intensive margin effect.

In Appendix B, we consider alternative specifications and robustness tests, such as different functional forms, sources for estimating γ_{jt}^{-1} and time variation in it, and different sample periods. These coefficient estimates on the key variables are broadly robust to these alternatives.

4.2 Empirical Analysis of International Shock Transmission

The theoretical analysis in section 3 produced a novel prediction: the interaction between profit shifting and investment should amplify cross-border shock transmission between high-tax and low-tax countries and attenuate it between high-tax (low-tax) and other high-tax (low-tax) countries.

Table 4: Consolidated MNE CapEx Regression Results

Dependent variable:	log(CapEx)			CapEx/PPE		
Sample source of γ_{jt}^{-1}:	Full	Full	Segment	Full	Full	Segment
ETR measure for γ_{jt}^{-1}:	Current	MA	Current	Current	MA	Current
γ_{jt}^{-1}	0.0270***	0.0260**	-0.00745	0.0134***	0.0169***	0.0259*
	(0.00785)	(0.0112)	(0.0595)	(0.00174)	(0.00258)	(0.0153)
log(Sales)	0.182***	0.203***	0.184***	-0.00831***	-0.00873***	-0.0233***
	(0.00770)	(0.00849)	(0.0523)	(0.000475)	(0.000516)	(0.00486)
log(Capital)	0.806***	0.798***	0.754***			
	(0.00518)	(0.00554)	(0.0415)			
log(Emp)	0.0276***	0.00919	0.0633			
	(0.00681)	(0.00711)	(0.0405)			
Profitability	0.0506*	0.0382	-0.518	0.0132*	0.0112	-0.00583
	(0.0262)	(0.0351)	(0.709)	(0.00800)	(0.0102)	(0.155)
Market/book equity	0.0952***	0.0943***	0.0955***	0.0248***	0.0247***	0.0230***
	(0.00264)	(0.00292)	(0.0266)	(0.000746)	(0.000827)	(0.00769)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	38,556	32,880	663	39,290	33,393	690
R-squared	0.932	0.935	0.951	0.238	0.245	0.454

These regress measures of firm investment at the firm level on the firm's estimated ability to shift profits γ_{jt}^{-1} and standard investment regression control variables. All regressions use year fixed effects, and columns (2) and (4) use industry fixed effects. Profitability is measured as the ratio of operating income before depreciation to sales. Profitability and the market-book equity ratio are winsorized at the 1st and 99th percentiles.

The analysis is at the consolidated level using Compustat data for 1998-2023. All standard errors are robust. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

To test for this, we conduct an event study around the check-the-box regulation.

The check-the-box regulation, which took effect in 1997, was ostensibly intended to simplify the process of determining the legal entity form of a business, such as choosing between an S corporation or a C corporation. Instead of applying for an entity type and waiting for the federal government to confirm it, firms could instead "check the box" to elect a certain form. However, this regulation produced an unintended consequence of enabling profit shifting by facilitating the creation of hybrid entites—companies receiving different tax and legal treatments according to different countries. A subsequent effort to repeal the regulation in 1998 failed, and it was formally codified in law via look-through rules, which are similar in effect.

To understand how this enabled profit shifting, consider a multinational with a U.S. parent company, which owns a corporation in Ireland, which in turn owns another corporation in Germany. The multinational's intellectual property is owned by its Irish affiliate, and the German affiliate pays a royalty to the Irish affiliate for the use of this IP.

This royalty payment reduces the multinational's taxable income in high-tax Germany and increases its taxable income in low-tax Ireland, reducing the multinational group's overall tax liabilities. Under pre-check-the-box rules, this royalty income would have been caught by the subpart F rules, requiring that the Irish affiliate's royalty income be included in U.S. taxable income. This application of subpart F would reduce or eliminate the multinational's incentive to shift profits from Germany to Ireland using royalty payments on IP.

Table 5: Segment CapEx Regression Results

Dependent:	log(CapEx)		CapEx/PPE	
1 - ETR	0.124	0.152	0.0667**	0.0857***
	(0.106)	(0.122)	(0.0261)	(0.0312)
γ_{jt}^{-1}	-0.234***	-0.277***	-0.0448***	-0.0463**
	(0.0549)	(0.0785)	(0.0130)	(0.0208)
$\gamma_{jt}^{-1}(\bar{\tau}_{jt} - \tau_{ijt})^2$	2.291***	0.879	0.649***	0.556***
	(0.566)	(0.605)	(0.156)	(0.162)
log(Capital)	0.634***	0.382***		
	(0.0252)	(0.0453)		
log(Employment)	0.203***	0.284***		
	(0.0359)	(0.0524)		
Profitability	-0.0594***	-0.0587**	0.00135	0.000755
	(0.0191)	(0.0232)	(0.00360)	(0.00422)
log(Sales)	0.176***	0.241***	-0.0177***	-0.0158*
	(0.0376)	(0.0589)	(0.00360)	(0.00894)
Market/book equity	0.0193	-0.00535	0.0191***	0.0137*
	(0.0163)	(0.0294)	(0.00457)	(0.00727)
Foreign indicator	-0.0547	-0.259***	0.0229	0.00429
	(0.0592)	(0.0648)	(0.0145)	(0.0155)
Year FE	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes
Group FE	Industry	Firm	Industry	Firm
Observations	1,943	1,938	1,998	1,992
R-squared	0.907	0.926	0.304	0.421

These regress measures of firm investment at the segment level on the firm's net-of-tax rate, estimated ability to shift profits γ_{jt}^{-1}, a profit shifting interaction term, and standard investment regression control variables. All regressions use year fixed effects. Columns (1) and (3) use industry fixed effects, and columns (2) and (4) use firm fixed effects. The market/book equity ratio and γ_{jt}^{-1} are computed at the firm level; all other variables are segment-specific.

The analysis is at the segment level using Compustat data for 1998-2023. All standard errors are robust. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

However, under check-the-box, the multinational can declare to the U.S. government that the German corporation is actually a foreign disregarded entity (FDE) of the Irish corporation. As a FDE, the IRS attributes the assets and income of the German corporation directly to the Irish corporation, viewing the royalty as a payment from the Irish corporation to itself, which does not trigger subpart F inclusions. Meanwhile, the Irish and German governments would continue to treat these as separate companies.

4.2.1 Data and Methodology

To test for the impact of the new theoretical channel, we use a differences-in-differences estimation. The dependent variable is the correlation of Hamilton-filtered log-GDP between country pairs, over

the ten-year period before the regulation (1987-1996) and the ten-year period after (1997-2006).[5] The GDP data come from the Penn World Tables. Unlike the cross-sectional approach in the literature (see Frankel and Rose (1998)), we use country-pair fixed effects to remove all variation due to permanent country factors.

We regress the country-pair correlations on an indicator for the post-check-the-box period, bilateral trade intensity—combined exports and imports between the country pairs (from the IMF direction of trade statistics) as percentages of their combined GDP—and an interaction term constructed from the theory. Table 6 presents the summary statistics for GDP correlations and bilateral trade intensity. Although trade intensity is right-skewed, the key results are robust to this.[6]

Table 6: Summary Statistics for Transmission Regressions

Variable	Obs	Mean	StDev	Min	Median	Max
Full sample						
GDP correlation	5663	0.154	0.372	-0.687	0.173	0.797
Trade intensity	5663	0.072	0.12	0	0.019	0.465
Interaction term	5663	0	0.003	-0.015	0	0.114
Period: 1987-1996						
GDP correlation	2510	0.048	0.384	-0.687	0.036	0.797
Trade intensity	2510	0.061	0.11	0	0.015	0.465
Interaction term	2510	0	0.001	-0.002	0	0.027
Period: 1997-2006						
GDP correlation	3153	0.239	0.339	-0.687	0.264	0.797
Trade intensity	3153	0.081	0.127	0	0.023	0.465
Interaction term	3153	0	0.003	-0.015	0	0.114

The sample consists of cross-country bilateral variables over ten-year periods. The initial period runs from 1987-1996, and the second period runs from 1997-2006. The GDP correlation variable is the bilateral correlation of Hamilton-filtered logged GDP during each ten-year period, winsorized at the first and 99th percentiles. The trade intensity variable is computed as total annual bilateral trade between country pairs as a percent of their combined GDP, averaged over the periods.

The theoretical interaction term between countries i and m is based on the relation in equation (3). The empirical interaction term is shown in equation (4). The magnitude and sign of the interaction depends on the product of the tax shields (fourth term, in blue), the abilities of the multinationals to shift profits (third term, green), and the importance of the two countries to these multinationals (second term, magenta). Because multinationals only constitute a share of business activity in any given country, the interaction is weighted by the importance of U.S. multinationals to the two countries (first term, red).

$$\bar{X}_{imt} = \frac{1}{|T|} \sum_{t \in T} \sum_{j} \underbrace{\left(\frac{k_{ijt} + k_{mjt}}{GDP_{it} + GDP_{mt}} \right)}_{\text{MNE importance}} \underbrace{\left(\frac{k_{ijt} + k_{imt}}{\sum_{\iota} k_{\iota jt}} \right)}_{\text{Country importance}} \gamma_{jt}^{-1} \underbrace{(\bar{\tau}_{jt} - \tau_{ijt})(\bar{\tau}_{jt} - \tau_{mjt})}_{\text{Tax shields}} \tag{4}$$

[5]The detrending is applied to the full time series for each country, so the end-of-sample bias in the HP filter does not apply. The regression results are robust to using Hamilton, BK or CF filters instead of the Hamilton filter. See Appendix B for more discussion and filtering results.

[6]Using winsorized trade intensity in the regressions slightly increases the coefficient estimates, whereas using the log of trade intensity produces smaller and potentially insignificant coefficient estimates. However, the coefficient estimates on the interaction term remain significant and robust to the measure of trade intensity.

To estimate each of the components, we draw on BEA data on the activities of U.S. multinationals by country and industry, in particular their majority-owned foreign affiliates (MOFAs). We use different methods to estimate the profit shifting parameters, potentially allowing them to vary before and after, by year, by industry, and combinations of these. We also average over the years in the period. These different combinations correspond to different columns in Tables 7 and 8.

The theoretical transmission channel suggests that the coefficient estimate on this interaction term should be negative, as in equation (3).

4.2.2 Results

Table 7 contains the main regression results. The different columns correspond to different methods of estimating the semi-elasticities $(\gamma_{jt}\lambda_{jt})^{-1}$ using the standard profit shifting estimation equation, and multiplying by λ_{jt} to estimate γ_{jt}^{-1}. The first column only allows the semi-elasticity to vary between the pre-check-the-box and post-check-the-box periods; the second column has industry-specific estimates for the pre- and post- semi-elasticities. The third column allows them to vary by year. The fourth column allows variation by year and by industry, using a year-specific component and an industry-specific component. The fifth column estimates semi-elasticities separately for each industry-year. The coefficient estimates on the interaction terms have been standardized.

Note that in these regressions, there may be unobserved country factors that vary over time, which introduce correlations across observations. For example, the country pairs of Germany-Ireland, Germany-France, and Germany-Switzerland may have unmodeled correlations due to sharing Germany as one of the countries. To address this, we use two-way clustered standard errors on each country in country pairs. In Appendix B, we also use country-time fixed effects in addition to the country-pair fixed effects. The results are robust to these additional controls.

Regardless of the estimation strategies for γ_{jt}^{-1}, the coefficient estimate on the interaction term is significant and negative, consistent with the theoretical framework. Because all country-pair variation is absorbed by the country-pair fixed effects, this should be considered as causal evidence of the transmission channel, whereby profit shifting induces more positive GDP correlations between high-tax and low-tax countries and more negative correlations between high-tax and other high-tax countries or between low-tax and other low-tax countries.

However, it is difficult to provide an economic interpretation of the coefficient estimates on these interaction terms because it is unclear which component of the interaction is driving changes in this term.

To address this, Table 8 includes each of the components of the interaction term as well as the interaction itself. The first five columns correspond to the five columns of Table 7, and the final column drops the interaction term.

The coefficient estimates on each of the components are insignificant, except for the importance of U.S. multinationals. In other words, increasing the importance of countries i and m to U.S. multinationals on its own does not affect cross-country GDP correlations, nor does the tax shield interaction, or the change in profit shifting on its own. Consistent with the theoretical result, these matter only through their interaction.

In the results above, we focused on the correlations between GDP. However, in the model, the spillover channel should be through the capital stock and investment. We compute investment rates (the ratio of investment to the previous year's capital stock, both expressed in constant dollars), detrend these these the HP filter, and run the regression in Table 7) for each of the relevant series, presented in Table 9. We find highly significant effects on the capital stock, on investment in structures, on investment in transportation equipment, and on overall investment,

Table 7: Transmission Regressions

Dependent variable	HP-filtered GDP correlations				
γ^{-1} varies by	Pre/Post	Pre/Post × Industry	Year	Year, Industry	Year × Industry
Post-CtB	0.164***	0.164***	0.164***	0.164***	0.163***
	(0.0308)	(0.0308)	(0.0308)	(0.0308)	(0.0308)
Trade intensity	0.300	0.300	0.300	0.300	0.301
	(0.191)	(0.191)	(0.191)	(0.191)	(0.191)
Interaction term	-0.0156***	-0.0160***	-0.0166***	-0.0167***	-0.0185***
	(0.00216)	(0.00319)	(0.00240)	(0.00245)	(0.00448)
Fixed effects:	Country-pair (i, m)				
Observations	5,268	5,268	5,268	5,268	5,268
R-squared	0.597	0.597	0.597	0.597	0.597

The dependent variable is the ten-year correlation of HP-filtered log GDP between country pairs. All regressions use country-pair fixed effects, an indicator for the period, trade intensity (as a percent of combined GDP), and the interaction term in equation (4).

All standard errors are robust and estimated through two-way clustering on countries i and m. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

To construct the interaction term, we estimate γ_{jt}^{-1} by first estimating the profit shifting semi-elasticity $(\gamma_{jt}\lambda_{jt})^{-1}$ and then multiplying by the estimate of λ_{jt} from the BEA MOFA data. The first column only allows the semi-elasticity to vary by pre- and post-check-the-box. For the second column, the semi-elasticity is estimate pre- and post- separately for each industry. For the third column, the semi-elasticity is estimated separately for each year. For the fourth column, the semi-elasticity is estimated in a single regression with a year-specific interaction and an industry-specific interaction, which are then combined into industry-year specific semi-elasticities. For the fifth column, semi-elasticities are estimated separately for each firm-year. Negative semi-elasticity estimates are set to zero. The interaction term is standardized by demeaning and dividing by its standard deviation.

with standardized coefficients of similar magnitude to the effects on GDP. The coefficients for investment in machinery and other equipment are insignificant.

5 Quantitative Analysis

The previous sections provide novel theoretical and empirical results on the implications of joint profit shifting and investment decisions, but these analyses have two limitations. First, the theoretical analysis—as is standard in theoretical and structural models—uses linear corporate tax systems. This ignores asymmetries in the tax treatments of losses and of various provisions intended to reduce profit shifting incentives. Moreover, the international corporate tax system is moving away from linearity. The GILTI and FDII provisions in the U.S. and Pillar 1 and Pillar 2 of the OECD proposals represent decisive breaks with approximately linear corporate tax schedules, potentially creating new and unanticipated incentives and consequences. To understand the effects of these changes, we need a strucutral model of profit shifting and investment that captures these more complicated tax rules.

Moreover, while the empirical results provide evidence to support the theoretical effects of profit shifting and investment, they are not useful for quantifying the magnitudes of these effects. A structural framework can quantify the magnitude of the effects from the theoretical interaction, as well as how this changes under the new tax regimes. We can use this to study more complex extensive margin decisions of which countries to sell to and where to produce, as well as incorporating equilibrium effects like crowding out and misallocation.

Table 8: Transmission Regression Decomposition

Dependent variable	HP-filtered GDP correlations					
γ^{-1} varies by	Pre/Post	Pre/Post, Industry	Year	Year, Industry	Year × Industry	Year × Industry
Post-CtB	0.149***	0.148***	0.149***	0.148***	0.148***	0.147***
	(0.0287)	(0.0286)	(0.0287)	(0.0286)	(0.0285)	(0.0284)
Trade intensity	0.296	0.297	0.296	0.296	0.298	0.302
	(0.194)	(0.194)	(0.194)	(0.193)	(0.193)	(0.193)
US MNE importance	0.000879	0.00101	0.000879	0.00111	0.00105	0.00101
	(0.00123)	(0.00132)	(0.00125)	(0.00126)	(0.00131)	(0.00122)
Country importance	0.0606	0.0649	0.0620	0.0683	0.0691	0.0669
	(0.115)	(0.116)	(0.116)	(0.116)	(0.117)	(0.116)
$(\bar{\tau} - \tau_i)(\bar{\tau} - \tau_m)$	-1.048	-1.041	-1.047	-1.045	-1.020	-1.009
	(0.650)	(0.650)	(0.651)	(0.649)	(0.650)	(0.647)
Exposure to γ_{jt}^{-1}	-0.258*	-0.234*	-0.323*	-0.323*	-0.366*	-0.350*
	(0.143)	(0.123)	(0.185)	(0.164)	(0.205)	(0.205)
Interaction term	-0.0161***	-0.0168***	-0.0173***	-0.0174***	-0.0204***	
	(0.00223)	(0.00305)	(0.00241)	(0.00243)	(0.00483)	
Fixed effects:	Country-pair (i, m)					
Observations	5,268	5,268	5,268	5,268	5,268	5,268
R-squared	0.599	0.599	0.599	0.599	0.598	0.598

The dependent variable is the ten-year correlation of HP-filtered logged GDP between country pairs. All regressions use country-pair fixed effects, an indicator for the period, trade intensity (as a percent of combined GDP), and the interaction term in equation (4).

All standard errors are robust and estimated through two-way clustering on countries i and m. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients. To remove outliers, the US MNE importance is winsorized at the first and 99th percentiles, and multiplied by 100.

To construct the interaction term, we estimate γ_{jt}^{-1} by first estimating the profit shifting semi-elasticity $(\gamma_{jt}\lambda_{jt})^{-1}$ and then multiplying by the estimate of λ_{jt} from the BEA MOFA data. The first column only allows the semi-elasticity to vary by pre- and post-check-the-box. For the second column, the semi-elasticity is estimate pre- and post- separately for each industry. For the third column, the semi-elasticity is estimated separately for each year. For the fourth column, the semi-elasticity is estimated in a single regression with a year-specific interaction and an industry-specific interaction, which are then combined into industry-year specific semi-elasticities. For the fifth and sixth columns, semi-elasticities are estimated separately for each industry-year. Negative semi-elasticity estimates are set to zero. The interaction term is standardized by dividing by its standard deviation.

5.1 Structural Model

We use a model of firm decisions resembling Helpman et al. (2004), augmented with profit shifting and general equilibrium.

Each country $i \in \mathbb{I}$ has a representative household of mass N_i. These households work, save, receive labor income, and receive dividends from equity they own. There is a final good in each country, produced by a representative CES aggregator in that country, using intermediate goods that come from domestic or foreign production. Each country's final good is nontradeable, has a price P_i, and can be used for household consumption, government consumption, and domestic investment. Each country has a government that imposes corporate income taxes and consumes the local final good using this revenue.

The world has a set of intermediate good producers, with set $J(i)$ of mass m_i headquartered in country i. These firms own capital, produce differentiated products using capital and labor, and face isoelastic demand. They differ idiosyncratically on productivity and ability to shift profits, as in the theoretical framework. As in Helpman et al. (2004), a firm headquartered in country h always produces in h for local consumption. It makes extensive margin decisions for whether to export to country ι, to produce in ι for sale there, or not to sell to ι. It can also shift profits as in the theoretical framework. By assumption, firms headquartered in country h are owned by shareholders of that country.[7]

[7]Alternatively, we could allow households to choose a portfolio of firms from different countries, but optimal portfolios are not uniquely identified in the steady state. Cross-border firm ownership is not important in the steady

Table 9: Transmission Regressions: Capital and Investment

Dependent variable	HP-filtered aggregate variable correlations					
Aggregate variable	Capital stock	Total investment	Structures investment	Machinery investment	Transportation equipment investment	Other equipment investment
Post-CtB	0.162***	0.0755**	0.0286**	0.0758**	0.0565**	-0.00232
	(0.0442)	(0.0307)	(0.0135)	(0.0312)	(0.0244)	(0.0189)
Trade intensity	-0.203	-0.382***	0.00208	0.172	-0.0912	-0.0942
	(0.224)	(0.130)	(0.138)	(0.152)	(0.157)	(0.232)
Interaction term	-0.0110***	-0.00578***	-0.0129***	-0.000169	-0.0189***	0.000214
	(0.00233)	(0.00125)	(0.000941)	(0.00125)	(0.000921)	(0.000581)
Fixed effects:	Country-pair (i, m)					
Observations	5,268	4,874	5,268	5,268	5,268	4,874
R-squared	0.623	0.611	0.556	0.574	0.577	0.505

The dependent variable is the ten-year correlation of HP-filtered aggregate variables between country pairs. The capital stock is logged first, whereas the investment measures are divided by the previous year's relevant capital stock. Capital stock is the *rnna* measure from PWT (capital stock at constant 2017 national prices). Total investment comes from the PWT national accounts table. The investment type measures come from the capital detail table for the PWT, computed as the current-price values divided by their price indexes. All regressions use country-pair fixed effects, an indicator for the period, trade intensity (as a percent of combined GDP), and the interaction term in equation (4).

All standard errors are robust and estimated through two-way clustering on countries i and m. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

To construct the interaction term, we estimate γ_{jt}^{-1} by first estimating the profit shifting semi-elasticity $(\gamma_{jt}\lambda_{jt})^{-1}$ and then multiplying by the estimate of λ_{jt} from the BEA MOFA data. The first column only allows the semi-elasticity to vary by pre- and post-check-the-box. For the second column, the semi-elasticity is estimate pre- and post- separately for each industry. For the third column, the semi-elasticity is estimated separately for each year. For the fourth column, the semi-elasticity is estimated in a single regression with a year-specific interaction and an industry-specific interaction, which are then combined into industry-year specific semi-elasticities. For the fifth column, semi-elasticities are estimated separately for each firm-year. Negative semi-elasticity estimates are set to zero. The interaction term is standardized by demeaning and dividing by its standard deviation.

Because this is a real model, we normalize all exchange rates to 1 (common unit of account), and normalize the price of the final good in one country to 1. As a result, the price levels P_i can be interpreted as real exchange rates (deviations from purchasing power parity).[8]

5.1.1 Representative Households

The representative household in country i supplies labor H_{it} in period t, consumes C_{it} of the final good, receives labor income $w_{it}H_{it}$ and dividends D_{it}, and saves through bonds B_{it}, with preferences following Greenwood et al. (1988). Because we focus on a positive analysis, we do not need to consider a value of government consumption in the agent's utility. All variables are expressed in real terms. Each representative household solves the following problem.

$$\max_{C_{it},H_{it},B_{it}} E\left[\sum_{t=0}^{\infty} \frac{\beta^t}{1-\sigma}\left(\frac{C_{it}}{N_i} - \frac{(H_{it}/N_i)^{1+1/\varphi}}{1+1/\varphi}\right)^{1-\sigma}\right]$$

state of this model, but it would have nontrivial implications on a transition path following a policy change.

[8]This model has as many budget constraints as countries (n). Combined with a triangular no-arbitrage assumption for exchange rates, per Walras' Law, this nominal exchange rate normalization pins down $n-1$ prices, allowing us to also normalize one country's price level to 1.

$$\text{s.t.} \qquad P_{it}C_{it} + B_{it} \leq w_{it}H_{it} + (1 + r_{i,t-1})B_{i,t-1} + D_{it}$$

The labor supply optimality condition gives aggregate labor supply.

$$H_{it} = N_i w_{it}^{\varphi}$$

The Euler equation identifies the stochastic discount factor as

$$M_{i,t+1} = \beta \frac{\left(\frac{C_{i,t+1}}{N_i} - \frac{(H_{i,t+1}/N_i)^{1+1/\varphi}}{1+1/\varphi}\right)^{-\sigma}}{\left(\frac{C_{it}}{N_i} - \frac{(H_{it}/N_i)^{1+1/\varphi}}{1+1/\varphi}\right)^{-\sigma}} \left(\frac{P_{it}}{P_{i,t+1}}\right).$$

5.1.2 Representative Aggregators

A representative aggregator in country i uses a set of available intermediate goods J_i to produce a final good, using a CES production function with constant returns to scale.[9] It solves the following cost minimization problem.

$$\min_{\{y_{ijt}\}} \int_{J_i} p_{ijt} y_{ijt} dj \qquad \text{s.t.} \qquad \left(\int_{J_i} y_{ijt}^{\frac{\varepsilon-1}{\varepsilon}} dj\right)^{\frac{\varepsilon}{\varepsilon-1}} \geq Y_{it}$$

The solution to this problem and constant returns to scale determine the equilibrium price level

$$P_{it} \equiv \left(\int_{J_i} p_{ijt}^{1-\varepsilon} dj\right)^{\frac{1}{1-\varepsilon}}$$

and good-specific demand curve

$$y_{ijt} = Y_{it} P_{it}^{\varepsilon} p_{ijt}^{-\varepsilon}.$$

5.1.3 Intermediate Good Producers

Each country i has a set $J(i)$ of firms headquartered in i, with decision problems similar to Helpman et al. (2004). Firms are monopolistically competitive, with technology exhibiting constant returns to scale, and face CES demand functions; this is isomorphic to the theoretical framework. Each firm has an exogenous idiosyncratic state ω consisting of its productivity z, its cost of shifting profits γ, and its home country h. It also begins each period with an endogenous state consisting of the set of countries where it produces for local consumption (I_p), the set countries that it exports to (I_e), and initial capital for each country it sells to ($\{k_i\}_{i \in I_p \cup I_e}$). We will refer to these sets of countries it sells to I_p and I_e as the firm's "configuration." As in Helpman et al. (2004), it incurs a fixed cost χ_e and iceberg trade cost κ to export to a country, and it incurs a higher fixed cost χ_f to produce in any country other than its home country.

In each period, for every country the firm sells to, it chooses the price of the good, its labor demand, and profits to shift into or out of the affiliate. It also chooses its new configuration and capital stocks for the next period.

We express the firm's dynamic optimization problem as follows. Its flow value is its after-tax cash flow, less fixed operating costs and taxes. We denote the aggregate state as Ω. As an

[9] Note that the set of available intermediate inputs J_i is not the same as the set of firms $J(i)$ headquartered in that country, except in autarky.

assumption, all fixed costs are incurred in the home country; this aligns the location of the producer surplus before the fixed cost with the location of the fixed cost.

$$
\begin{aligned}
V(\{k_i\}, I_p, I_e; \omega, \Omega_t) = \\
&\max_{\substack{(\ell_i, p_i, s_i, y_i)_{i \in I_p \cup I_e} \\ I'_p, I'_e \\ \{k'_i\}_{i \in I'_p \cup I'_e}}} \sum_{i \in I_p} \left[Y_{it} P_{it}^{\varepsilon} p_i^{1-\varepsilon} - w_i \ell_i - \big(k'_i + (1-\delta) k_i\big) P_{it} - \chi_f P_{ht} \mathbb{1}\{i \neq h\} + s_i - \frac{\gamma s_i^2}{2 y_i} \right] \\
&\qquad + \sum_{i \in I_e} \left[Y_{it} P_{it}^{\varepsilon} p_i^{1-\varepsilon} - w_h \ell_i - \big(k'_i - (1-\delta) k_i\big) P_{ht} - \chi_e P_{ht} + s_i - \frac{\gamma s_i^2}{2 y_i} \right] \\
&\qquad - \sum_{i \in I'_p \setminus I_p} k'_i P_{it} - \sum_{i \in I'_e \setminus I_e} k'_i P_{ht} - \mathcal{T}(\,\cdot\,) + E_t \Big[M_{h,t+1} V(\{k'_i\}, I'_p, I'_e; \omega, \Omega'_t) \Big]
\end{aligned}
$$

s.t.

$$
Y_{it} P_{it}^{\varepsilon} p_{\iota}^{-\varepsilon} = A_{it} z k_i^{\alpha} \ell_i^{1-\alpha} \qquad \forall i \in I_p \qquad \text{and} \qquad Y_{it} P_{it}^{\varepsilon} p_{\iota}^{-\varepsilon} = \frac{A_{ht} z}{1+\kappa} k_i^{\alpha} \ell_i^{1-\alpha} \qquad \forall i \in I_e
$$

$$
\sum_{i \in I_p \cup I_e} s_i = 0
$$

$$
y_i = Y_{it} P_{it}^{\varepsilon} p_i^{1-\varepsilon} - w_i \ell_i - \delta k_i P_i \qquad \forall i \in I_p \qquad \text{and} \qquad y_i = Y_{it} P_{it}^{\varepsilon} p_i^{1-\varepsilon} - w_h \ell_i - \delta k_i P_h \qquad \forall i \in I_e
$$

$$
I'_p, I'_e \subseteq \mathbb{I} \qquad I'_p \cap I'_e = \emptyset \qquad h \in I'_p
$$

The first line is the firm's pre-tax cash flow from affiliates where it produces for local consumption, and the second line is the same measure for exporting affiliates. The third line contains the firm's capital investments in new affiliates, its total tax liabilities, and its expected continuation value, discounted using the home country's stochastic discount factor. The tax function is potentially general and can allow for arbitrary tax systems as a function of other variables.

The first set of constraints impose that supply equal demand at the chosen prices. The second is the requirement that profits shifted into an affiliate must be shifted out of others, and vice versa. The third are the income definitions; we use an analog to operating income for these calculations instead of taxable income, as taxable income may be measured by multiple countries using minimum taxes, as well as being subject to reapportionment under Pillar 1. This definition produces the intensive- and extension-margin facilitation effects of profit shifting as in the theoretical framework. The final line imposes constraints on the firm's configuration—it does not produce locally and also export to the same country (reflecting demand crowd-out and constant returns to scale), and it always produces in its home country.

Appendix C solves the intensive-margin components of this decision problem in a steady state under linear corporate income taxes, which we use to calibrate the model. In the calibration, we also use small Gumbel-distributions shocks over the extensive margin decisions to smooth the aggregate variables when using a discretized cross-sectional grid.

We express firm decisions as functions of its exogenous idiosyncratic state ω, the aggregate state Ω, and the endogenous idiosyncratic state $\varkappa \equiv (I_p, I_e, \{k_i\}_{i \in I_p \cup I_e})$. We denote the optimized after-tax cash flow of the firm as $\pi(\varkappa, \omega, \Omega)$.

5.1.4 Aggregation

Let $\Phi_\iota(\varkappa, \omega; \Omega)$ denote the cross-sectional mass function of firms headquartered in country ι.

The price of the final good in country i is

$$P_i(\Omega) = \left(\sum_{\iota \in \mathbb{I}} \int_{J(\iota)} \left[p_i(\varkappa, \omega, \Omega)^{1-\varepsilon} \mathbb{1}\{i \in I_p(\varkappa)\} + p_i(\varkappa, \omega, \Omega)^{1-\varepsilon} \mathbb{1}\{i \in I_e(\varkappa)\} \right] d\Phi_\iota(\varkappa, \omega; \Omega) \right)^{\frac{1}{1-\varepsilon}},$$

an aggregate of prices chosen by all firms producing locally in i and prices chosen by firms exporting to i.

Capital and labor demand depend on demand by firms producing locally and by domestic firms exporting. The initial capital stock in each country is

$$K_i(\Omega) = \sum_{\iota \in \mathbb{I}} \int k_i(\varkappa) \mathbb{1}\{i \in I_p(\varkappa)\} d\Phi_\iota(\varkappa, \omega; \Omega) + \int_{J(i)} \left(\sum_{\iota \in I_e(\varkappa)} k_\iota(\varkappa) \right) d\Phi_i(\varkappa, \omega; \Omega),$$

and the end-of-period capital stock is

$$K_i'(\Omega) = \sum_{\iota \in \mathbb{I}} \int_{J(\iota)} k_i'(\varkappa, \omega, \Omega) \mathbb{1}\{i \in I_p'(\varkappa)\} d\Phi_\iota(\varkappa, \omega; \Omega) + \int_{J(i)} \left(\sum_{\iota \in I_e'(\varkappa)} k_\iota'(\varkappa, \omega, \Omega) \right) d\Phi(\varkappa, \omega; \Omega)$$

Aggregate investment is thus $K_i'(\Omega) - (1-\delta) K_i(\Omega)$. Aggregate labor demand is

$$L_i(\Omega) = \sum_{\iota \in \mathbb{I}} \int_{J(\iota)} \ell_i(\varkappa, \omega, \Omega) \mathbb{1}\{i \in I_p(\varkappa)\} d\Phi_\iota(\varkappa, \omega; \Omega) + \int_{J(i)} \left(\sum_{\iota \in I_e(\varkappa)} \ell_\iota(\varkappa, \omega, \Omega) \right) d\Phi_i(\varkappa, \omega; \Omega)$$

Aggregate firm costs consist of fixed operating costs and costs of profit shifting. The costs of profit shifting are incurred where affiliates operate. We assume the fixed operating costs are incurred in the firm's home country; this assumption aligns the location where profits accrue with the location where the costs offset against them are accounted. Domestic operations of domestic-headquartered firms only face profit shifting costs; domestic affiliates of foreign multinationals incur fixed operating costs and profit shifting costs, as do domestic exporting affiliates.

$$\begin{aligned} F_i(\Omega) = & \int_{J(i)} \frac{\gamma(\omega) s_i(\varkappa, \omega, \Omega)^2}{2 y_i(\varkappa, \omega, \Omega)} d\Phi_i(\varkappa, \omega; \Omega) \\ & + \sum_{\iota \in \mathbb{I} \setminus i} \int_{J(\iota)} \left(\chi_f + \frac{\gamma(\omega) s_i(\varkappa, \omega, \Omega)^2}{2 y_i(\varkappa, \omega, \Omega)} \right) \mathbb{1}\{i \in I_p(\varkappa)\} d\Phi_\iota(\varkappa, \omega; \Omega) \\ & + \int_{J(i)} \sum_{\iota \in I_e(\varkappa)} \left(\chi_e + \frac{\gamma(\omega) s_\iota(\varkappa, \omega, \Omega)^2}{2 y_\iota(\varkappa, \omega, \Omega)} \right) d\Phi_i(\varkappa, \omega; \Omega) \end{aligned}$$

Aggregate tax revenue T_i depends on the tax functions. Aggregate cash flows of firms headquartered in country i are

$$\Pi_i(\Omega) = \int_{J(i)} \pi(\varkappa, \omega, \Omega) d\Phi(\varkappa, \omega; \Omega)$$

wher π is the firm's worldwide after-tax cash flow.

5.1.5 Equilibrium

In this model, goods markets clear by design. In equilibrium, the labor market must also clear, with $L_i(\Omega) = H_i(\Omega)$, and the aggregate resource constraint below must hold in each country.

$$Y_i(\Omega) = C_i(\Omega) + G_i(\Omega) + K_i'(\Omega) - (1-\delta)K_i(\Omega) + F_i(\Omega)$$

Dividends distributed to households must equal aggregate cash flows in each country, with $D_i(\Omega) = \Pi_i(\Omega)$. Government budget constraints must hold, with $G_i(\Omega) = T_i(\Omega)$. The equilibrium prices for final goods must also match the aggregates of prices chosen by sellers.

5.2 Calibration

The calibration of the model uses linear territorial corporate tax systems, as in the theoretical framework, to estimate parameters and target data for 2014.[10] Appendix C contains derivations of firms' intensive-margin decisions under this assumption. This allows the model to be solved quickly and calibrated. To incorporate cross-sectional heterogeneity consistent with the theoretical analysis and the data, we include heterogeneity in productivity and ability to shift profits. Firm idiosyncratic poductivity is drawn from a $logN(-\sigma_z^2/2, \sigma_z^2)$ distribution. Consistent with the empirical results, we assume $\gamma^{-1} \sim N(\mu_\gamma, (v_\gamma \mu_\gamma)^2)$; the normal distribution closely matches the estimated distribution in the data. The parameter μ_γ governs the ability of firms to shift profits (and to turn off profit shifting in the counterfactuals), and v_γ is the coefficient of variation for γ_j^{-1} estimated in the empirical analysis. Both of these distributions are discretized, with small Gumbel shocks to smooth the aggregate variables.[11]

For the calibration, we use four countries: the U.S., a representative tax haven, the non-haven European countries, and the rest of the world.[12]The mass of firms headquartered in each country is related to that country's population by $m_i = N_i^\nu$. In equilibrium, these masses matter (relative to each other) for the prices of the final goods in each country and deviations from purchasing power parity.

Table 10 presents the calibrated parameters. The first set of parameters are assigned standard values in the macroeconomics literature. The second set have values assigned based on external calculations. The ability of firms to shift profits uses a mean from the literature review by Heckemeyer and Overesch (2017), with a coefficient of variation from our empirical analysis. Populations in billions of people come from the Penn World Tables for 2016. The U.S. corporate tax rate is set at 35%, and other tax rates are computed as the effective tax rates on the reported income of majority-owned foreign affiliates of U.S. multinationals, in BEA data. This calculation includes the correction for income double-counting from Blouin and Robinson (2020).

The third panel of Table 10 shows the internally calibrated parameters. Country productivity terms are calibrated to match GNP per capita for each country. The costs of cross-border activities

[10] 2014 is the last BEA benchmark survey for the Activities of U.S. Multinationals before the TCJA.

[11] Combining extensive margin decisions and a discretized grid makes the calculation of aggregate variables step functions of the input equilibrium variables, making it potentially impossible to solve for the equilibrium computationally. Using small Gumbel shocks and finer grids smooth these functions.

[12] The representative tax haven consists of: Ireland, Luxembourg, the Netherlands, Switzerland, Barbados, Hong Kong, Singapore, the British Virgin Islands, the Cayman Islands, Montserrat, and the Turks and Caicos Islands. The last two are included despite not being tax havens because the BEA groups them together with the British Virgin Islands and the Cayman Islands. This list omits Bermuda, which has some data anomalies. The non-haven European countries are Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Norway, Poland, Portugal, Russia, Spain, Sweden, Turkey, Great Britain, Belarus, Serbia, Andorra, Bulgaria, Montenegro, Slovakia, Malta, Ukraine, Croatia, Moldova, Monaco, Liechtenstein, Iceland, San Marino, Bosnia and Herzegovina, Albania, Lithuania, North Macedonia, Slovenia, Romania, Latvia, and Estonia.

Table 10: Calibration

Assigned Parameters					
Param	Description	Value			
β	Discount factor	0.95			
φ	Frisch labor elasticity	2			
σ	CRRA coefficient	3			
δ	Depreciation rate	0.2			
α	Capital production share	0.3			
ε	Substitution elasticity	5			
Externally Calibrated Parameters					
Param	Description	Value	Source		
μ_γ	Mean profit shifting	0.8	Heckemeyer and Overesch (2017)		
v_γ	CoV for profit shifting	0.35	Estimated in Section 4		
N_1	US population, billions	0.323	Penn World Tables		
N_2	Haven population, billions	0.044	Penn World Tables		
N_3	Europe NH population, billions	0.747	Penn World Tables		
N_4	RoW population, billions	6.223	Penn World Tables		
τ_1	US corporate tax rate	0.35			
τ_2	Haven corporate tax rate	0.105	ETR on USMNE haven income		
τ_3	Europe NH corporate tax rate	0.310	ETR on USMNE Europe HN income		
τ_4	RoW corporate tax rate	0.271	ETR on USMNE RoW income		
Calibrated in Model					
Param	Description	Value	Target	Data	Model
A_1	US productivity	1.729	US log(GNP/capita)	4.129	4.149
A_2	Haven productivity	1.213	Haven log(GNP/capita)	4.050	4.044
A_3	Europe NH productivity	1.452	Europe NH log(GNP/capita)	3.513	3.516
A_4	RoW productivity	1.091	RoW log(GNP/capita)	2.401	2.389
χ_e	Fixed exporting cost	0	US (Exp-Imp)/GDP	-0.027	0.001
χ_f	Fixed MP cost	0.705	USMNE foreign share of sales	0.661	0.708
κ	Iceberg trade cost	0.075	US final imports/GDP	0.060	0.161
σ_z	Productivity dispersion	0.516	USMNE share of US labor	0.188	0.218
ν	Firm mass-population power	0.438	Relative capital price in havens	1.064	1.142

and the dispersion of productivity are calibrated to match a set of moments of foreign affiliates of U.S. multinationals (from BEA data) and U.S. trade data. The power coefficient governing the relationship between firm masses and population is calibrated based on the price of capital in tax havens relative to the price in the U.S., from the Penn World Tables.

5.3 Validation and Aggregate Mismeasurement

An unusual implication of profit shifting relates to aggregate mismeasurement (Guvenen et al. 2022). As a part of profit shifting, firms misattribute the location of value added and where profits are reported. This makes measured net exports and GDP in high-tax countries lower than their actual values, and the reverse in low-tax countries.

To explore this, Table 11 presents a set of model and data moments for the U.S. under the main calibration. It presents net exports, both real and measured, as shares of GDP; the relationship between GNP, GDP and measured GDP; and corporate tax revenue.

In the model, actual net exports reflect the net international investment positions of countries induced by the activities of multinationals; when a U.S. multinational invests abroad, this gives

Table 11: Baseline Moments, USA, 2016

Moment	Model	Data
Net exports / GDP, measured	0.001	-0.027
Net exports / GDP, actual	0.018	-
GDP / GNP, measured	1.001	0.988
GDP / GNP, actual	1.018	-
Corporate income tax revenue / GNP	0.103	0.016

All quantities are estimated in the general equilibrium of the model, presenting results for the U.S. (country 1). Net exports are defined as total exports by firms less total imports; measured net exports also add net profits shifted. Actual GDP is GNP plus net exports; measured GDP is GNP plus measured net exports. The measured trade gap is computed as the ratio of measured net exports to measured GDP, and the actual trade gap is the ratio of actual net exports to actual GDP.

U.S. shareholders a claim on foreign assets, which corresponds to higher imports or lower exports in equilibrium. The model underestimates the trade deficit. Correcting for profit shifting reduces the trade deficit as a share of GDP by approximately 1.8 percentage points in the model; this is larger than the estimate from Guvenen et al. (2022) of 0.8 percent of GDP, although their estimate excludes the effects of profits shifted by U.S. affiliates of foreign multinationals.

The model closely fits the ratio of measured GDP to GNP, which is not a targeted moment. Actual GDP exceeds measured GDP by 1.8 percent of GNP. The model overestimates corporate tax revenue in the U.S., reflecting that much of U.S. business activity occurs through pass-through businesses (although multinationals are almost exclusively C corporations), as well as the numerous other deductions and tax credits in the U.S. corporate tax system.

5.4 Main Counterfactual: A World Without Profit Shifting

We now consider the implications of ending profit shifting. Both Guvenen et al. (2022) and Tørsløv et al. (2022) attempted to reapportion profits based on the location of observable inputs into production, like physical capital and labor, to represent a counterfactual with no profit shifting. Bruner et al. (2018) conduct a similar exercise for the U.S. national accounts, exploring how profit shifting distorts the official statistics and constructing an alternative, corrected set of accounts.

However, ending profit shifting ($\mu_\gamma = 0$ in the model) also affects firm decisions, which in turn have general equilibrium effects. Unlike empirical studies, this structural model can capture these optimal adjustments and equilibrium feedback.

Table 12 presents the effects of eliminating profit shifting, measured as the percent change in relevant aggregate variables relative to their baseline values. We conduct three exercises. The first, static exercise mimics those of Guvenen et al. (2022) and Tørsløv et al. (2022); we reapportion profits and impose taxes, holding fixed all firm and agent decisions and prices. The second exercise allows firms to respond to the elimination of profit shifting, holding fixed equilibrium variables (price levels, real wages, the GNP inputs that affect firm decisions). The third exercise solves for the new general equilibrium without profit shifting.

In the purely static exercise, reapportioning profits raises U.S. corporate tax revenue by 5.7% and European non-haven revenue by 1.4%, and decreases revenue for tax havens by 11.1% and for the rest of the world 2.1%. Measured GDP rises by 1.7% in the U.S. and 0.4% in Europe, and it falls by 11.1% in tax havens and by 0.6% in the rest of the world. The estimate for the

Table 12: Effects of Ending Profit Shifting, % Change from Baseline

Moments	USA	Havens	Europe NH	RoW	World
Static Reapportionment					
GDP, measured	+1.69	-11.08	+0.43	-0.63	0.00
CIT revenue	+5.74	-11.14	+1.44	-2.07	+0.29
With Responses					
Capital	-0.43	-0.47	+0.07	-0.04	-0.09
Foreign-owned capital	-0.72	-4.08	0.00	-0.19	-0.27
GDP, actual	-0.39	-1.10	+0.08	-0.03	-0.07
GDP, measured	+1.30	-12.06	+0.51	-0.66	-0.07
CIT revenue	+5.67	-10.15	+1.54	-2.05	+0.34
Consumption	-0.07	-0.12	-0.03	-0.03	-0.04
General Equilibrium					
Capital	-0.23	-0.70	+0.04	-0.02	-0.05
Foreign-owned capital	-0.20	-3.76	+0.07	-0.13	-0.10
GDP, actual	-0.14	-0.82	+0.04	-0.01	-0.03
GDP, measured	+1.55	-11.81	+0.47	-0.64	-0.03
CIT revenue	+5.88	-10.36	+1.51	-2.03	+0.39
Consumption	-0.16	-0.19	+0.05	+0.08	+0.03

In the static exercise, shifted profits are reset to zero ex post, shifting the locations of reported income, both economic and taxable. This holds fixed all firm decisions, as well as all equilibrium variables.

The exercise with responses sets $\mu_\gamma = 0$, and recomputes firm decisions. It holds fixed the equilibrium variables (Y_i, w_i, P_i).

The general equilibrium exercise sets $\mu_\gamma = 0$ and solves for the new general equilibrium.

mismeasurement of U.S. GDP by 1.7% is slightly higher but close to the estimate from Bruner et al. (2018) of 1.5%. Overall, this static experiment redistributes from shareholders and foreign governments to the U.S. government; because world tax revenue only rises slightly (0.3%), this redistribution primarily comes from foreign governments to the U.S. government.

Once we allow for firm responses, the effects on corporate tax revenue shrink slightly in the U.S. and the rest of the world. Foreign investment falls in across the board, although capital rises in the European non-haven countries as the U.S. and tax havens become less attractive places to invest without profit shifting. Aggregate output falls in the U.S. and falls more in tax havens. World capital, output, and consumption fall slightly, although multinational investment falls more.

In equilibrium, adjustments in real wages and relative prices as well as to misallocation alter some of the aggregate effects. In the U.S., this counterfactual decreases investment and consumption. It also slightly decreases output (actual GDP), although measured GDP rises. In tax havens, the large 3.8% percentage point decrease in foreign-owned capital is largely offset by higher domestic investment by haven-headquartered firms, consistent with recent evidence from Gauß et al. (2024). However, GDP still falls sharply in the tax havens—by more than total capital—because this reallocation shifts capital from highly productive foreign multinationals to less productive local firms.

5.5 Profit Shifting, Investment, and Policy Implications

In this section, we explore how profit shifting and multinational investment affect the implications of tax policies. As in the rest of the analysis, we focus on the positive implications, not the normative

effects.

The following figures plot the effects of changing the U.S. corporate tax rate on relevant aggregate variables in the U.S.: corporate tax revenue, the capital stock, GNP and GDP, profit shifting, and net exports. Each plot includes an income tax base as in the main analysis (solid blue lines) and a cash flow tax base (dashed red lines). We consider this under three environments: autarky as a benchmark, the model with international trade and multinational production but without profit shifting, and the main calibration.

Figure 5a presents the effects of corporate tax rates on the U.S. in autarky. The broader income tax base raises more tax revenue (except at very high tax rates), but it distorts capital. On the other hand, the cash flow tax does not distort investment in the conventional autarkic environment.

Figure 5b allows for the model's cross-border activities (exporting and multinational production) but without profit shifting. As the U.S. corporate tax rate rises, U.S. firms shift production abroad instead of exporting, and foreign firms export to the U.S. instead of producing locally. This reduces the U.S. capital stock and production but raises the U.S. net international investment position, which coincides with decreasing net exports (or increasing trade deficits) in equilibrium. Notably, in contrast to falling GDP, GNP rises with the corporate tax rate under a cash flow tax, although it begins decreasing at rates above 40%. This occurs because the higher corporate income tax redistributes from foreign shareholders to the U.S. government; the decreased GDP is made up for by higher imports.

Finally, Figure 5c presents these under the main calibration. Relative to Figure 5b, profit shifting increases the sensitivity of capital to taxes at low tax rates and decreases this sensitivity at higher tax rates, an effect consistent with the theoretical model; this also differs slightly from the results in De Simone et al. (2022), which argued that profit shifting should decrease the overall sensitivity of investment to taxes. Notably, profit shifting introduces substantially more curvature in the tax revenue plots (Laffer curves) than present in autarky or in the absence of profit shifting. While low-tax countries collect more tax revenue because of profit shifting, higher-tax countries collect less revenue and face more rapidly decreasing marginal revenue from higher corporate tax rates.

5.6 Policy Experiments

We now explore a set of policy experiments. Although profit shifting increases investment, it reduces corporate tax revenue for the U.S., and turning off profit shifting in the model raises U.S. corporate tax revenue. This equilibrium effects of profit shifting can thus be compared to the effects of changing the corporate income tax rate.

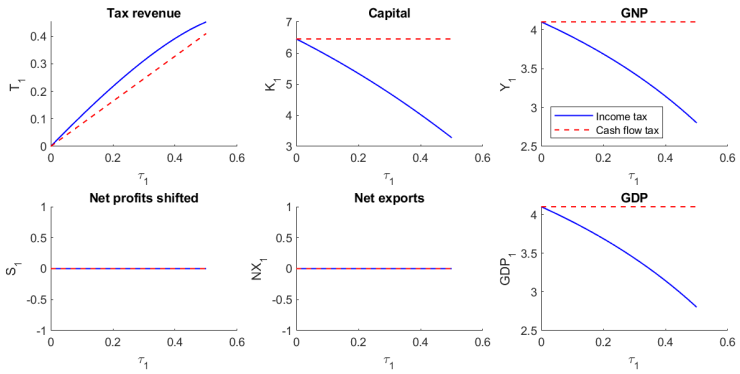
There are two potential ways to implement this comparison. We could remove profit shifting from the model, and reduce the U.S. corporate tax rate until corporate tax revenue equals the baseline revenue. Table 13 shows the results of this comparison (no profit shifting, but a 32.07% corporate tax rate) against the baseline. Relative to the baseline, the U.S. is unambiguously better off, with higher capital and GDP despite zero net change in corporate tax revenue. On the other hand, tax havens, and to a lesser extent the rest of the world, are worse off, with lower foreign investment, GDP and corporate tax revenue.

Alternatively, we could raise the U.S. corporate tax rate to try to achieve the same revenue increase as eliminating profit shifting. However, this experiment is not possible! In 2016, the U.S. corporate income tax rate was close to the equilibrium revenue-maximizing rate, and so the revenue increase achieved by turning off profit shifting cannot be matched by raising the corporate tax rate when firms can shift profits.

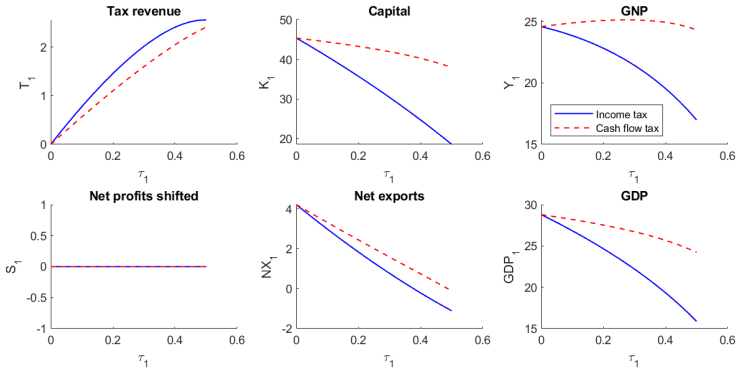
So far, the experiments in eliminating profit shifting consist of changing underlying parameters.

Figure 5: Corporate Tax Effects on U.S. Aggregate Variables

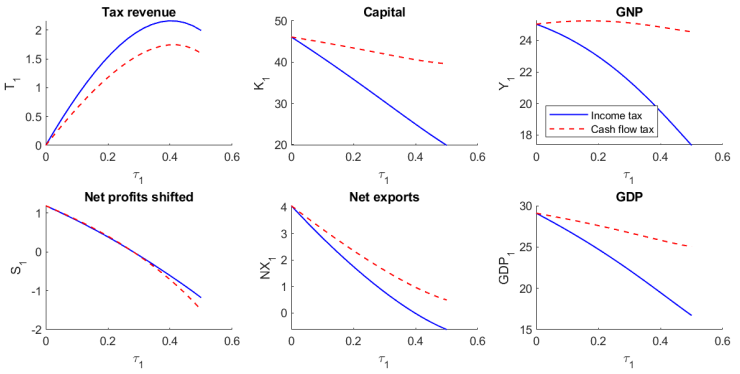
(a) Autarky



(b) No Profit Shifting



(c) Main Calibration



All of these figures present the effects of changing the U.S. corporate tax rate on aggregate variables. Each graph presents the effect under an income tax base (solid blue line) and under a cash flow tax base (dashed red line). Part (a) displays the effects in autarky. Part (b) displays the effects with the cross-border parameters from the main calibration but with no profit shifting ($\mu_\gamma = 0$). Part (c) displays the effects under the main calibration.

But in reality, there exist policies that can eliminate profit shifting via tax rate harmonization, in which all countries choose the same tax rates. This eliminates any profit shifting incentives, and it also removes misallocation from the location of investment; taxes would no longer affect the location of production. Table 14 displays the effects of tax rate harmonization on corporate tax

Table 13: Revenue Neutral Alternative (No Profit Shifting, 32.07% CIT Rate), Comparison to Baseline

Moments	USA	Havens	Europe NH	RoW	World
Capital	+5.75	-1.19	0.00	+0.78	+0.98
Foreign-owned capital	+6.25	-2.65	+0.03	-0.51	+1.33
GDP, actual	+3.78	-0.27	-0.02	-0.04	+0.66
CIT revenue	0.00	-10.80	+1.47	-2.03	-0.85

This experiment eliminates profit shifting ($\mu_\gamma = 0$) and reduces the U.S. corporate tax rate to achieve the same corporate tax revenue as in the baseline. This requires a 32.073% U.S. corporate tax rate.
All numbers are the percent difference from the baseline.

revenue, capital, and GDP, for different coordinated corporate tax rates.

Table 14: Tax Rate Harmonization, Percent Change from Baseline

Corporate Tax Revenue					
CIT rate	USA	Havens	Europe NH	RoW	World
15%	-47.74	+28.72	-45.97	-42.98	-44.34
20%	-32.05	+72.09	-29.65	-25.43	-28.62
25%	-17.45	+115.35	-14.41	-8.81	-11.35
30%	-4.12	+158.21	-0.42	+6.71	+3.49
35%	+7.74	+200.21	+12.12	+20.95	+16.97
Capital					
CIT rate	USA	Havens	Europe NH	RoW	World
15%	+35.29	-3.08	+24.76	+15.19	+20.51
20%	+27.35	-6.20	+17.59	+9.05	+13.87
25%	+19.07	-9.66	+10.11	+2.64	+6.95
30%	+10.46	-13.48	+2.33	-4.06	-0.28
35%	+1.53	-17.72	-5.76	-11.06	-7.82
GDP					
CIT rate	USA	Havens	Europe NH	RoW	World
15%	+21.16	-10.74	+14.59	+8.32	+11.96
20%	+16.74	-13.84	+10.56	+4.97	+8.27
25%	+12.01	-16.93	+6.24	+1.39	+4.32
30%	+6.94	-20.04	+1.61	-2.47	+0.08
35%	+1.51	-23.18	-3.36	-6.62	-4.48

All scenarios display the percent changes from baseline values for tax policy harmonization, which consists of all countries choosing the same tax rate.
Rows in the table correspond to the coordinated corporate tax rates.

The U.S. would lose corporate tax revenue from harmonization unless other countries all raised their tax rates to match the U.S.'s 35% rate. Across all of these policy scenarios, U.S. capital and GDP are higher than in the baseline, tax haven revenue is higher than the baseline, and tax haven capital and GDP are lower than in the baseline. Across all countries, tax revenue is increasing in the coordinated tax rate, and capital and GDP are decreasing in this rate.

6 Conclusion

This paper conducted theoretical, empirical, and quantitative analyses of how profit shifting affects investment decisions. The theoretical framework with profit shifting, endogenous investment and firm heterogeneity identified this interaction, whereby profit shifting facilitates investment by reducing the distortion of the corporate income tax. In high-tax countries, profit shifting reduces the effective tax rate on income produced in that country by subjecting it to a blend with a lower tax rate on income shifted out of that country. Moreover, because optimal profit shifting is proportional to production income, additional production in low-tax countries facilitates greater profit shifting into those countries and out of higher-tax countries. These incentives also apply on the extensive margin, increasing the return to greenfield investment in low-tax and high-tax countries.

I test for this channel empirically using a mixed effects regression to estimate firm-specific profit shifting semi-elasticities, using these estimates to back out underlying profit shifting parameters, and regressing segment-level capital investment on an interaction term based on the theoretical interaction. The regression results support the theoretical interaction between profit shifting and investment.

This interaction also induces endogenous patterns of complementarities between investment in different countries, inducing more positive business cycle correlations between high-tax and low-tax countries and more negative correlations between high-tax and other high-tax countries or between low-tax and other low-tax countries. I provide causal evidence of this novel channel using an event study with differences-in-differences estimations around the check-the-box regulation, which facilitated profit shifting by U.S. multinationals.

Finally, I quantify the effects of profit shifting in a structural multi-country general equilibrium model. Consistent with other recent work, profit shifting increases measured trade deficits for the U.S. and decreases measured U.S. GDP by four percent. While eliminating profit shifting would appear to benefit the U.S. in a non-equilibrium analysis, in equilibrium it could make the U.S. and the rest of the world worse off, and eliminating profit shifting raises substantially less revenue.

Overall, this paper demonstrates that profit shifting and multinational investment are not separate problems. The ability of firms to shift profits influences investment at the firm level and in aggregate, with implications for understanding international spillovers of business cycles and for policy design.

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A Additional Theoretical Results

A.1 Microfoundation for Convex Costs of Profit Shifting

In this section, we microfound a convex cost of profit shifting that can be closely approximated by the reduced-form version in the paper. A tax collection agency ("auditor") observes the firm's reported income $\rho = y + s$, as well as a noisy signal of its actual production income, $\omega = y/\varepsilon$, where $\varepsilon \sim F$. This game design reflects that when a firm submits its tax return, IRS auditors can use data from this tax return as well as publicly available financial statements to attempt to determine what the firm's income *should* be. Because this information is also available to the firm, the firm effectively observes the auditor's signal.

Within this game, each subsidiary of the multinational is treated as a separate firm, consistent with the separate entity accounting rules. For convenience, we drop the i subscript for this section.

The auditor chooses auditing intensity a, attempting to catch the firm engaging in illegal profit shifting activities, such as transfer mispricing. If caught, the firm pays a penalty proportional to the amount of profit shifting it engaged in, $\alpha|s|$; this structure reflects that punishments for violating the Arm's Length Principle require the firm to refile its taxes as a unitary firm, which claws back the entire value of the profits shifted (both legally and illegally). See section A.3 for further discussion of this.

The firm pays for tax planning services c to defend against this audit. The probability a firm is caught shifting profits illegally is $G(a, c)$. This function should have the following properties: if $a = 0$, $G(a, c) = 0$; if $a > 0$ and $c = 0$, $G(a, c) = 1$; $0 \leq G(a, c) \leq 1$; G is weakly increasing in a and weakly decreasing in c. For this game, I use the following functional form:

$$G(a,c) \equiv \begin{cases} 0 & \text{if } a = 0 \\ 1 & \text{if } c = 0, a > 0 \\ \min\left\{\frac{a}{vc}, 1\right\} & \text{if } a > 0 \end{cases}$$

The parameter v governs how difficult it is for the tax agency to identify illegal profit shifting. This presumably varies by firm, and depends on the firm's technology. For example, a firm with lots of unique intellectual property could easily locate this IP in low-tax countries and would have substantial flexibility in choosing the royalties its other affiliates should pay to this low-tax affiliate.

From the auditor's perspective, the expected penalty is as follows:

$$\begin{aligned} E[Penalty] &= G(a,c)E\big[\alpha|s|\big|\rho,\omega\big] \\ &= \alpha F(a,c)\bigg(P\big(\varepsilon < \rho/\omega\big)\big(\rho - \omega E[\varepsilon|\varepsilon < \rho/\omega]\big) + P\big(\varepsilon > \rho/\omega\big)\big(\omega E[\varepsilon|\varepsilon > \rho/\omega] - \rho\big)\bigg) \\ &= \alpha G(a,c)\bigg(\rho\big(2F(\rho/\omega) - 1\big) + \omega\big(2\int_{\rho/\omega}^{\infty} \varepsilon dF(\varepsilon) - E[\varepsilon]\big)\bigg). \end{aligned}$$

The auditor and the firm engage in the following simultaneous move game. The auditor maximizes the expected penalty less the cost of auditing (wages for employees), which is increasing in the firm's production income. (Bigger firms are more difficult to audit.)

$$\max_{a \geq 0} \alpha G(a,c)\bigg(\rho\big(2F(\rho/\omega) - 1\big) + \omega\big(2\int_{\rho/\omega}^{\infty} \varepsilon dF(\varepsilon) - E[\varepsilon]\big)\bigg) - waE[y|\rho,\omega]$$

Note that from the auditor's perspective, $E[y|\rho,\omega] = \omega E[\varepsilon]$.

Note that the firm has an informational advantage; it knows s and observes the signal ω. It therefore knows the penalty if caught engaging in illegal forms of profit shifting. The firm minimizes

the expected penalty and cost of paying for tax planning services; this cost also depends on the wage and on the absolute value of profits shifted (how much work it takes the tax planning service to defend the profit shifting).

$$\min_{c\geq 0} \alpha|s|G(a,c) + wc|s|$$

This game has the following equilibrium properties.

Proposition 1. *Using the functional form for G above, if $s \neq 0$, the unique pure strategy Nash equilibrium has the following strategies.*

$$a^* = \frac{\alpha}{\upsilon w \omega^2 E[\varepsilon]^2}\left(\rho\big(2F(\rho/\omega)-1\big) + \omega\big(2\int_{\rho/\omega}^{\infty} \varepsilon dF(\varepsilon) - E[\varepsilon]\big)\right)^2$$

$$c^* = \frac{\alpha}{\upsilon w \omega E[\varepsilon]}\left(\rho\big(2F(\rho/\omega)-1\big) + \omega\big(2\int_{\rho/\omega}^{\infty} \varepsilon dF(\varepsilon) - E[\varepsilon]\big)\right)$$

This equilibrium has the following expected cost for the firm.

$$X(s,y) = \frac{2\alpha|s|}{\upsilon} E\left[\frac{\varepsilon}{E[\varepsilon]}\big(1+s/y\big)\Big(2F\big(\varepsilon(1+s/y)\big)-1\Big) + \frac{2}{E[\varepsilon]}\int_{\varepsilon(1+s/y)}^{\infty} e dF(e) - 1\right]$$

Proof. First, if $a = 0$, then the firm's best response is $c = 0$, to which the auditor would prefer a sufficiently small positive audit intensity to guarantee penalizing the firm). Second, if $\frac{a}{\upsilon c} \geq 1$, then the firm would strictly prefer $c = 0$. If $\frac{a}{\upsilon c} < 1$, then the auditor's problem is linear in a; combining the auditor's indifference condition and the firm's first order optimality condition yield the Nash equilibrium strategies in the proposition. The linearity of the auditor's problem when $\frac{a}{\upsilon c} < 1$ requires a unique value of c; the strict convexity of the firm's (minimization problem) and the required value of c require a unique value of a. This equilibrium yields an expected cost for the firm of

$$x(s,\rho,\omega) = \frac{2\alpha|s|}{\upsilon\omega E[\varepsilon]}\left(\rho\big(2F(\rho/\omega)-1\big) + \omega\big(2\int_{\rho/\omega}^{\infty} \varepsilon dF(\varepsilon) - E[\varepsilon]\big)\right)$$

Beccause the firm knows y, s and ω, substituting in $\rho = y+s$ and $\omega = y/\varepsilon$ and taking an expectation over ε yields the ex ante expected cost in the proposition,

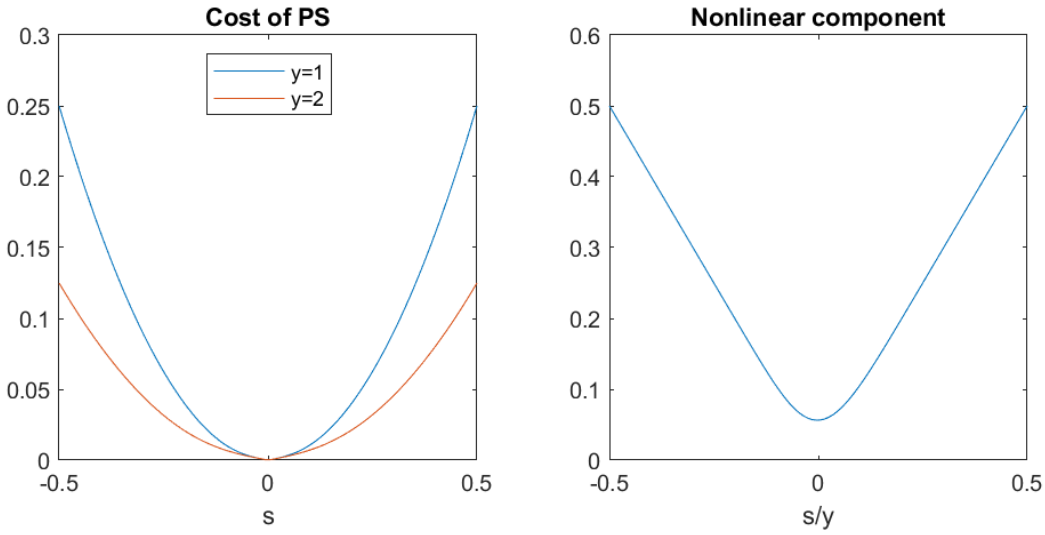
$$X(s,y) = E_\varepsilon[x(s, y+s, y/\varepsilon)].$$

□

The equilibrium described above is the unique pure strategy Nash equilibrium. It is not, however, the unique Nash equilibrium. As described in the proof, in the equilibrium, the auditor is indifferent between different auditing efforts, and the equilibrium auditing effort is pinned down by the firm's first order condition. There can thus also be equilibria in which the auditor randomizes its audit effort, as long as the randomization still has the same expected audit effort (as the firm's objective function is linear in a in equilibrium. Any such mixed equilibria, therefore, would have the same expected payoffs.

Note that the expected cost function depends on the absolute value of profits shifted as well as a nonlinear term that depends on s/y. Figure 6 plots this expected cost function, assuming $\varepsilon \sim logN\big(-\sigma^2/2, \sigma^2\big)$. The figure on the left plots the cost function for different values of s and two values of y. This can be closely approximated by term that is quadratic in s. To understand why, the second graph displays the nonlinear component of the cost that depends on s/y. As s moves away from zero, this rapidly converges into a locally linear function.

Figure 6: Cost of Profit Shifting



A.2 Alternative Functional Forms for Costs of Profit Shifting

We now consider alternative, more generalized functional forms for the cost of profit shifting. The firm's problem is instead written as follows.

$$\max_{s_i,k_i,\ell_i,y_i} \sum_i (1-\tau_i)\left(y_i + s_i - \frac{\gamma|s_i|^\phi}{\phi y_i^\psi}\right) - \sum_i (1-\theta_i) r_r k_i$$

s.t.

$$\sum_i s_i = 0$$

$$y_i = A_i z k_i^\alpha \ell_i^\beta - w_i \ell_i - \theta_i r_i k_i$$

We assume that $\phi > 1$ (convex costs) and $\psi > 0$ (substance connection). We later discuss the special cases of $\phi = 1$ or $\psi = 0$.

The solution for profit shifting, given the multiplier λ on the constraint that shifted profits sum to zero, is

$$s_i = \frac{y_i^{\frac{\psi}{\phi-1}}}{\gamma^{\frac{1}{\phi-1}}} \left|\frac{1-\tau_i-\lambda}{1-\tau_i}\right|^{\frac{1}{\phi-1}} sgn\left(\frac{1-\tau_i-\lambda}{1-\tau_i}\right)$$

The first order conditions for labor and capital can be written in the same way as in the main problem, with multiplier η_i for the definition of y_i.

$$w_i = \beta A_i z k_i^\alpha \ell_i^{\beta-1}$$

$$\theta_i r_i + \frac{1-\theta_i}{\eta_i} r_i + \delta = \alpha A_i z k_i^{\alpha-1} \ell_i^\beta$$

Then the multiplier η_i, the tax wedge on production income, is

$$\eta_i = (1-\tau_i)\left(1 + \frac{\psi\gamma|s_i|^\phi}{\phi y_i^{\psi+1}}\right) = (1-\tau_i)\left[1 + \frac{\psi}{\phi}\left(\frac{y_i^{\frac{\psi}{\phi-1}-1}}{\gamma^{\frac{1}{\phi-1}}}\right)\left|\frac{1-\tau_i-\lambda}{1-\tau_i}\right|^{\frac{\phi}{\phi-1}}\right] \geq 1-\tau_i$$

The key result of the paper—that profit shifting increases investment in high-tax countries and in low-tax countries—continues to hold in this context, $\eta_i > 1-\tau_i$ when $1-\tau_i \neq \lambda$ and η_i is decreasing in γ (or increasing in γ^{-1}).

We now consider the two special cases mentioned above. Suppose that $\phi = 1$, so the cost of profit shifting is linear in profits shifted. Then optimal profits shifted are $+\infty$ for the lowest-tax country and $-\infty$ for all other countries, and there is no well-defined solution. If we also impose that each affiliate cannot shift out more than 100% of its profits, then we get two types of countries (lowest-tax and all others), with the following results.

$$\tau_i > \min\{\tau_\iota\} \qquad \Rightarrow s_i = -y_i \qquad \Rightarrow \qquad \eta_i = (1-\tau_i)\left(1 + \frac{\psi\gamma}{y_i^\psi}\right) > 1-\tau_i$$

$$\tau_i = \min\{\tau_\iota\} \qquad \Rightarrow s_i = \sum_{\iota \neq i} y_\iota \qquad \Rightarrow \qquad \eta_i = (1-\tau_i)\left(1 + \frac{\psi\gamma \sum_{\iota \neq i} y_\iota}{y_i^\psi}\right) > 1-\tau_i$$

Under this constraint (to retain a well-defined problem), the results still hold.

Finally, suppose $\psi = 0$, so the costs of profit shifting do not depend on production income. Then optimal profits shifted are

$$s_i = \frac{1}{\gamma^{\frac{1}{\phi-1}}} \left|\frac{1-\tau_i-\lambda}{1-\tau_i}\right|^{\frac{1}{\phi-1}} sgn\left(\frac{1-\tau_i-\lambda}{1-\tau_i}\right)$$

Note that this predicts that the amount of profits a firm shifts is completely independent of how much income it actually produces, a seemingly unreasonable prediction. However, under this assumption, there would thus be no interaction between profit shifting and investment.

A.3 Nondeductible Costs of Profit Shifting

Suppose the cost of profit shifting is nondeductible. Then the firm's problem becomes

$$\max_{s_i,k_i,\ell_i,y_i} \sum_i (1-\tau_i)(y_i + s_i) - \sum_i \frac{\gamma s_i^2}{2y_i} - \sum_i (1-\theta_i) r_r k_i$$

s.t.

$$\sum_i s_i = 0$$

$$y_i = A_i z k_i^\alpha \ell_i^\beta - w_i \ell_i - \theta_i r_i k_i$$

The profit shifting decision is

$$s_i = \frac{y_i}{\gamma}(1-\tau_i-\lambda)$$

and the multiplier λ is one minus the firm's weighted average tax rate, or the tax rate on its worldwide income.

$$\lambda = 1 - \frac{\sum_i y_i \tau_i}{\sum_i y_i}$$

The blended tax rate on production income is thus

$$\eta_i = 1 - \tau_i + \frac{1}{2\gamma}(1-\tau_i-\lambda)^2 \geq 1-\tau_i$$

A.4 Vertically Integrated Multinational

In this appendix, we consider how profit shifting affects optimal decisions by a vertically integrated multinational. This multinational operates in two countries, producing an intermediate input in country 1, selling this input from one affiliate to another, and using the input to produce a final good in country 2. The quantity of the intermediate input produced is q_1, and the quantity of the final good is q_2. It uses capital and labor in both countries. The price at which it sells this input from one affiliate to another is p; this is a choice variable, but it may be constrained by the Arm's Length Principle (ALP). Under the ALP, the firm is supposed to price this intrafirm transaction as though it were with an unrelated party; let the price of this hypothetical transaction be p_*. The more aggressively the firm misprices, the greater the risk of being caught and penalized.

For convenience, we can assume the cost of capital is fully deductible.

The firm solves the following function.

$$\max_{k_1,k_2,\ell_1,\ell_2,q_1,q_2,p} (1-\tau_1)\big(pq_1 - w_1\ell_1 - (r+\delta)k_1\big) + (1-\tau_2)\big(q_2 - w_2\ell_2 - (r+\delta)k_2 - pq_1\big) - \frac{\gamma(p-p_*)^2}{p_*}$$

$$\text{s.t.} \qquad q_1 = A_1 k_1^{\alpha}\ell_1^{\beta} \qquad q_2 = A_2 k_2^{\alpha}\ell_2^{\beta} q_1^{1-\alpha-\beta}$$

Let ϕ_1 and ϕ_2 denote the multipliers on the constraints. For an optimizing firm, $\phi_2 = 1-\tau_2$. We can write out the production decisions in country 1 given ϕ_1 as follows.

$$q_1 = \left(\frac{\phi_1}{1-\tau_1}\right)^{\frac{\alpha+\beta}{1-\alpha-\beta}} A_1^{\frac{1}{1-\alpha-\beta}} \left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha-\beta}} \left(\frac{\beta}{w_1}\right)^{\frac{\beta}{1-\alpha-\beta}}$$

$$\ell_1 = \left(\frac{\phi_1}{1-\tau_1}\right)^{\frac{1}{1-\alpha-\beta}} A_1^{\frac{1}{1-\alpha-\beta}} \left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha-\beta}} \left(\frac{\beta}{w_1}\right)^{\frac{1-\alpha}{1-\alpha-\beta}}$$

$$k_1 = \left(\frac{\phi_1}{1-\tau_1}\right)^{\frac{1}{1-\alpha-\beta}} A_1^{\frac{1}{1-\alpha-\beta}} \left(\frac{\alpha}{r+\delta}\right)^{\frac{1-\beta}{1-\alpha-\beta}} \left(\frac{\beta}{w_1}\right)^{\frac{\beta}{1-\alpha-\beta}}$$

Given output from country 1, country 2 production decisions are

$$q_2 = q_1 A_2^{\frac{1}{1-\alpha-\beta}} \left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha-\beta}} \left(\frac{\beta}{w_2}\right)^{\frac{\beta}{1-\alpha-\beta}}$$

$$\ell_2 = q_1 A_2^{\frac{1}{1-\alpha-\beta}} \left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha-\beta}} \left(\frac{\beta}{w_2}\right)^{\frac{1-\alpha}{1-\alpha-\beta}}$$

$$k_2 = q_1 A_2^{\frac{1}{1-\alpha-\beta}} \left(\frac{\alpha}{r+\delta}\right)^{\frac{1-\beta}{1-\alpha-\beta}} \left(\frac{\beta}{w_2}\right)^{\frac{\beta}{1-\alpha-\beta}}$$

The firm's optimal transfer price solves

$$p = p_*\left(1 + \frac{q_1(\tau_2-\tau_1)}{\gamma}\right)$$

If country 2 has a high tax rate, the firm wants to overprice the transaction, as this generates a larger tax shield from the deduction than the tax payment to country 1. If country 2 is a low-tax country, it wants to underprice the transaction.

The multiplier ϕ_1 is then

$$\phi_1 = (1-\alpha-\beta)(1-\tau_2)A_2^{\frac{1}{1-\alpha-\beta}}\left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha-\beta}}\left(\frac{\beta}{w_2}\right)^{\frac{\beta}{1-\alpha-\beta}} + p_*(\tau_2-\tau_1) + \frac{p_* q_1(\tau_2-\tau_1)^2}{\gamma}$$

Suppose $\tau_2 > \tau_1$. If country 2 raises its tax rate, there are three effects on production incentives. First, the value of producing in country 2 falls, which reduces optimal production in both countries. Second the value of the deduction from intrafirm trade increases, which increases optimal production in both countries. These first two incentives do not involve profit shifting. The third effect is that the firm misprices more aggressively, which increases optimal production in both countries. Moreover, firms that are better at transfer mispricing (lower γ) have higher ϕ_1, and thus produce more in both countries.

A.5 Worldwide Profits

The firm's total economic profits are as follows.

$$\begin{aligned}\Pi_j(I) &= \sum_{i\in I} X_{ij}\Bigg[(1-\alpha-\beta)(1-\tau_i) + \left(1-\beta-\alpha\frac{\theta_i r_i+\delta}{\theta_i r_i+(1-\theta_i)r_i/\eta_{ij}+\delta}\right)\frac{1-\tau_i-\lambda_j}{2\gamma_j} \\ &\qquad + \frac{\alpha(1-\theta_i)r_i\left(\frac{\eta_{ij}-(1-\tau_i)}{\eta_{ij}}\right)}{\theta_i r_i+(1-\theta_i)r_i/\eta_{ij}+\delta}\Bigg] \\ &= \underbrace{\sum_{i\in I} X_{ij}(1-\alpha-\beta)(1-\tau_i)}_{\text{economic profits}} + \underbrace{\sum_{i\in I} y_i\left(\frac{1-\tau_i-\lambda_j}{2\gamma_j}\right)}_{\text{gain from profit shifting}} - \underbrace{\sum_{i\in I}\frac{\alpha(1-\theta_i)r_i}{\theta_i r_i+(1-\theta_i)r_i/\eta_{ij}+\delta}\left(\frac{\eta_{ij}-(1-\tau_i)}{\eta_{ij}}\right)}_{\text{facilitation inefficiency}}\end{aligned}$$

where

$$X_{ij} \equiv (A_i z_j)^{\frac{1}{1-\alpha-\beta}}\left(\frac{\alpha}{\theta_i r_i+(1-\theta_i)r_i/\eta_{ij}+\delta}\right)^{\frac{\alpha}{1-\alpha-\beta}}\left(\frac{\beta}{w_i}\right)^{\frac{\beta}{1-\alpha-\beta}}$$

The firm's net benefit per country contains three parts. The first is the net economic profit, ignoring the profit shifting adjustment. The second part is the net benefit of profit shifting; because λ_j is a harmonic mean instead of an arithmetic mean, this is weakly positive. The third part is the efficiency loss due to the interaction between profit shifting and investment. Namely, the facilitation channel makes it optimal for a firm to invest until its marginal product of capital is less than its marginal cost of capital; the third part reflects the revenue loss from that inefficiency.

We can thus consider the value of entering country ι. This adds new profits, presumably against some fixed cost, but it also changes λ_j. The magnitude of the change in λ_j depends on how large the country is compared to the rest of the MNE's activities. We use this calculation for the exercise in section 3.3.

B Empirical Appendix

B.1 Data Preparation for Firm Profit Shifting and Investment Analysis

B.2 Data Preparation for Business Cycle Correlation Analysis

B.3 Additional Profit Shifting Estimation Results

The regression estimation in Table 2 present profit shifting regressions using segment-level data. As noted by Givoly et al. (2000), segment data has measurement error, and firms can choose the

segmentation and what information to report per segment. This results in selection bias, in which the main sample may not be representative of all firms. For example, firms that engage in much profit shifting, such as large technology companies, may elect to not report geographically-classified income and tax data that could be used against them. However, selection bias does not invalidate the main analysis, which relies on heterogeneity for identification. Insofar as selection bias reduces heterogeneity, it would reduce identification power.

Nevertheless, we can address selection bias using an alternative profit shifting estimation strategy. Using consolidated income statement data, we split each firm's profits and taxes into their domestic and foreign components, using these as separate observations per firm. Instead of estimating semi-elasticities based on income, tax rates, capital and labor in each foreign geographic segment, we use consolidated Compustat fundamentals to estimate it, with two observations per firm per year: foreign and domestic ($i \in \{f, d\}$). The estimation equation used is

$$\log PreTaxIncome_{ijt} = a_j + b_i + c_t + \alpha \log PPE_{jt} + \beta \log Emp_{jt} + \Delta \log MeasuredProd_{jt} + \frac{1 - \tau_{ijt}}{\tilde{\gamma}_j \lambda_j} + \epsilon_{ijt}$$

This strategy reduces the geographic information for any individual firm, but it includes the full sample of multinationals in Compustat and has more observations of each firm over time. Moreover, because the geographic classifications for each firm do not change from year to year under this setup, we can also replace current tax rates with moving average tax rates to address the potential weaknesses of annual measures documented by Klassen and Laplante (2012).

Table 15 reports the results of these regressions, alternating between the current and moving average tax rate measures. The first two columns correspond to the first column of Table 2, the third and fourth columns to the second column of Table 2, the fifth and sixth columns to the fourth column of Table 2, and the seventh and eighth columns to the last column of Table 2; we cannot compare against the firm-year fixed effect regression in the third column of Table 2, which would eliminate identification in this alternative setting. The mean semi-elasticities in this larger sample are larger using current tax rates, consistent with the narrative above of firms selectively reporting. The mean semi-elasticities with moving average tax rates are also smaller but still significant, consistent with the results from Klassen and Laplante (2012).

In addition to considering alternative samples, we can also consider alternative allowances of time variation in the estimates of semi-elasticities. The main estimates allow the semi-elasiticities to vary by firm and by year, with additive components (i.e. the sample year component across firms, and the same firm component over time). We can also allow variation only across firms, or variation over time for each firm (time variation nested within firm variation), or variation across firm-years without nesting. Figure 7 plots the distribution of these semi-elasticities across these different methods and comparing the segment sample with the consolidated sample.

Table 16 presents summary statistics comparing estimates of γ_{jt}^{-1} across the three estimation methods. As with the semi-elasticities, the mean estimates are higher with the consolidated sample than the segment sample, and the mean estimates are lower with moving average tax rates. Notably, however, many of the estimates with moving average tax rates are negative and thus inconsistent with the theoretical model, while the estimates using current tax rates are broadly positive.

B.4 Investment Sensitivity Analysis

In this appendix, we explore the sensitivity or robustness of the investment regressions to alternative approaches. Table 17 replaces the main estimates of γ_{jt}^{-1} with those estimated using different forms of time variation, as in the previous subsection. The coefficient estimates are robust to these alternatives.

Table 15: Profit Shifting Regressions for Expanded Consolidated Sample

Dependent variable:	log(Pretax income)							
ETR measure:	Current	MA	Current	MA	Current	MA	Current	MA
Elasticity variation:	None	None	None	None	Firm	Firm	Firm+Year	Firm+Year
1 - ETR	1.599***	0.832***	1.703***	0.858***	1.730***	0.883***	0.337***	1.816***
	(0.0243)	(0.0291)	(0.0236)	(0.0291)	(0.0504)	(0.0644)	(0.0744)	(0.0488)
log(Capital)	0.414***	0.422***	0.397***	0.400***	0.409***	0.406***	0.410***	0.407***
	(0.00494)	(0.00546)	(0.0126)	(0.0146)	(0.0155)	(0.0162)	(0.0153)	(0.0160)
log(Employment)	0.473***	0.459***	0.475***	0.443***	0.490***	0.477***	0.482***	0.484***
	(0.00584)	(0.00646)	(0.0152)	(0.0176)	(0.0180)	(0.0196)	(0.0178)	(0.0191)
Firm productivity	0.835***	0.853***	0.650***	0.680***	0.698***	0.720***	0.694***	0.696***
	(0.00590)	(0.00651)	(0.00891)	(0.0101)	(0.0126)	(0.0134)	(0.0125)	(0.0132)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Domestic/Foreign FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Group FE	Industry	Industry	Firm	Firm				
Observations	43,649	38,551	43,649	38,551	43,649	38,551	43,649	38,551
R-squared	0.779	0.760	0.828	0.810				

These regressions estimate the model parameters using the estimation equation from Hines and Rice (1994). Capital is defined as PPE. The coefficient estimate on 1 - ETR is the estimated semielasticity of profit shifting $\varepsilon = (\gamma\lambda)^{-1}$. All standard errors reported are robust. All columns use year and geographic fixed effects. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels.

Column 1 uses industry fixed effects, column 2 uses firm fixed effects, and column 3 uses firm-year fixed effects. Columns 4 and 5 are estimated using a mixed effects model with heterogeneity by firm, and the regression in column 5 also includes interactions between the net-of-tax rate and year dummy variables. The mixed effects specifications report the overall mean for the coefficient estimate. The estimated variances of the random coefficients are statistically significantly greater than zero.

Table 18 replaces the estimates of γ_{jt}^{-1} with those from the larger, consolidated sample, as in the previous subsection. Note that the investment measures are still at the segment level. The key interaction coefficients remain positive and significant, although the magnitude is not robust. The coefficients signs on the effective tax rate and on the estimates of γ_{jt}^{-1}, however, are not robust to the alternative sample.

Another potential concern relates to the pair of crises occurring during the period of analysis. Table 19 compares the estimates for the full sample against those when excluding the Great Financial Crisis (2008-2010) and Covid (2020-2021). The key coefficient estimates are larger when exluding crises, but the difference is not statistically significant.

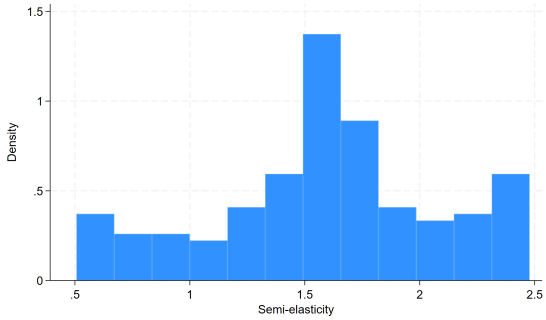
We can also consider robustness to alternative specifications in Tables 20 and 21. Table 20 compares the main specifications against using the actual logged functional forms, against using the semi-elasticities instead of the estimates for γ_{jt}^{-1}, and against using the firm's ratio of intangible assets (excluding goodwill) to total assets as a proxy for γ_{jt}^{-1}. The results are fairly robust to these alternatives. Table 21 adds an additional squared tax rate differential term with or instead of the interaction term; the effect comes from the interaction, not from some nonlinearity in the effects of tax rate differentials. It also splits the interaction into effects for low-tax and high-tax segments, but it is ambiguous which type has a larger effect.

B.5 Business Cycle Correlation Sensitivity Analysis

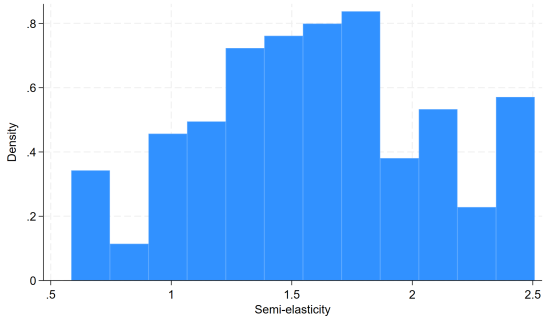
One potential concern with the estimation of business cycle correlations relates to the detrending process. The main regressions use the filter from Hodrick and Prescott (1981). However, this filter can be flawed, with false cycles, bias at the end of the sample, and reverse causality (Hamilton 2018). The reverse causality issue is due to the data on subsequent years being used when constructing the smoothed trend value for the current year, and it is specific to the VAR context and forecasting,

Figure 7: Distributions of Profit Shifting Semi-Elasticities

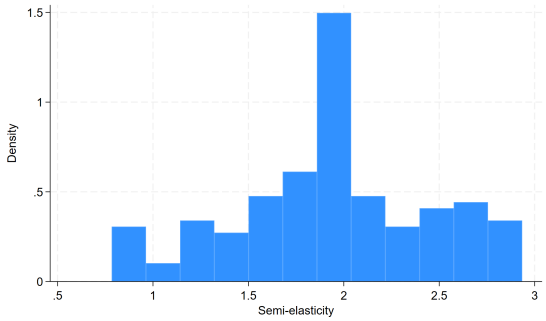
(a) Firm only, Segment sample



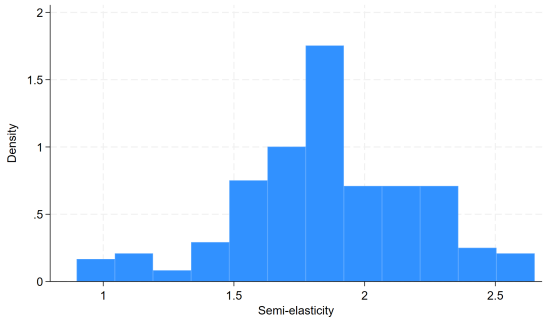
(b) Firm+time, Segment sample



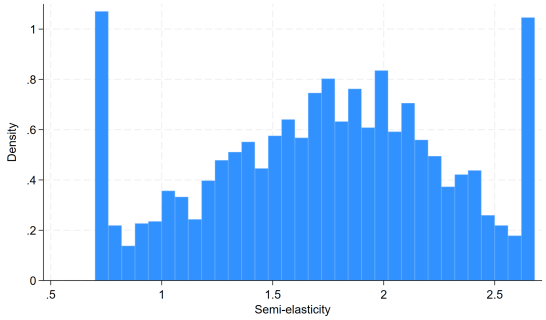
(c) Firm & nested time, Segment sample



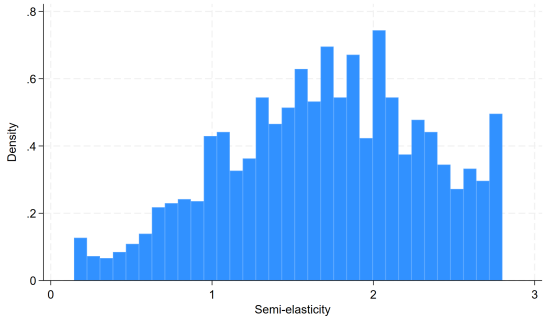
(d) Firm & time, Segment sample



(e) Firm only, Consolidated sample



(f) Firm+time, Consolidated sample



The semi-elasticities are winsorized at the 5th and 95th percentiles, and averaged over time for each firm. The estimation for (a) and (e) allow the coefficients to vary across firms. (b) and (f) allow it to vary by firm and by year, with the firm-year estimate generated by adding the firm and year components. (c) allows it to vary by firm and year, with variation across years nested within firm variation. (d) allows it to vary by firm and year, with no additional structure. The estimations for (a), (b), (c) and (d) use the segment sample, while (e) and (f) use the consolidated firm sample.

not in the context of constructing cross-country correlations. The end-of-sample issue does not apply here, as the detrending is done on all available data for each country, while the period of the regression ends in 2006, well before the end of the sample. The spurious cycle concern, however, remains relevant.

As alternatives, we can use the bandpass filters of Baxter and King (1999) or Christiano and Fitzgerald (2003) or the regression-based filter of Hamilton (2018). However, the Hamilton filter

Table 16: Comparison of γ_{jt}^{-1} Across Estimation Approaches

Sample	Tax rate	Variation	Obs	Mean	SD	P5	Median	P95
Segment	Current	Firm+time	767	1.142	0.502	0.135	1.217	1.860
Segment	Current	Firm	767	1.087	0.498	0.139	1.161	1.830
Segment	Current	Firm, nested time	767	1.354	0.580	0.182	1.452	2.159
Segment	Current	Firm & time	767	1.306	0.510	0.177	1.390	1.997
Consolidated	Current	Firm+time	43,225	1.226	0.675	0.113	1.231	2.351
Consolidated	Current	Firm	43,259	1.331	0.535	0.497	1.324	2.246
Consolidated	3-year MA	Firm+time	35,036	0.560	0.568	-0.401	0.566	1.497
Consolidated	3-year MA	Firm	36,765	0.668	0.423	-0.026	0.657	1.401

Table 17: Segment CapEx Regressions—Robustness to Time Variation

Dependent variable:	log(CapEx)				CapEx/PPE			
Elasticity variation:	Firm+time	Firm	Firm, nested time	Firm & time	Firm+time	Firm	Firm, nested time	Firm & time
1 - ETR	0.124	0.131	0.0110	-0.0130	0.0667**	0.0645**	0.0477*	0.0464*
	(0.106)	(0.108)	(0.105)	(0.107)	(0.0261)	(0.0260)	(0.0257)	(0.0261)
γ_{jt}^{-1}	-0.234***	-0.226***	-0.0322	-0.00728	-0.0448***	-0.0424***	-0.00814	-0.00590
	(0.0549)	(0.0542)	(0.0412)	(0.0453)	(0.0130)	(0.0123)	(0.00984)	(0.0106)
$\gamma_{jt}^{-1}(\bar{\tau}_{jt} - \tau_{ijt})^2$	2.291***	1.727**	2.122***	2.294***	0.649***	0.636***	0.539***	0.523***
	(0.566)	(0.698)	(0.436)	(0.430)	(0.156)	(0.180)	(0.124)	(0.133)
log(Capital)	0.634***	0.632***	0.631***	0.631***				
	(0.0252)	(0.0253)	(0.0252)	(0.0252)				
log(Employment)	0.203***	0.198***	0.229***	0.232***				
	(0.0359)	(0.0361)	(0.0356)	(0.0353)				
Profitability	-0.0594***	-0.0608***	-0.0606***	-0.0606***	0.00135	0.00129	0.00101	0.00104
	(0.0191)	(0.0194)	(0.0194)	(0.0194)	(0.00360)	(0.00364)	(0.00366)	(0.00366)
log(Sales)	0.176***	0.179***	0.158***	0.156***	-0.0177***	-0.0183***	-0.0179***	-0.0181***
	(0.0376)	(0.0379)	(0.0374)	(0.0372)	(0.00360)	(0.00354)	(0.00355)	(0.00354)
Market/book equity	0.0193	0.0194	0.0100	0.00795	0.0191***	0.0192***	0.0179***	0.0176***
	(0.0163)	(0.0164)	(0.0164)	(0.0164)	(0.00457)	(0.00458)	(0.00459)	(0.00459)
Foreign indicator	-0.0547	-0.0469	-0.0679	-0.0711	0.0229	0.0239	0.0207	0.0209
	(0.0592)	(0.0597)	(0.0596)	(0.0595)	(0.0145)	(0.0146)	(0.0148)	(0.0148)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Group FE	Industry	Industry	Industry	Industry	Industry	Industry	Industry	Industry
Observations	1,943	1,943	1,943	1,943	1,998	1,998	1,998	1,998
R-squared	0.907	0.906	0.906	0.906	0.304	0.302	0.301	0.301

These regress measures of firm investment at the segment level on the firm's net-of-tax rate, estimated ability to shift profits γ_{jt}^{-1}, a profit shifting interaction term, and standard investment regression control variables. All regressions use year, geographic, and industry fixed effects. The market/book equity ratio and γ_{jt}^{-1} are computed at the firm level; all other variables are segment-specific.

The analysis is at the segment level using Compustat data for 1998-2023. All standard errors are robust. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

also has known problems; Schler (2024) finds that the Hamilton filter mutes short-term fluctuations. Hodrick (2020) argues that the Hamilton filter does better for detrending simple dynamic processes, but the Hodrick-Prescott and Baxter-King filters do better for more complex dynamic processes. Table 22 compares these different filter options, as well as a one-sided Hodrick-Prescott filter to address the causality concern. The coefficient on the interaction terms is robust to all except the Christiano-Fitzgerald filter. The coefficient on bilateral trade intensity, on the other hand, is not robust to the filter used.

Another potential concern arises from the non-independence of observations. For example, the Germany-Ireland observations are presumably correlated with those for Germany-Switzerland and Germany-France, due to sharing Germany as one of the countries. The main regressions partly address this by using two-way clustering on countries i and m for the $i - m$ pairs, but the identification comes from variation across country-pairs, before and after check-the-box. We can further address it by including country-period fixed effects, one for each iT and mT pairs. This should remove this correlation across observations, with the new identification coming from

Table 18: Segment CapEx Regressions—Robustness to Sample

Dependent variable:		log(CapEx)			CapEx/PPE	
Sample	Segment	Consolidated	Consolidated	Segment	Consolidated	Consolidated
ETR measure	Current	Current	MA	Current	Current	MA
1 - ETR	0.124	-0.307***	-0.147***	0.0667**	-0.0293***	-0.0115
	(0.106)	(0.0537)	(0.0561)	(0.0261)	(0.0106)	(0.0121)
γ_{jt}^{-1}	-0.234***	0.0507***	0.0552**	-0.0448***	0.0202***	0.0190***
	(0.0549)	(0.0170)	(0.0237)	(0.0130)	(0.00404)	(0.00599)
$\gamma_{jt}^{-1}(\bar{\tau}_{jt} - \tau_{ijt})^2$	2.291***	1.367***	2.234***	0.649***	0.347***	0.573***
	(0.566)	(0.298)	(0.517)	(0.156)	(0.0805)	(0.144)
log(Capital)	0.634***	0.819***	0.823***			
	(0.0252)	(0.00846)	(0.00919)			
log(Employment)	0.203***	0.0530***	0.0203			
	(0.0359)	(0.0120)	(0.0130)			
Profitability	-0.0594***	-0.0388***	-0.0427***	0.00135	-0.00289**	-0.00173
	(0.0191)	(0.00645)	(0.00680)	(0.00360)	(0.00124)	(0.00126)
log(Sales)	0.176***	0.162***	0.173***	-0.0177***	0.00241**	-0.000360
	(0.0376)	(0.0135)	(0.0145)	(0.00360)	(0.00110)	(0.00117)
Market/book equity	0.0193	0.118***	0.129***	0.0191***	0.0336***	0.0337***
	(0.0163)	(0.00563)	(0.00622)	(0.00457)	(0.00162)	(0.00182)
Foreign indicator	-0.0547	0.245***	0.323***	0.0229	0.0617***	0.0641***
	(0.0592)	(0.0822)	(0.0835)	(0.0145)	(0.0177)	(0.0187)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes	Yes
Group FE	Industry	Industry	Industry	Industry	Industry	Industry
Observations	1,943	9,612	8,096	1,998	9,903	8,331
R-squared	0.907	0.911	0.915	0.304	0.303	0.302

These regress measures of firm investment at the segment level on the firm's net-of-tax rate, estimated ability to shift profits γ_{jt}^{-1}, a profit shifting interaction term, and standard investment regression control variables. All regressions use year, geographic, and industry fixed effects. The market/book equity ratio and γ_{jt}^{-1} are computed at the firm level; all other variables are segment-specific.

The analysis is at the segment level using Compustat data for 1998-2023. All standard errors are robust. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

country-pairs, before and after, net of variation driven by any individual country over time.

Table 23 conducts this exercise, and Tables 24 and 25 extend it to the decomposition regressions and those for investment capital correlations instead of GDP correlations. In general, this extra differencing modestly shrinks the estimated coefficients on the interaction term and slightly raises the standard errors, but the estimates are still highly significant. Notably, however, this extra differencing improves the identification for investment correlations, yielding smaller standard errors and typically larger, more significant coefficient estimates.

C Characterizing the Quantitative General Equilibrium Model

Table 19: Segment CapEx Regressions—Robustness to Excluding Crises

Dependent variable:	log(CapEx)		CapEx/PPE	
Exclude crises	No	Yes	No	Yes
1 - ETR	0.124	0.00863	0.0667**	0.0738**
	(0.106)	(0.126)	(0.0261)	(0.0312)
γ_{jt}^{-1}	-0.234***	-0.177***	-0.0448***	-0.0414***
	(0.0549)	(0.0618)	(0.0130)	(0.0146)
$\gamma_{jt}^{-1}(\bar{\tau}_{jt} - \tau_{ijt})^2$	2.291***	3.528***	0.649***	0.778***
	(0.566)	(0.864)	(0.156)	(0.209)
log(Capital)	0.634***	0.668***		
	(0.0252)	(0.0306)		
log(Employment)	0.203***	0.161***		
	(0.0359)	(0.0403)		
Profitability	-0.0594***	-0.0412	0.00135	0.00182
	(0.0191)	(0.0254)	(0.00360)	(0.00469)
log(Sales)	0.176***	0.167***	-0.0177***	-0.0176***
	(0.0376)	(0.0430)	(0.00360)	(0.00377)
Market/book equity	0.0193	0.0445**	0.0191***	0.0251***
	(0.0163)	(0.0179)	(0.00457)	(0.00454)
Foreign indicator	-0.0547	-0.0485	0.0229	0.0377**
	(0.0592)	(0.0679)	(0.0145)	(0.0147)
Year FE	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes
Group FE	Industry	Industry	Industry	Industry
Observations	1,943	1,469	1,998	1,520
R-squared	0.907	0.917	0.304	0.350

These regress measures of firm investment at the segment level on the firm's net-of-tax rate, estimated ability to shift profits γ_{jt}^{-1}, a profit shifting interaction term, and standard investment regression control variables. All regressions use year, geographic, and industry fixed effects. The market/book equity ratio and γ_{jt}^{-1} are computed at the firm level; all other variables are segment-specific.

The analysis is at the segment level using Compustat data for 1998-2023. All standard errors are robust. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

Table 20: Segment CapEx Regressions—Sensitivity to Functional Forms

Dependent variable:	log(CapEx)				CapEx/PPE			
1 - ETR	0.124		-0.0801	-0.189***	0.0667**		0.0275	-0.0231***
	(0.106)		(0.105)	(0.0253)	(0.0261)		(0.0255)	(0.00487)
γ_{jt}^{-1}	-0.234***				-0.0448***			
	(0.0549)				(0.0130)			
$\gamma_{jt}^{-1}(\bar{\tau}_{jt} - \tau_{ijt})^2$	2.291***				0.649***			
	(0.566)				(0.156)			
log(1 - ETR)		0.221*				0.0663**		
		(0.128)				(0.0295)		
$\log\left(1 + \frac{1}{2\gamma_{jt}}\left(\frac{\bar{\tau}_{jt}-\tau_{ijt}}{1-\tau_{ijt}}\right)\right)$		0.317***				0.0325		
		(0.0741)				(0.0230)		
$(\gamma_{jt}\lambda_{jt})^{-1}$			-0.0628				-0.0148	
			(0.0506)				(0.0109)	
$(\gamma_{jt}\lambda_{jt})^{-1}(\bar{\tau}_{jt} - \tau_{ijt})^2$			0.380***				0.0775***	
			(0.0970)				(0.0282)	
Intangibility				-0.324***				0.0125
				(0.0506)				(0.0117)
$Intangibility * (\bar{\tau}_{jt} - \tau_{ijt})^2$				6.911***				1.274**
				(2.378)				(0.522)
log(Capital)	0.634***	0.625***	0.632***	0.731***				
	(0.0252)	(0.0252)	(0.0254)	(0.00483)				
log(Employment)	0.203***	0.236***	0.215***	0.0444***				
	(0.0359)	(0.0350)	(0.0359)	(0.00703)				
Profitability	-0.0594***	-0.0645***	-0.0568***	-0.0575***	0.00135	0.000509	0.00181	-0.00267***
	(0.0191)	(0.0198)	(0.0200)	(0.00257)	(0.00360)	(0.00373)	(0.00365)	(0.000537)
log(Sales)	0.176***	0.154***	0.158***	0.274***	-0.0177***	-0.0200***	-0.0208***	-0.000446
	(0.0376)	(0.0374)	(0.0387)	(0.00722)	(0.00360)	(0.00361)	(0.00356)	(0.000476)
Market/book equity	0.0193	0.00772	0.0162	0.0903***	0.0191***	0.0177***	0.0186***	0.0196***
	(0.0163)	(0.0166)	(0.0167)	(0.00339)	(0.00457)	(0.00464)	(0.00463)	(0.000829)
Foreign indicator	-0.0547	-0.0625	-0.0478	0.250***	0.0229	0.0226	0.0240	0.0492***
	(0.0592)	(0.0599)	(0.0608)	(0.0293)	(0.0145)	(0.0146)	(0.0148)	(0.00658)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Group FE	Industry	Industry	Industry	Industry	Industry	Industry	Industry	Industry
Observations	1,943	1,943	1,943	53,280	1,998	1,998	1,998	59,507
R-squared	0.907	0.905	0.905	0.904	0.304	0.291	0.295	0.188

These regress measures of firm investment at the segment level on the firm's net-of-tax rate, estimated ability to shift profits γ_{jt}^{-1}, a profit shifting interaction term, and standard investment regression control variables. All regressions use year, geographic, and industry fixed effects. The market/book equity ratio and γ_{jt}^{-1} are computed at the firm level; all other variables are segment-specific.

The analysis is at the segment level using Compustat data for 1998-2023. All standard errors are robust. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

Table 21: Segment CapEx Regressions—Sensitivity to Additional Interactions

Dependent variable	log(CapEx)				CapEx/PPE			
1 - ETR	0.124	0.132	0.201*	0.0277	0.0667**	0.0611**	0.0845***	0.0905***
	(0.106)	(0.118)	(0.114)	(0.126)	(0.0261)	(0.0285)	(0.0272)	(0.0305)
γ_{jt}^{-1}	-0.234***	-0.228***	-0.297***	-0.208***	-0.0448***	-0.0378**	-0.0594***	-0.0506***
	(0.0549)	(0.0659)	(0.0665)	(0.0564)	(0.0130)	(0.0151)	(0.0155)	(0.0134)
$(\bar{\tau}_{jt} - \tau_{ijt})^2$		0.102	-0.311			0.0488	-0.0719	
		(0.190)	(0.209)			(0.0531)	(0.0591)	
$\gamma_{jt}^{-1}(\bar{\tau}_{jt} - \tau_{ijt})^2$	2.291***		2.692***		0.649***		0.747***	
	(0.566)		(0.638)		(0.156)		(0.179)	
$\gamma_{jt}^{-1}(\bar{\tau}_{jt} - \tau_{ijt})^2 \mathbb{1}\{\tau_{ijt} < \bar{\tau}_{jt}\}$				3.109***				0.451*
				(0.983)				(0.245)
$\gamma_{jt}^{-1}(\bar{\tau}_{jt} - \tau_{ijt})^2 \mathbb{1}\{\tau_{ijt} > \bar{\tau}_{jt}\}$				1.711**				0.785***
				(0.788)				(0.193)
log(Capital)	0.634***	0.633***	0.632***	0.631***				
	(0.0252)	(0.0255)	(0.0252)	(0.0253)				
log(Employment)	0.203***	0.198***	0.203***	0.208***				
	(0.0359)	(0.0362)	(0.0360)	(0.0358)				
Profitability	-0.0594***	-0.0605***	-0.0644***	-0.0601***	0.00135	0.00159	0.000512	0.00147
	(0.0191)	(0.0198)	(0.0190)	(0.0189)	(0.00360)	(0.00363)	(0.00357)	(0.00358)
log(Sales)	0.176***	0.172***	0.181***	0.177***	-0.0177***	-0.0207***	-0.0172***	-0.0181***
	(0.0376)	(0.0381)	(0.0379)	(0.0376)	(0.00360)	(0.00354)	(0.00367)	(0.00362)
Market/book equity	0.0193	0.0192	0.0185	0.0199	0.0191***	0.0188***	0.0188***	0.0188***
	(0.0163)	(0.0165)	(0.0164)	(0.0163)	(0.00457)	(0.00461)	(0.00458)	(0.00458)
Foreign indicator	-0.0547	-0.0404	-0.0514	-0.0511	0.0229	0.0247*	0.0235	0.0223
	(0.0592)	(0.0597)	(0.0590)	(0.0588)	(0.0145)	(0.0146)	(0.0145)	(0.0146)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Group FE	Industry	Industry	Industry	Industry	Industry	Industry	Industry	Industry
Observations	1,943	1,943	1,943	1,943	1,998	1,998	1,998	1,998
R-squared	0.907	0.906	0.907	0.907	0.304	0.295	0.305	0.305

These regress measures of firm investment at the segment level on the firm's net-of-tax rate, estimated ability to shift profits γ_{jt}^{-1}, a profit shifting interaction term, and standard investment regression control variables. All regressions use year, geographic, and industry fixed effects. The market/book equity ratio and γ_{jt}^{-1} are computed at the firm level; all other variables are segment-specific.

The analysis is at the segment level using Compustat data for 1998-2023. All standard errors are robust. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

Table 22: Transmission Regressions—Robustness to Filtering

Dependent variable	Filtered GDP correlations				
Filter	Hamilton	HP	HP one-sided	Baxter-King	Christiano-Fitzgerald
Post-CtB	0.0816**	0.164***	0.0637	0.145***	0.197***
	(0.0310)	(0.0308)	(0.0387)	(0.0285)	(0.0274)
Trade intensity	0.692***	0.300	0.413*	0.394*	0.315
	(0.210)	(0.191)	(0.208)	(0.206)	(0.222)
Interaction term	-0.0121***	-0.0167***	-0.0101***	-0.0194***	-0.00434
	(0.00305)	(0.00245)	(0.00236)	(0.00264)	(0.00351)
Fixed effects:	Country-pair (i, m)				
Observations	5,268	5,268	5,268	5,268	5,268
R-squared	0.521	0.597	0.525	0.591	0.634

The dependent variable is the ten-year correlation of detrended GDP between country pairs. All regressions use country-pair fixed effects, an indicator for the period, trade intensity (as a percent of combined GDP), and the interaction term in equation (4).

All standard errors are robust and estimated through two-way clustering on countries i and m. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

To construct the interaction term, we estimate γ_{jt}^{-1} by first estimating the profit shifting semi-elasticity $(\gamma_{jt}\lambda_{jt})^{-1}$ and then multiplying by the estimate of λ_{jt} from the BEA MOFA data. The semi-elasticity is estimated in a single regression with a year-specific interaction and an industry-specific interaction, which are then combined into industry-year specific semi-elasticities. The interaction term is standardized by demeaning and dividing by its standard deviation.

Table 23: Transmission Regressions—Robustness to Extra Differencing

Dependent variable	HP-filtered GDP correlations				
γ^{-1} varies by	Pre/Post	Pre/Post, Industry	Year	Year, Industry	Year × Industry
Trade intensity	0.282	0.281	0.282	0.282	0.281
	(0.203)	(0.203)	(0.203)	(0.203)	(0.203)
Interaction term	-0.0117***	-0.0119***	-0.0125***	-0.0127***	-0.0143***
	(0.00173)	(0.00278)	(0.00189)	(0.00198)	(0.00454)
Fixed effects:	Country-pair (i,m), Country-Pre/Post				
Observations	5,268	5,268	5,268	5,268	5,268
R-squared	0.684	0.684	0.684	0.684	0.684

The dependent variable is the ten-year correlation of HP-filtered log GDP between country pairs. All regressions use country-pair (i,m) fixed effects, country-period (i,T) and (m,T) fixed effects, trade intensity (as a percent of combined GDP), and the interaction term in equation (4).

All standard errors are robust and estimated through two-way clustering on countries i and m. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

To construct the interaction term, we estimate γ_{jt}^{-1} by first estimating the profit shifting semi-elasticity $(\gamma_{jt}\lambda_{jt})^{-1}$ and then multiplying by the estimate of λ_{jt} from the BEA MOFA data. The semi-elasticity is estimated in a single regression with a year-specific interaction and an industry-specific interaction, which are then combined into industry-year specific semi-elasticities. The interaction term is standardized by demeaning and dividing by its standard deviation.

Table 24: Transmission Regressions—Robustness to Decomposition and Extra Differencing

Dependent variable	HP-filtered GDP correlations					
γ^{-1} varies by	Pre/Post	Pre/Post, Industry	Year	Year, Industry	Year × Industry	Year × Industry
Trade intensity	0.282	0.282	0.282	0.282	0.281	0.752***
	(0.199)	(0.199)	(0.199)	(0.198)	(0.199)	(0.217)
US MNE importance	0.000299	0.000217	0.000280	0.000110	-9.03e-06	0.00372**
	(0.000924)	(0.00101)	(0.000924)	(0.00100)	(0.00102)	(0.00161)
Country importance	-0.0666	-0.0673	-0.0677	-0.0687	-0.0774	0.213
	(0.0857)	(0.0844)	(0.0861)	(0.0858)	(0.0856)	(0.169)
$(\bar{\tau}-\tau_i)(\bar{\tau}-\tau_m)$	-0.153	-0.158	-0.157	-0.152	-0.167	-2.068***
	(0.628)	(0.628)	(0.627)	(0.627)	(0.628)	(0.669)
Exposure to γ_{jt}^{-1}	0.236	0.219	0.320	0.314	0.490	-0.772**
	(0.366)	(0.294)	(0.460)	(0.336)	(0.364)	(0.319)
Interaction term	-0.0101***	-0.0101**	-0.0108***	-0.0109***	-0.0115*	
	(0.00305)	(0.00408)	(0.00324)	(0.00337)	(0.00596)	
Fixed effects:	Country-pair (i,m), Country-Pre/Post					
Observations	5,268	5,268	5,268	5,268	5,268	5,268
R-squared	0.684	0.684	0.684	0.684	0.684	0.575

The dependent variable is the ten-year correlation of HP-filtered log GDP between country pairs. All regressions use country-pair (i,m) fixed effects, country-period (i,T) and (m,T) fixed effects, trade intensity (as a percent of combined GDP), and the interaction term in equation (4).

All standard errors are robust and estimated through two-way clustering on countries i and m. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

To construct the interaction term, we estimate γ_{jt}^{-1} by first estimating the profit shifting semi-elasticity $(\gamma_{jt}\lambda_{jt})^{-1}$ and then multiplying by the estimate of λ_{jt} from the BEA MOFA data. The semi-elasticity is estimated in a single regression with a year-specific interaction and an industry-specific interaction, which are then combined into industry-year specific semi-elasticities. The interaction term is standardized by demeaning and dividing by its standard deviation.

Table 25: Investment Transmission Regressions—Robustness to Extra Differencing

Dependent variable	HP-filtered aggregate variable correlations					
Aggregate variable	Capital stock	Total investment	Structures investment	Machinery investment	Transportation equipment investment	Other equipment investment
Trade intensity	0.178	-0.165	-0.0314	0.431**	0.227	0.114
	(0.305)	(0.212)	(0.171)	(0.176)	(0.207)	(0.168)
Interaction term	-0.00785***	-0.00704***	-0.00864***	-0.00541***	-0.0124***	-0.00688***
	(0.00131)	(0.000501)	(0.000192)	(0.00109)	(0.00134)	(0.000458)
Fixed effects:	Country-pair (i, m), Country-Pre/Post					
Observations	5,268	4,874	5,268	5,268	5,268	4,874
R-squared	0.740	0.702	0.583	0.679	0.643	0.566

The dependent variable is the ten-year correlation of HP-filtered investment and capital measures between country pairs. All regressions use country-pair (i, m) fixed effects, country-period (i, T) and (m, T) fixed effects, trade intensity (as a percent of combined GDP), and the interaction term in equation (4).

All standard errors are robust and estimated through two-way clustering on countries i and m. *, **, and *** denote statistical significance at the 10, 5 and 1 percent confidence levels. The intercept is omitted from the reported coefficients.

To construct the interaction term, we estimate γ_{jt}^{-1} by first estimating the profit shifting semi-elasticity $(\gamma_{jt}\lambda_{jt})^{-1}$ and then multiplying by the estimate of λ_{jt} from the BEA MOFA data. The semi-elasticity is estimated in a single regression with a year-specific interaction and an industry-specific interaction, which are then combined into industry-year specific semi-elasticities. The interaction term is standardized by demeaning and dividing by its standard deviation.