Optimal Benefit-Based Corporate Income Tax

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Abstract

I argue that the corporate income tax is justified by the benefit view of taxation—that firms should pay tax according to the benefits they receive from using public inputs. Benefit-based taxation of firms is fair, both within and across countries. I derive a formula for the optimal benefit-based corporate tax rate. It is a function of two estimable elasticities: the public input elasticity of profits and the (net of) tax elasticity of profits. I empirically apply this formula to public firms in the United States, finding an optimal tax rate in the region of 35 to 59 percent. The benefit principle implies that we should tax profits at source, that we should aim to limit the tax base to returns on public inputs, and that profit shifting is wrong because firms avoid contributing to the public input.

JEL: H21; H25; H32; H41

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1 Introduction

The view that 'corporations must pay their fair share' dominates public opinion. In 2017, Americans' biggest complaint about the federal tax system was the feeling that

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some corporations do not pay their fair share of tax. Sixty-two percent of respondents said they were bothered 'a lot' by corporations who did not pay their fair share (Pew Research Center, 2017a). In 2018, only 26 percent of Americans believed that corporations paid their fair share of tax. Sixty-two percent felt that corporations paid too little tax (Gallup, 2018). Fifty-nine percent of Americans felt that corporations made too much profit (Pew Research Center, 2017b).

But what is anyone's fair share of tax? For example, Datt (2014) says the Australian Taxation Office's call for corporations to pay a 'fair share of tax' is not an objective calculation of tax liability. Is there any way for us to convert the idea of a 'fair share' into a formal guideline for tax liability? The concern is not that a 'fair share' is not a good fundamental principle. The concern is that it implies no formal guideline for the calculation of tax liability. To be useful, guidelines for the optimal taxation of corporations must be rooted in a purpose. Weisbach (2015) says:

> The basic point is that we cannot know what the optimal pattern of international capital income taxation should be without understanding the reasons for taxing capital income in the first place... To understand the design of firm-level taxation, however, we need to know why we are taxing firms.

To be able to define the purpose for taxing corporations, we first have to ask: *'why does the corporate tax exist?'*

The dominant view of the corporate tax is that it serves an administrative purpose (OECD, 2001; Mirrlees et al., 2011). The administrative view encompasses three arguments. The first is that the corporate income tax exists to prevent individuals from incorporating themselves to avoid personal taxation. The second is that the corporate income tax exists to prevent firms from hoarding profits to avoid dividend taxation. The third is that it is easier to tax a firm's profits rather than to tax individual shareholders. According to the administrative view, the corporate tax exists to support taxes on individuals. This, Zucman (2014) points out, was the original purpose of the corporate tax in the United States.

I propose an alternative **benefit-based** view: *firms should contribute to the provision of the public input according to the benefits they receive from the use of the public input.* The corporate income tax should exist for firms to contribute to public input provision. This is an application of the classical principle of benefit-based taxation to corporations (Weinzierl, 2018a). I will refer to this simply as benefit-based taxation. This benefit-based view of corporate taxation justifies and is supported by the widespread norm that firms should pay tax where the relevant economic activity takes place (OECD, 2013; Pogge and Mehta, 2016a). Similarly, the IMF (2019) suggests that the only widely-accepted principle of inter-nation equity is that governments should have taxing rights over location-specific rents that arise in their country. Since the public input creates a location-specific rent, Musgrave and Musgrave (1972) conclude that the benefit principle automatically satisfies the notion of inter-nation equity. The benefit-based view of corporate taxation is supported by our widely-held norms of corporate taxation.

I incorporate the benefits of public spending by putting a non-excludable non-rival productive public good in the firm's production function. I refer to this productive public good as the public input. To identify an optimal benefit-based corporate tax rate, I use the Lindahl (1919) method of solving the cost-sharing problem. I modify the Lindahl (1919) thought experiment to account for the distortionary nature of the corporate tax by supposing that the government chooses the public input and the corporate tax separately for each firm type. I draw heavily from Weinzierl (2018b), who integrates the Lindahl (1919) thought experiment into modern tax theory under the case of non-distorting labour income taxation.

I derive a simple optimal benefit-based corporate tax rate formula: $t^* = e^G/(1+e^T)$. The formula is a function of two estimable elasticities: the elasticity of profits with respect to the net of tax rate (e^T), and the elasticity of profits with respect to the public input (e^G). While the tax elasticity accounts for the distortionary effects of corporate taxation, the public input elasticity captures the benefits generated by the public input. This optimal tax formula integrates the benefit view with more common efficiency concerns.

I apply the benefit-based optimal tax formula to the United States. Using Compustat data, I estimate the necessary elasticities for public corporations, which tend to be the largest and most visible corporations. The preferred estimate of the public input elasticity is 0.653, and the preferred estimate of the tax elasticity is 0.427. These estimates imply the optimal benefit-based corporate income tax rate would be $t^* = 0.653/(1 + 0.653 \times 0.427) = 46$ percent for public corporations in the US. This exceeds both the US' old and new corporate tax rates of 35 percent and 21 percent respectively. It suggests that the Tax Cuts and Jobs Act of 2017 moves the tax rate in the opposite direction of what an optimal benefit based tax on public corporations would suggest. Employing full range of estimates for sensitivity testing suggests that the optimal benefit-based tax lies in the range of 35 to 59 percent.

The benefit principle gives three guidelines for designing the international corporate tax system. The first guideline is that corporate taxation should follow the source principle so that governments can tax the returns to their own public inputs. The second guideline is the tax base should be narrowed to economic rents so as to target returns to the public input. This implies we should distort other factors of production as little as possible. The third guideline is that profit shifting is unfair. Despite the efficiency-enhancing nature of profit shifting, it allows firms to evade their contribution to providing the public input.

In the following section, I present the case for benefit-based taxation as the fundamental principle of corporate taxation. In Section 3, I formalise these insights to derive an optimal benefit-based corporate tax formula. I then apply this model to the case of the United States in Section 4. In Section 5, I describe the policy insights that can be gained from applying the benefit principle to the corporate income tax.

2 The Case for Benefit-Based Corporate Taxation

There is no clear consensus on why the corporate income tax exists. Even canonical public economics texts are vague on the purpose of the corporate tax. For example, Kaplow (2011) and Myles (1995) find it difficult to rationalise the tax's existence. While Atkinson and Stiglitz (1980) try to examine the validity of some of the beliefs behind the various justifications of the corporate income tax, none of these texts appear convinced.

I propose a fundamental economic purpose for the corporate income tax. I argue that the corporate income tax *should exist* as a benefit-based tax. The case for benefit-based taxation is built on two arguments. First, I argue that benefit-based taxation is fair. Second, I argue that benefit-based taxation is feasible. I now present logical evidence in support of these arguments.

2.1 Benefits-Based Taxation as Normatively Fair

Benefits-based taxation has root in Adam Smith's (1776) first maxim of taxation: "The subjects of every state ought to contribute towards the support of the government, as nearly as possible, in proportion to their respective abilities; that is, in proportion to the revenue which they respectively enjoy under the protection of the state." This maxim reflects Smith's normative perspective on how firms should be taxed. Ideally, he says, tax liability should be linked to the revenue a firm derives from the state's public services. This is the foundation of benefit-based taxation.

Benefit-based taxation of corporations leads to a quite natural conclusion: *firms should pay tax where profit-generating production takes place.* Graetz (2000) says:

> The services a nation provides may contribute substantially to the ability of both residents and foreigners to earn income there. Taxing that income is one way for the source country to be compensated for its expenditures on the services it provides. One need not thoroughly embrace the benefit theory of taxation—the idea that the expenses of government should be paid by those who benefit in proportion to the benefits they receive—which is fraught with difficult problems of measurement and allocation, to recognize a country's legitimate claim to tax income produced within its borders.

In fact, the legitimacy of a country's claim to tax income generated within its borders is a principle on which we are in widespread agreement. The essays in Pogge and Mehta (2016a) collectively demand that tax liability should arise where the income-generating economic activity takes place. This principle is also the fundamental driving force behind the OECD's Base Erosion and Profit Shifting (BEPS) project. Weinzierl (2018a) reverse-engineers these views, pointing out that this principle is a natural implication of the benefit principle of taxation. Further, the benefit principle provides a normative foundation for this broad notion of inter-nation fairness. Under benefit taxation, the multinational firm pays tax where its income-generating economic activity takes place because that activity is supported and made possible by the government where that activity takes place.

This principle is effectively a statement of **inter-nation equity**. Inter-nation equity concerns the allocation of national gains and losses in an international context, aiming to ensure that each country is allocated an equitable share of the tax revenues that arise from international or cross-border activity of corporations (OECD, 2014). In practical terms, it defines who should have the ability to tax a multinational firm's profits—the source, residence, or destination country. Kaufman (1997) says that "fairness exists in the international tax system only when states distribute among themselves the competence to tax in a way that conforms to prevailing views of justice internationally."

The notion of inter-nation equity was developed by Musgrave and Musgrave (1972), and their original conclusion is striking: "Inter-nation equity under the benefit principle would be self-implementing." That is, a benefit-based corporate tax would automatically achieve inter-nation equity. According to Musgrave and Musgrave (1972), the benefit idea would be the ideal manner to allocate gains among countries by entitling each country to charge for the cost of public services rendered to the firm. This perspective of inter-nation equity is echoed by an IMF (2019) report, which says while that there is little agreement on standards of inter-nation equity, there is one principle of inter-nation equity on which we broadly agree: that taxing rights of location-specific rents should be allocated to the jurisdiction in which they arise.

From the perspective of within-country equity, benefit-based corporate taxation complies with the **just deserts principle** proposed by Mankiw (2010). The just deserts principle simply says "people should get what they deserve", implying no desire for redistribution from rich to poor. What does a firm deserve? The firm does not 'deserve' to receive returns to the public input. Instead, the returns to the public input should accrue to the public input's owner: the government. The corporate income tax is the only means of fairly allocating just deserts between firm and government.

The main economic arguments against the corporate tax as a benefit tax are positive rather than normative. For example, Weichenrieder (2005) does not argue that the benefit principle is invalid, but rather that the existing corporate tax system is an imperfect way to achieve the aims of the benefit principle. De Mooij (2005) makes a similar claim: since there exists a weak relationship between the taxes paid by a company and the benefits the company receives from public services, then the existing corporate income tax does not comply with the benefit principle. These are valid arguments against the *existing* corporate tax as a benefit tax. However, they do not invalidate the central thesis of this paper: *the corporate income tax should be a benefit-based tax.*

Fairness and equity should be a fundamental concern of the corporate income tax. Cui (2016) concludes that "theories that do not take into account distributional consequences and focus only on efficiency concerns are unlikely to be accepted as setting out adequate normative criteria for international taxation." And optimal international corporate tax system must be based both on the fairness and efficiency of the proposed tax.

2.2 The Ability to Tax Returns to Public Inputs

The seminal work of Gordon (1986) suggests that a small open economy cannot impose a tax on multinational firms. Gordon (1986) assumes an infinite elasticity of capital with respect to tax; even a small corporate income tax would cause all capital to disappear. The assumption of an infinite elasticity of capital requires the absence of location-specific rents. Any modern re-statement of Gordon's findings includes the qualification that a small open economy cannot impose a tax on multinational firms *if there are no location-specific rents* (Griffith et al., 2010). The obvious implication is that the existence of location-specific rents provides an opportunity for a small open economy to impose a non-zero corporate tax.

Huizinga and Nielsen (1997) then consider optimal corporate taxation in the presence of location-specific rents. Full taxation of location-specific rents becomes optimal. A tax on location-specific rents is not distortionary because the factors generating location-specific rents are immobile. However, if there is an upper limit on the tax rate on location-specific rents, the use of a distortionary tax on capital income becomes warranted. Similarly, if a government is forced to tax capital and rents at the same rate, it might be forced to impose a non-zero tax on capital. In reality, a government might be forced to tax them both at the same rate because it cannot distinguish between returns to capital and rents (Auerbach and Devereux, 2018). In the same manner, Keen and Piekkola (1997) find that if profits arising from location-specific rents are not taxed, then taxing returns to capital becomes optimal. In fact, McKeehan and Zodrow (2017) suggest that the main reason corporate income taxes have not simply converged to zero is the existence of location-specific rents. Therefore, location-specific rents give government the *ability* to impose positive corporate income taxes.

What exactly are these location-specific rents that give the government the ability to impose corporate taxes? First, the concept of Paretian rent, defined by Wessel (1967) is *"the excess earnings over the amount necessary to keep the factor in its present occupation."* Pure profits arising from a decreasing returns to scale production function suggests that there are some unobservable factors of production at work. Since it should always be possible to perfectly replicate production by replicating all rival factors, then decreasing returns to scale in observable factors must reflect the scarcity of (or normal returns to) an underlying unlisted factor of production. The popular microeconomic theory text by Mas-Colell et al. (1995) provides a proof for the proposition that any decreasing returns to scale production function can be represented by a constant returns to scale production function with implicit fixed inputs (page 134, Proposition 5.B.2).

If economic rents can be attributed to underlying factors of production, these factors can then be broadly divided into two categories: firm-specific factors or location-specific factors. That is, the factors generating economic profits must belong either to the firm or to the country in which production takes place. The most common example of an unobserved firm-specific asset is entrepreneurial inputs. Such firm-specific rents are considered to be highly mobile and subject to flight as described by Mirrlees et al. (2011). Firm-specific assets are a key element of the theory of the multinational firm, as described by Dunning (1988) in terms of specialized and patented technological knowledge, superior managerial skills or production techniques, or valuable product brands, trademarks, reputations, and other intangible assets (McKeehan and Zodrow, 2017).

The **public input** is a key source of location-specific rents. The public input is defined as a productive public good that the firm uses in its production process. Empirically, the public input is represented as public capital generating a flow of public services. Aschauer (1989) argues that public inputs are very important to the production process. The need for public goods and services arise when private agents are unwilling or unable to provide them. This might happen if private agents cannot charge a user fee for these goods, neither can they exclude agents from using the public good. It might also happen when the provision of a good requires economies of scale so large that only a government is willing to undertake provision. The body of empirical literature following Aschauer (1989) finds economically significant elasticities output with respect to public capital across a range of countries (Bom and Ligthart, 2014b).

Location-specific rents generated by the public input gives governments the *ability* to impose a positive corporate income tax. This ability to tax exists even in a small open economy where the optimal corporate tax rates is traditionally thought to be zero. A benefit-based corporate income tax that links a firm's tax liability to its returns generated by the public input is not only fair, but also feasible.

3 A Model of Benefit-Based Corporate Taxation

I apply the Lindahl (1919) approach to classical benefit-based taxation to the corporate income tax. I extend the Lindahl thought experiment laid out in Weinzierl (2018b) to incorporate a distortionary corporate tax instrument. To do so, I consider a thought experiment where the government chooses each firm's optimal level of public input provision and corporate tax rate individually. This differs to the standard Lindahl thought experiment where firms would choose their own optimal level of public input provision, and no distortionary tax exists.

3.1 Setup

There are I firm types and each firm type is indexed by i. To simplify the presentation of the model, I restrict attention to a single country. A firm of type i has a profit function $\pi_i(k_i, G)$ which is a function of private capital (k_i) and the public input (G). Each firm type is endowed with financial capital K_i which it can either invest in production or in an outside option. Investing in production generates profits through the profit function $\pi_i(k_i, G)$ while investing in the outside option offers a fixed return of return r.

For simplicity, I assume firms are price takers and there is no strategic interaction. Note that profits described here are not economic profits. Instead, they are the sum of the returns to equity capital and the returns to the public input. This definition of profits matches the common definition of corporate profits in the real world. I also normalise prices to unity.

The firm chooses k_i to maximises total income Π—the sum of profit and returns from the outside option. Each firm type i faces an ad valorem tax on its profits of t_i. The firm takes both the tax rate and the amount of the public input provided as given. This is the standard approach in tax theory, but it diverges from the traditional Lindahl thought experiment since firms do not choose the level of public input themselves. Firm type i's problem is:

$$\max_{k_i} \quad \Pi = (1 - t_i)\pi_i(k_i, G) + r(K_i - k_i). \tag{1}$$

Firm type i's first-order condition of the maximization problem with respect to k_i is given by:

$$(1 - t_i)\frac{\partial \pi_i(k_i, G)}{\partial k_i} - r = 0. \tag{2}$$

Intuitively, Equation 2 says that the firm uses capital in production up to the point where marginal after-tax profit is equal to the fixed return on the outside option. The outside option is the opportunity cost of investing in productive economic activity. I use the outside option to include any alternative uses of financial capital or behavioural responses a firm might have. This includes shifting from equity to debt, profit shifting, shifting the geographical location of productive activity, or even shifting to passive investment classes outside of the firm. The firm can be considered to be either a domestic or a multinational firm without altering the setup of the model.

Distorting Corporate Tax The firm's first-order condition in Equation 2 implies that the firm's optimal choice of capital—and therefore its maximized profits—depend on the tax rate. How? Using the first-order condition, the implicit differential of k_i with respect to the net-of-tax rate $(1 - t_i)$ is

$$\frac{dk_i}{d(1-t_i)} = \frac{-\partial \pi_i(k_i, G)/\partial k_i}{(1-t_i)\partial^2 \pi_i(k_i, G)/\partial k_i^2} \neq 0. \tag{3}$$

Consequently, the effect of a change in the net of tax rate on profits is also non-zero, given by:

$$\frac{d\pi(k_i, G)}{d(1-t_i)} = \frac{\partial \pi_i(k_i, G)}{\partial k_i} \frac{dk_i}{d(1-t_i)} \neq 0. \tag{4}$$

A change in the net-of-tax rate invokes a change in the firm's optimal value of k_i. Standard restrictions on the profit function so that $\partial \pi_i(k_i, G)/\partial k_i > 0$ and $\partial^2 \pi_i(k_i, G)/\partial k_i^2 < 0$ would imply that increasing the tax rate leads to a decrease in profit. More importantly in this simple setup, I show that the corporate income tax distorts the firm's choice of profits.

3.2 Optimal Corporate Tax

Lindahl (1919) devised a means for two parties to determine 'by free agreement' how much of a common good they would purchase. Lindahl's solution was based on the idea that either party would want the group to purchase less of the common good if they have to cover a larger share of the cost. If each party must cover half the cost of the common good but their valuations of the common good are different, then they will not agree on how much to purchase. Lindahl's solution is simple: increase the share of the cost covered by the party with a higher valuation of the common good. The high-valuation party now thinks the group should purchase less of the common good since they bear a greater portion of the burden. Meanwhile, the low-valuation party now thinks the group should purchase more. Lindahl suggests adjusting the share each party contributes until they agree on exactly how much of the common good should be purchased.

While Lindahl's solution is by no means the only proposition for how best to enforce benefit-based taxation, it is intuitive. Weinzierl (2018b) integrates Lindahl's approach into optimal tax theory by making the assumption that an individual's income is a function of the public good. I extend the Lindahl (1919) solution to the optimal corporate income tax.

The existing Lindahl (1919) method unrealistically assumes a non-distortionary tax instrument. But since Pigou (1947) we recognise that using distortionary tax instruments generates an additional cost to raising funds for provision of the public good (Stiglitz and Dasgupta, 1971; Atkinson and Stern, 1974). I use the term 'distortion' in the original sense of Atkinson and Stern (1974) as the excess burden the corporate income tax on profits generates compared to the alternative of lump-sum taxation (Browning and Liu, 1998). This distortion is created by the firm's behavioural responses to taxation, which we know to be empirically relevant (de Mooij and Ederveen, 2008; Devereux et al., 2014; Bachas and Soto, 2018; Seegert et al., 2018).

To find an implementable and realistic application of the benefit principle, I modify the traditional Lindahl approach. I introduce a Modified Lindahl Approach that adds the distortionary character of the corporate income tax to Lindahl's solution for provision of a public input.

Definition 1. Modified Lindahl Approach: *The Modified Lindahl Approach is a thought experiment where the government chooses the optimal level of public input provision g_i and the optimal tax on profits t_i for each firm type individually. The government is constrained by the condition*:

$$t_i \pi_i(k_i, g_i) - \tau_i g_i = 0 \tag{5}$$

so that the amount of tax paid by the firm must be equal to a fixed share τ_i of the cost of the provision of the public input g_i.

The Lindahl approach uses a firm-specific choice of public input g_i rather than the single aggregate value G that holds in reality. This firm-specific public input is a key mechanism in Lindahl's solution. The original Lindahl (1919) approach would ask: what if each individual firm could choose its optimal level of public input provision? Instead the modified approach asks: what if the government chose the optimal level of public input provision for each firm separately? The modified thought experiment incorporates the existence of a distortionary corporate tax. Moving the choice of g_i outside the firm means the firm does not internalise the link between the tax it pays and public input provision. The firm is separately aware that it pays tax and that it uses a public input, but it does not recognise that higher taxes imply higher public input provision. If a firm internalises the effect of a higher tax rate on public input provision then the corporate tax would not be distorting.

The Government's Lindahl Problem The government's aim is to maximise the value of the firm's profits rather than the firm's total income. I ignore the firm's outside option as these may not directly benefit the government. For the tax collected from firm i to be equal to firm i's share of the cost of the public input, the government uses the firm-specific constraint $t_i \pi_i(k_i, g_i) = \tau_i g_i$. For each firm, the government chooses a tax rate and level of public input provision for each individual firm type that maximises the firm's profits. The Lagrangian for the government's problem for firm type i is:

$$\max_{t_i, g_i} \quad \mathcal{L} = (1 - t_i)\pi_i(k_i, g_i) + \lambda \left(t_i \pi_i(k_i, g_i) - \tau_i g_i \right). \tag{6}$$

where k_i^* is the policy function from the firm's maximisation problem. From the first-order conditions of the firm, we know that k_i^* is a function of both g_i and t_i.

I define the elasticities of profit with respect to public inputs and the net-of-tax rate as:

$$e_i^G = \left(\frac{d\pi_i(k_i^*, g_i)}{dg_i} \right) \left(\frac{g_i}{\pi(k_i^*, g_i)} \right) \tag{7}$$

$$e_i^T = \left(\frac{d\pi_i(k_i^*, g_i)}{d(1 - t_i)} \right) \left(\frac{1 - t_i}{\pi_i(k_i^*, g_i)} \right) \tag{8}$$

Optimal Public Input Condition I derive the first-order condition with respect to the public input to characterise optimal public input provision in a setting with a productive public input. Full derivations are shown in Appendix A. I derive the condition:

$$\left(\frac{e_i^G}{1 - e_i^G} \right) \left(\frac{1 - t_i}{t_i} \right) = \lambda. \tag{9}$$

Increasing the public input directly and indirectly increases the firm's profits. Directly through the profit function, and indirectly through the effect on the firm's optimal choice of capital. By increasing firm profits, the public input also increases the government's tax base.

Optimal Corporate Tax Condition I derive the government's optimal choice of the net-of-tax rate $(1 - t_i)$. The first-order condition is:

$$\frac{1 + e_i^T}{1 - e_i^T \left(\dfrac{t_i}{1 - t_i}\right)} = \lambda. \tag{10}$$

An increase in the net-of-tax rate of firm type i induces a mechanical and a behavioural effect. The mechanical effect is the reduction in the tax rate the firm faces, holding profits constant. The behavioural effect is the firm's optimal response to the change in the tax rate through its first-order conditions and captures the distorting effect of the corporate tax. Normally a higher tax rate leads to lower profits and vice versa.

Definition 2. Lindahl Equilibrium: *A Lindahl equilibrium is a policy comprising a set of personalised tax shares* $\{\tau_i\}$ *and public input choice* G^* *where the following conditions hold*:

$$g_i = G^* \quad \forall i, \tag{11}$$

$$\sum_{i \in I} \tau_i = 1 \tag{12}$$

A Lindahl equilibrium is defined by the set of tax shares $\{\tau_1, \tau_2, ..., \tau_I\}$ that leads the government to optimally choose the same level of public input provision (g_i) for all firms. This level is the optimal level of public input provision G^*. This equilibrium concept requires that these tax shares must completely fund the provision of the optimal level of public input provision. Even though the Lindahl equilibrium concept remains unchanged, it is no longer a first-best equilibrium.

Optimal Tax Rate Formula How does the government set the optimal tax rate that achieves Lindahl equilibrium? Use **Definition 2** of Lindahl equilibrium to replace g_i with G^*. Combining the government's first-order conditions for optimal public input provision and for optimal taxation for an individual firm type i:

$$\left(\frac{e_i^{G^*}}{1 - e_i^{G^*}}\right)\left(\frac{1 - t_i}{t_i}\right) = \frac{1 + e_i^T}{1 - e_i^T \left(\dfrac{t_i}{1 - t_i}\right)}. \tag{13}$$

I can now state this paper's main proposition.

Proposition 1. *In a Modified Lindahl Equilibrium, the optimal benefit-based corporate income tax rate for any firm type i with a distortionary tax instrument is:*

$$t_i^* = \frac{e_i^{G^*}}{1 + e_i^T} \tag{14}$$

where $e_i^{G^*}$ *is the elasticity of profits with respect to the public input and* e_i^T *is the elasticity of profits with respect to the net-of-tax rate.*

Proof in Appendix A. The optimal corporate tax rate is expressed in terms of two estimable elasticities. A higher public input elasticity of profits implies a higher corporate tax rate since the firm derives a greater benefit. If the corporate tax rate is not distortionary such that $e_i^T = 0$, then the optimal corporate tax rate is $t_i^* = e_i^{G^*}$. As the firm's behavioural response to taxation increases, then the optimal corporate tax rate falls.

In a standard Lindahl equilibrium, the firm should pay for the public good according to the benefit they receive from the public good. When a firm is optimising, the marginal benefit the firm receives should be equal to their willingness to pay for an extra unit of the public input. The firm's total tax payment should be equal to their total willingness to pay for the optimal level of public inputs. This optimal tax formula therefore combines the firm's willingness to pay for the good with the fiscal externality induced by the behavioural response of the agent (Hendren, 2016).

The optimal tax formula in Equation 14 implies that a firm type contributes more to public input provision when it values the public input more. This is the classical logic of benefit-based taxation. Firms with a higher behavioural response to corporate taxation see their optimal corporate tax rate adjusted downward. Note, however, that there is only an economically significant adjustment to the optimal corporate tax rate for firms who receive a high benefit from the public input. This is shown in Figure 1. Those with a public input elasticity of 0.2 or below see almost no adjustment in their optimal corporate tax rate when their behavioural responses increase.

Notice that a firm that has a high level of profits independent of the public input so that $e^G = 0$ would pay no corporate income tax under this benefit-based corporate income tax system. This approach does not account for the 'ability to pay' rationale for taxation that underpins the Mirrlees (1971) approach. The ability to pay concept stems from an individual's inherent ability, an unobserved heterogeneity among individuals (Mankiw et al., 2009). Fleming Jr et al. (2001) make the argument that

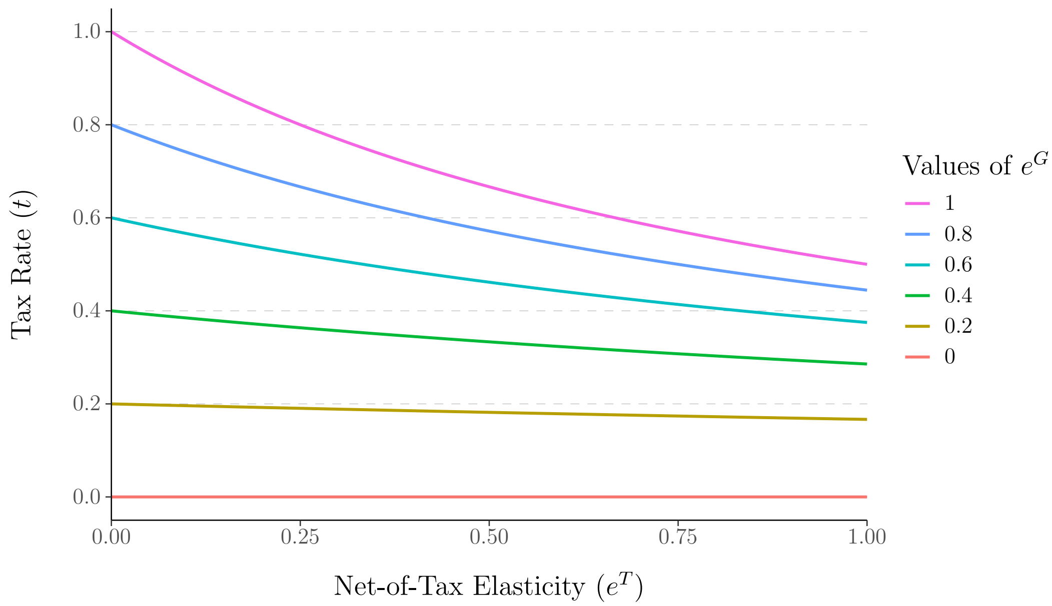


Figure 1: Optimal Tax Rate for Range of Elasticities

Modified Samuelson Condition For comparability with traditional tax literature, I can rewrite these findings in a modified version of the Samuelson (1955) condition for optimal public input provision. Rearranging the optimal public input condition to isolate the benefit received by the firm:

$$e_i^G \pi_i(k_i^*, g^i) = \tau_i g_i \left(\frac{\lambda_i}{1 - t_i + \lambda_i t_i} \right). \tag{15}$$

Substituting in for λ from the condition for optimal taxation gives:

$$e_i^G \pi_i(k_i^*, g^i) = \tau_i g^i (1 + e_i^T) \tag{16}$$

for each firm type. By **Definition 2** of Lindahl equilibrium, I replace g_i with G^* and sum the above condition across all firms. I propose a modified Samuelson condition for the optimal provision of the public input:

$$\sum e_i^G \pi_i(k_i^*, G^*) = G^* \sum \tau_i (1 + e_i^T) \tag{17}$$

Effectively this implies that at the second-best optimal provision of the public input, the sum of the firms' marginal rates of substitution (MRS) between public inputs and private profits is equal to the marginal rate of transformation (MRT) between them times the marginal cost of public funds (MCPF). This is the standard modified Samuelson condition that arose from the early work of Atkinson and Stern (1974) and Stiglitz and Dasgupta (1971). As reviewed in Ballard and Fullerton (1992), this line of work implies a modified Samuelson condition that takes the form $\sum \text{MRS}_i = \text{MRT} \times \text{MCPF}$. The question then is whether the marginal cost of public funds is equal to or greater than 1. The size of the MCPF depends on the aggregate behavioural responses of the firm. In this model, these behavioural responses are a weighted average $\sum \tau_i(1+e_i^T)$. Under- or over- provision of the public good depends on each firm's share of provision and their behavioural response.

3.3 Profit Shifting

Profit shifting is likely the biggest concern with the present international corporate taxation system. Any model of optimal corporate taxation must account for this enormous phenomenon. Tørsløv et al. (2018) estimate that close to 40% of multinational profits are artificially shifted to tax havens. Profit shifting is at the centre of the OECD's massive and wide-ranging project on Base Erosion and Profit Shifting.

Suppose firms can shift an amount q of the profits generated in the home country to a tax haven. While profits booked in the tax haven are not taxed, the act of shifting profits itself incurs a cost $c(q)$. The cost of profit shifting is increasing in the amount of profits shifted because it increases the likelihood of being caught and penalised. Because of this cost, the firm will not optimally shift all of its profits to the tax haven. The firm receives shifted profits free of tax but net of the cost of shifting. The firm's after-tax profits are now:

$$(1-t_i)[\pi(k_i, G) - q_i] + q_i - c(q_i) \tag{18}$$

with first-order condition for the choice of profits shifted $c'(q_i) = t_i$ so that the marginal benefit of shifting an extra dollar of profit t_i is equal to the marginal cost of doing so. The firm cannot deduct the cost of profit shifting from its tax base. Consider reported profits $\hat{\pi}_i$ to be actual profits less profits shifted: $\hat{\pi}_i = \pi_i - q_i$. We can simplify the new solution by redefining our elasticities to be elasticities of reported profits. In reality, we observe reported rather than real profits. Redefining the elasticities as reported profit elasticities, the optimal benefit-based corporate tax formula remains exactly the same. This is based on the tax evasion mechanism described in Feldstein (1995, 1999). Chetty (2009) shows that if we do not consider the entire cost of evasion to be lost to society (if costs are transfers to other agents or firms overestimate the cost of profit shifting), then we may need to consider some combination of the elasticities of actual profits and the elasticities of reported profits. This concern, however, extends beyond the scope of this paper and can be examined in future work.

3.4 Related Works

The model I present bears some resemblance to Haufler and Schjelderup (1999). Haufler and Schjelderup (1999) model the efficient provision of public inputs in the presence of profit shifting. The authors focus on the theoretical under-provision or over-provision of the public input due to profit shifting. Profit shifting allows firms to escape contributing to the provision of the public input. Their main trade-off is also between the benefits of increasing public inputs and the costs of increased taxation.

The resulting trade-off of this paper is also similar to the results of Benassy-Quere et al. (2007). However, Benassy-Quere et al. (2007) consider the effects of taxation and public investment on foreign direct investment alone. They propose that the elasticities of foreign direct investment with respect to public inputs and with respect to the tax rate identify the under-provision or over-provision of public inputs. Benassy-Quere et al. (2007) are concerned with optimal public input provision, but also suggest that the optimal tax rate should be set based on the marginal returns of the public input.

A recent set of papers by Gugl and Zodrow (2015a,b) and Matsumoto and Sugahara (2017) measures the efficiency of production taxes and capital taxes against the benefit-based holy grail of user fees. Their finding is not unambiguous, since neither tax perfectly substitutes for an explicit user fee. Instead, the relative efficiency of these taxes depends on the elasticity of substitution between capital and the public input.

The conceptual mechanisms of benefit-based taxation resemble the Tiebout (1956) model. The standard Tiebout model says that individuals will choose to locate where the local public good provision (and resulting tax) matches their preferences. In this paper I answer a variant of the policy question deemed important by Tiebout (1956): how should the government ascertain firms' demand for the public input and the accompanying tax?

The Tiebout (1956) model raised debate whether the property tax used to fund local public goods is a non-distortionary benefit tax or whether it acts as a distortionary capital tax. Most relevant is the proposal that the level of taxation and public good provision depends directly on whether the tax is considered to be a benefit tax or a capital tax. The literature broadly viewed the two characteristics of the tax as opposing, but Mieszkowski and Zodrow (1989) attempt to show that they can be reconciled. Wildasin (1986) suggests a 'theoretical synthesis', where the Tiebout property tax is both a benefit tax and a distortionary tax instrument. The model I present follows this theoretical synthesis.

4 Empirical Illustration: United States

In this section, I empirically demonstrate the application of the optimal benefit-based tax formula. Application requires the estimation of two key elasticities: the net-of-tax elasticity of profits, and the public input elasticity of profits.

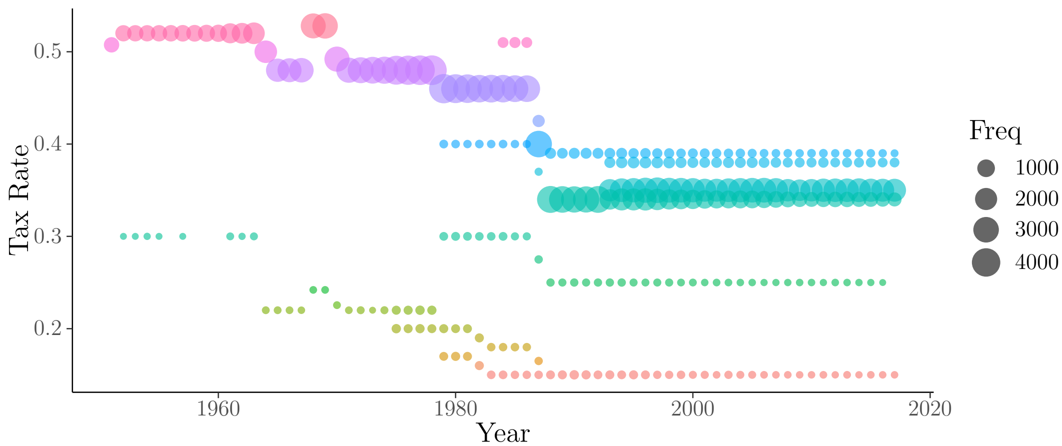
Public corporations, while only 1 percent of the number of United States corporations, contribute 70 percent of corporate tax receipts. When voicing opinions are about firms not paying their 'fair share', it is typically public corporations that are the source of discontent. These are the most visible and are frequently attacked by the press for their practices and attempts to limit their tax liability. I use available data on public corporations from the Compustat database published by Standard and Poor's to implement the optimal benefit-based tax formula.

From 1993 until 2017 the United States' main corporate tax rate was 35 percent. In December 2017, the United States government enacted major tax reform, including a substantial revamp of the corporate tax system. The tax reform reduced the top corporate tax rate from 35 percent to 21 percent. How does this reform compare to the optimal corporate tax rate implied under a benefit-based corporate tax?

4.1 Net-of-Tax Elasticity of Profits

From 1950 until 1992, the majority of United States public corporations in the Compustat dataset fell into the same corporate tax band. Figure 2 shows the number of firms which fell into each corporate tax band in a given year. Only after the tax reform of 1993 did the tax schedule create substantial variation in the marginal corporate tax rate facing public corporations.

1950 to 1992 Reforms Since most firms experienced the same changes in marginal tax rates in the 1950 to 1992 period, it means that meaningful identification can only come from temporal variation in the corporate tax rate. I use a panel differences



The size of the bubble represents the number of firms with a specific tax rate. Each tax rate is coloured differently to differentiate between them. Note that the total number of firms increases over time.

Figure 2: Firm-Level Corporate Tax Rates by Year

specification, using temporal variation in the corporate tax rate to estimate the tax elasticity of corporate income.

For each firm i, I express the data in log changes, using one-year $(s+1)$, to four-year $(s+4)$ differences. The variables of interest are therefore expressed as growth rates. The estimated equation takes the form:

$$\log\left(\frac{\pi_{is+1}}{\pi_{is}}\right) = e^T \cdot \log\left(\frac{1-t_{is+1}}{1-t_{is}}\right) + \delta_i + f(\pi_{is}) + u_{is} \tag{19}$$

where e^T is the elasticity of interest, δ_i are firm-specific fixed effects, and $f(\pi_{is})$ are a function of base-year profits. Using firm-specific fixed effects in this differences equation is the equivalent to including firm-specific linear times trends in the levels model. This eliminates firm-specific differences in the average growth rate. Identification therefore comes from within-firm changes in the growth rate of profit, eliminating between-firm variation in the level of the growth rate of profit. I control for base year profits using either the log of base year profits or a ten-piece spline of log base-year profit. The main aim of including controls in base year profits is to control for the strong possibility of mean reversion. This is especially important for profits since they are commonly thought to be mean reverting (De Bondt and Thaler, 1989; Canarella et al., 2013). All variables are expressed in real terms to control for inflation-induced common shocks.

As usual, there is mechanical endogeneity present. The corporate tax rate a firm faces is determined by the firm's profits. To deal with this endogeneity, I adapt the standard instrumental variable strategy of Gruber and Saez (2002), which is also applied to public corporations in Gruber and Rauh (2007). For year $s+1$, I calculate the tax rate that the firm would have faced if it made the same profits as at time s, but using the tax schedule as at time $s+1$. This predicted tax rate t^P allows tax policy to vary, holding profits constant. This means the instrument will be zero whenever the statutory tax schedule is unchanged, but non-zero when the government makes a policy intervention. The first-stage regression is therefore:

$$\log\left(\frac{1-t_{is+1}}{1-t_{is}}\right) = \alpha \cdot \log\left(\frac{1-t^P_{is+1}}{1-t_{is}}\right) + \delta_i + f(\pi_{is}) + \epsilon_{is}. \tag{20}$$

This first stage regression limits the identifying variation to tax rate changes that were induced by policy reform. All estimates are weighted by real sales so that estimates are effectively dollar-weighted. Note that sales are winsorized at the 95th percentile within each year to ensure that very large firms do not have an outsized impact on the estimates. All standard errors are clustered at the firm level. The results of this estimation are given in Table 6.

Table 1: Estimate of Tax Elasticity using Temporal Variation from 1950 to 1991

	1 Year		2 Year		3 Year	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \ln(1-\tau)$	0.381***	0.246**	0.501***	0.390***	0.527***	0.427***
	(0.097)	(0.097)	(0.092)	(0.093)	(0.095)	(0.095)
Base-Year Profit	Log	Spline	Log	Spline	Log	Spline
Observations	109,216	109,216	98,932	98,932	90,850	90,850
R^2	0.216	0.250	0.294	0.316	0.342	0.356

Notes: Standard errors in parentheses. Standard errors are clustered at the firm level. Regressions include firm-level fixed effects. Statistical significance is given by *** p< 0.01, ** p< 0.05, and * p< 0.1.

The results suggest a net-of-tax elasticity of profits between 0.246 in the short run to 0.527 in the long run. Adding non-linear base year profit controls reduces the size of the estimated tax elasticities at each difference length. Previous works on tax elasticities have frequently found estimates to be sensitive to the choice of base-year controls.

Importantly, long-run responses are higher than short-run responses as you might intuitively expect. Using longer differences (beyond a one-year difference) is important. Not only does it capture medium- or long-run responses, but it also allows us to consider cases where tax reform occurred over a period of more than one year. Multi-year reforms occurred from 1964 to 1965, 1970 to 1971, 1982 to 1984, and 1986 to 1988. The longest multi-year reform was three years. As per Weber (2014), long-differences are one way to encompass the response to multi-year reforms. One concern, however, is that they might capture overlapping responses. For example, the three-year difference from 1984 to 1986 captures the difference between the response to the 1984 reform and the response to the 1986 reform. On the other hand, one-year responses capture only the initial response to taxation, ignoring potential longer-run responses. At the same time, it might pick up second- or third-year responses for other tax changes.

A conservative estimate of the long-run response to changes in the corporate tax rate is that a 1 percent increase in the net-of-tax rate would lead to a 0.427 percent increase in taxable income for United States public corporations over a period of three years. In the short run, we would expect that 1 percent increase in the net-of-tax rate to lead to a 0.246 percent increase in profits in the first year.

1993 Reform I use the 1993 reform to add graphical evidence of these estimated elasticities. In 1993, a new category of taxation was created for the largest firms, with profits over \$18.3 million being taxed at 35 percent, up from the previous marginal tax rate of 34 percent.

I adopt the share-based approach outlined by Saez et al. (2012) and used by Saez (2017) for the 2013 increase in the capital income tax rate. I consider this the simplest methodology given the typically noisy nature of both aggregate and firm-level corporate profit. The methodology proposes to measure the short-run elasticity of taxable income by using the share of income going to the top earners affected by the tax rate reform. In this case, the top earners are those firms whose profits exceed \$18.3 million. The elasticity simply compares the share of income going to firms in the top tax band before and after the tax reform. It is measured as:

$$e_S = \frac{\log(sh_{1993}) - \log(sh_{1992})}{\log(1 - t_{1993}) - \log(1 - t_{1992})} \tag{21}$$

That is, it is the difference in the logged share of profits above \$18.3 million from 1992 to 1993 divided by the change in the logged net of tax rate. This would provide an unbiased estimate if the assumption holds that the share of income above \$18.3 million had remained the same in the absence of the tax reform. If this identification assumption holds then the elasticity e_S should capture the effect of the tax rate reform on the log change in income. The substantial benefit of this approach is that it controls for changes in economic activity. Profits are particularly volatile and sensitive to the business cycle. The relative stability of shares allows for easier and more convincing inference. One concern with this approach is that firms with profits above $18.3 million do account for an enormous share of the total profits of public corporations even though they only accounted for 24 percent of the number of public corporations in 1993.

The share of profits in the range above $18.3 million decreased from 96.58 percent in 1992 to 96.00 percent in 1993. This appears small, but this is in response to a 1 percentage point increase in the marginal tax rate from 34 to 35 percent. It therefore implies a short-run tax elasticity of 0.396 using the 1993 corporate tax reform. This behavioural response is shown in Figure 3, captured by the grey shading. Closer inspection of the chart suggests firstly that the reform only had a short-run impact, as the share quickly reversed course. This simple share-based method for the 1993 corporate tax reform provides confirmation that the previous estimates for the 1950 to 1992 period are convincing.

The line represents the share of total profit of all firms in Compustat going to firms with profits over $18.3 million. The grey column represents the period of change under investigation: from the tax rate schedule in 1992 to the new schedule in 1993.

Figure 3: Share of Profits of Public Corporations in the Tax Band Above $18.3 Million

Comparison to Existing Estimates Seegert et al. (2018) find an elasticity of 0.55 using a bunching estimator on data for the population of private United States corporations from the Internal Revenue Service (IRS). They use variation in the net operating losses faced by firms to estimate the elasticity over a 10-year period from 2004 to 2014.

While private corporations are typically smaller than public corporations, the number of public corporations is only 0.5% of all C-corporations in IRS data during that period. Using temporal variation with standard regression methods, I find a short-run elasticity of 0.246 and a long-run elasticity reaching 0.527 with data from 1950 to 1991. Using a simple and transparent share-based approach for the largest 24 percent of United States public corporations, I find a short-run elasticity of 0.396.

Gruber and Rauh (2007) provide an early estimate of the elasticity for public corporations in the United States. They use cross-sectional variation in the tax rate between industries that arises because some firms make profits and face a positive marginal (statutory) tax rate and other make losses and therefore face a zero marginal tax rate. Their definition of profit is quite different, since they do not remove interest payments from total profits. They find a large but statistically insignificant (imprecisely estimated) elasticity of 1.122. This elasticity is not the central result in their paper.

4.2 Public Input Elasticity of Profits

Economic research has mainly focused on estimating the elasticity of *output* with respect to public inputs. This is a broader measure of the provision of the public input on the entire economy, rather than simply on the returns to corporations. This literature was made popular by Aschauer (1989). A meta-study by Bom and Ligthart (2014b) combines 578 estimates of the public input elasticity of output from 68 studies from 1983 to 2008 focusing on OECD countries. These studies typically focus on the tangible capital stock owned by the public sector. This may be measured at different levels of government, from central government to the local or regional level. Other studies focus on only 'core' public capital—roads, railways, airports, and utilities. The assumption is made that public services flow to firms in proportion to the level of installed public capital. Output is usually an aggregate measure such as real GDP less public sector output. This is used because public capital is also an aggregate measure. The average elasticity of output in these studies is 0.106, correcting for publication bias. The short-run elasticity is smaller at 0.083, but considering only core capital installed by local government raises the elasticity to 0.154. Further extending this measure to the long run raises the estimated elasticity a bit further to 0.193. Using a standard Cobb-Douglas production function, these elasticities represent the share of output generated by the public input. If most of the returns to the public input are captured by profits, and profits make up a small portion of total output, then one might expect that returns to the public input actually make up a substantial portion of profits.

I take a simple approach to the estimation of the public input elasticity of profits. As in the theoretical model, I express profits as a function of public inputs. I do not control for private capital because I require the total derivative. I estimate the model in natural logs for simplicity. The estimated equation is

$$\log(\pi_{is}) = \alpha_i + e^G \cdot \log(G_s) + u_{is} \tag{22}$$

I also estimate an auxiliary model with a single intercept so that $\alpha_i = \alpha \ \forall i$. Identification of the public input elasticity comes from temporal variation in the public input.

I use data on firm-level domestic profit from Compustat. Using domestic profits shrinks the sample size substantially, but allows for clear estimation of the correct public input elasticity. As in most of the literature discussed in Bom and Ligthart (2014b), I assume that public services flow from public capital in proportion to the stock of public capital. I use the stock of public capital as the measure of the public input. All variables are expressed in real values.

To measure the public capital stock, I follow the methodology of Kamps (2006) and Gupta et al. (2014) used by the International Monetary Fund's Fiscal Affairs Department to produce the Investment and Capital Stock Dataset. The IMF (2017) manual describes the perpetual inventory equation:

$$G_{s+1} = (1 - \delta_s)G_s + \left(1 - \frac{\delta_s}{2}\right) I_s \tag{23}$$

where δ_s is the time-varying rate of depreciation and I_s is new investment in public capital. To measure new investment, I use data for gross federal government fixed non-defence investment. To estimate this measure of the public capital stock, the International Monetary Fund assumes that the public capital stock is zero in the year 1860 and that investment grew by 4 percent a year to reach its five-year-forward moving average in the first year of data available. The first year of data available is 1929. I alter this assumption slightly, setting the capital stock equal to zero in 1790, as the first United States Secretary of the Treasury, Alexander Hamilton, was sworn in during 1789. While the International Monetary Fund uses 1860 for consistency across countries, I do not require cross-country consistency. Private capital is measured as gross property, plant and equipment. All variables are deflated by the Consumer Price Index (1982-

1984=100).

I consider the possibility of changes in both public capital and profits being driven by the business cycle. To control for this possibility, I use the lag of public capital as an instrument for public capital. With public investment usually being decided in the preceding year, using the lag of public capital as an instrument would mean that public investment is determined a full two years in advance of profits being realised.

In addition, I consider the possibility that there is some sample selection bias for those firms which report domestic profits. In Figure 5 I plot the real average profits, sales, total assets, and plant, property, and equipment for each firm. I separate the plot into two histograms to consider whether the distribution of the size of firms that report domestic profits is different from the distribution of the size of firms that do not. To control for the possibility of selection bias being incurred by the fact that larger firms may be more likely to report more detailed figures, I re-weight the sample. I put each firm into a bin that reflects the interaction of the decile of total assets and the decile of sales for each year. I split the bins into firms that report domestic profits (Dom=1) and firms that do not (Dom=0). Suppose that a bin q contains n_q firms in year s. Then the weight for each bin q in period s is calculated as:

$$w_q = \frac{n_q(\text{Dom=0}) + n_q(\text{Dom=1})}{n_q(\text{Dom=1})}. \tag{24}$$

This re-weights the sample so that the distribution of firms reporting domestic profits matches the overall distribution of firms. I define the distribution on the interaction of total assets and sales. This re-weighting is done within each year.

The results of the estimation are presented in Table 2. All estimates are weighted by real sales, which are winsorized at the 95th percentile for each year. Note that for the re-weighted specification I multiply the binned weight by real winsorized sales.

The results of this estimation are given in Table 2. Three main estimates are presented: without firm fixed effects, with firm fixed effects, and with firm fixed effects and the instrumental variable, and re-weighted with firm fixed effects. The estimated elasticities range from 0.535 to 0.739. Adding firm fixed effects so as to consider only within-firm variation increases the estimated elasticity from 0.535 to 0.653. Using the lag of public capital as an instrument reduces the elasticity only marginally to 0.647. Re-weighting the estimates so that the distribution of firms reporting domestic profits matches the overall distribution of firms in Compustat, I retrieve a higher elasticity of 0.739. These estimates suggest that public capital plays a substantial role in gener-

Table 2: Public Input Elasticity of Profits for U.S. Public Corporations

	(1)	(2)	(3)	(4)
$\ln(G)$	0.535***	0.653***	0.645***	0.739***
	(0.084)	(0.068)	(0.068)	(0.068)
Fixed Effects		Yes	Yes	Yes
IV			Yes	
Reweighted				Yes
Observations	34,051	34,051	33,026	33,026
R^2	0.014	0.852	0.852	0.861

Notes: Fixed effects, when included, are firm fixed effects. When included, the instrument used for public capital is the one-year lag of public capital. All estimates are weighted by real sales, winsorized each year at the 95th percentile. Standard errors in parentheses. Standard errors are clustered at the firm level. Statistical significance is given by *** p< 0.01, ** p< 0.05, and * p< 0.1.

ating corporate profits. I now consider whether these corporation-level estimates are corroborated by aggregate elasticities.

Aggregate Evidence To confirm whether these firm-level estimates for public corporations are plausible, I estimate an aggregate version of the model. I use quarterly data from the Federal Reserve Bank of St. Louis' Economic Database. I calculate the quarterly public capital stock using the quarterly version of the perpetual inventory equation. I estimate a model similar to the firm-level model:

$$\log(\Pi_s) = \alpha + e^G \cdot \log(G_s) + u_s \tag{25}$$

I lag public capital by 1, 4, 8, and 12 quarters to eliminate concerns that both profits and public capital are affected by the business cycle. Results are shown in Table 3.

The aggregate public input elasticity estimated using this simple method is quite similar to that estimated using firm-level Compustat data. Using the contemporaneous of public capital gives an estimated elasticity of 0.611. Lagging the value of public capital reduces the estimated elasticity. Using a 12-quarter (3-year) lag, the elasticity falls to 0.544. This range is quite nearly the same as those estimated using firm-level data. These aggregate estimates appear to corroborate the firm-level finding that the

Table 3: Aggregate Time Series Estimate of the Public Input Elasticity

	(1)	(2)	(3)	(4)	(5)
$\ln(G)$	0.611***	0.608***	0.587***	0.560***	0.544***
	(0.033)	(0.034)	(0.035)	(0.036)	(0.037)
Lag of G	0 periods	1 periods	4 periods	8 periods	12 periods
Observations	232	231	228	224	220
R^2	0.592	0.588	0.561	0.526	0.503

Notes: Regressions are estimated using quarterly data from the Federal Reserve Bank of St Louis Economic Database. A constant is included in all regressions but the coefficient is excluded. Standard errors in parentheses. Statistical significance is given by *** p< 0.01, ** p< 0.05, and * p< 0.1.

public input elasticity of profits is economically quite large.

Consider also the average public capital elasticity of output of 0.106 from Bom and Ligthart's (2014a) review of 68 studies with 578 estimates. If we make the assumption of a well-behaved constant returns to scale aggregate production function, we can use the shares of total output accruing to factors to make some statement about the relevant elasticity of output. To move to an elasticity of profit, we need to make the additional assumption that all rents from the public input accrue to profits. This may be a somewhat ambitious assumption since workers may also benefit to some extent from the public input. However, it would mean that the average public capital elasticity of output from Bom and Ligthart (2014a) acts as an upper bound. With this assumption, I propose that the public input elasticity of profits can be recovered from the ratio of the public capital elasticity of output (σ) divided by total before-tax corporate profitability (π/Y):

$$e^G = \frac{\sigma}{\pi/Y}. \tag{26}$$

To approximate before-tax corporate profitability, I use data on the aggregate profit per unit of real gross value added of non-financial corporate business in the United Stated from the United States Bureau of Economic Analysis. At the peak, corporate profitability in the United States amounted to 15.7 percent of corporate output in 2014. Assuming a Cobb-Douglas production function with constant returns to scale would imply that 10.6 percent of total output are actually returns to the public input. That would imply a public input elasticity of profits of $0.106 \div 0.157 = 0.675$. Once again, this is very similar to the estimated public input elasticity of profits for public corporations.

Average corporate profitability from the first quarter of 2010 to the first quarter of 2019 has been lower, at 13.6 percent. This would give an even higher implied public input elasticity. Further, notice that Bom and Ligthart (2014a) finds substantial heterogeneity in the average elasticity—an average short-run elasticity of 0.083, and an average long-run elasticity of 0.122. Restricting the sample to only studies for the United States, the average elasticity actually increases to 0.133. This would imply an even higher public input elasticity of profits of $0.133 \div 0.157 = 0.847$. This reflects an upper bound on the public input elasticity of profits—one which the firm-level estimates do not breach. The extent to which this should be dampened would depend on the extent to which other factors of production—particularly labour—manage to extract rents that are due to the public input. This exercise justifies the magnitude of the public input elasticities I uncover using firm-level data. Together, these aggregate findings provide substantial confidence in the estimated public input elasticity.

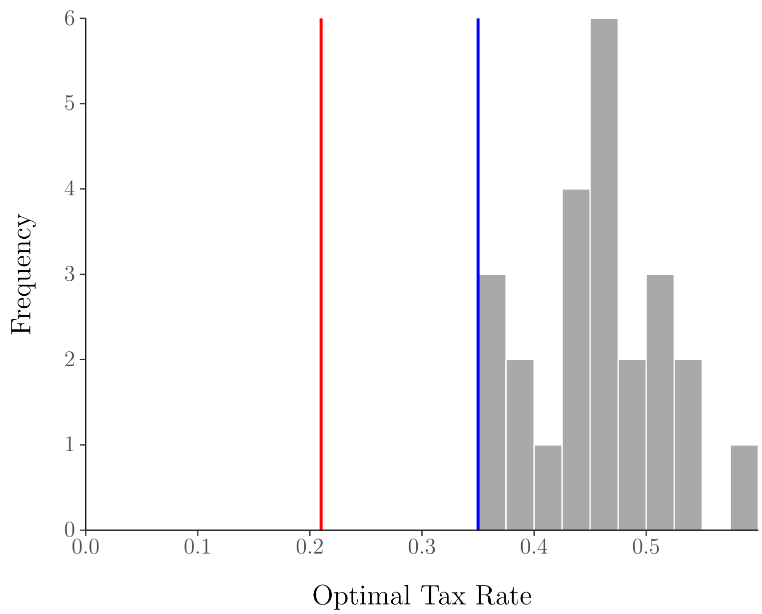
4.3 Estimated Optimal Tax Rates

In December 2017, the United States Congress passed the Tax Cuts and Jobs Act of 2017. This bill substantially lowered the top corporate tax rate from 35 percent to 21 percent. Note that under the previous corporate tax schedule, the average tax rate for firms over $18.3 million was equal to the 35 percent marginal tax rate. Many argued both for and against this lower corporate tax rate, mostly on the grounds of the impact it would have on investment and wages. A few discussed the normative underpinnings of the corporate income tax and whether the tax was being used to fulfil a purpose. I focus on deepening the normative discussion by applying the benefit principle to the Unites States tax reform.

I focus on the optimal tax rate for one type of firm—public corporations. Public corporations generate the largest proportion of revenue as they are the biggest and most visible corporations. The corporate tax rate on these firms is likely to have the greatest impact on revenue and on public perception of the fairness of the corporate tax. This optimal tax analysis only holds for public corporations. The estimated elasticities can be used to give guidance as to what an optimal benefit-based corporate income tax rate would look like in the United States. I do this by applying the elasticities to the optimal tax formula to public corporations. This analysis treats public corporations as an individual firm type.

The preferred estimate of the tax elasticity is the longer run (three-year differences) estimate with a log-spline of base-year profits: 0.427. The preferred estimate of the public input elasticity is the within-firm estimate without the instrumental variable: 0.653. These are both estimated using the Compustat firm-level data for public corporations. Plugging these estimated elasticities into the optimal tax formula gives a preferred estimate of the optimal benefit-based corporate income tax rate of $t^* = 0.653/(1 + 0.427) = 46$ percent.

To present a range of estimated tax rates, I use all combinations of the public input elasticity and the tax elasticity in the optimal tax formula. The resulting histogram of 18 estimated optimal tax rates are presented in Figure 4. This should provide a plausible range for the optimal benefit-based tax on public corporations in the United States.



The blue line represents the pre-reform top corporate tax rate of 35 percent. The red line represents the post-2017 reform rate of 21 percent. This histogram shows the estimated optimal benefit-based corporate tax rate for all the combinations of tax and public input elasticities.

Figure 4: Histogram of Estimates of Optimal Benefit-Based Tax in the United States

Strikingly, these estimated optimal benefit-based tax rates are all above the pre-reform corporate tax rate of 35 percent. They range from 35.0 percent to 59.3 percent. The median estimate is substantially higher at 46.1 percent. This suggests that the pre-reform rate was actually a lower bound on an data-driven benefit-based tax rate. The clear implication of these estimates is that large public corporations' 'fair share' of tax is actually a much larger proportion of their profits than they currently pay in tax.

In contrast, a simple revenue-maximising tax rate would be calculated as $1/(1 + e^T) = 70$ percent. To justify the tax rate cut to 21 percent as revenue-maximising, the tax elasticity would need to be in the range of 3.8. This is near the magnitude of elasticity uncovered by Bachas and Soto (2018) for Costa Rica, a developing economy with poor tax enforcement. In contrast, if we hold the tax elasticity fixed at 0.427, the public input elasticity would need to be approximately 0.30—around half the estimated value—to justify the 2017 tax rate cut to 21 percent.

5 Design of the Corporate Tax System

The debate on the optimal design of the corporate income tax commonly encompasses four policy questions. First, which country should have taxing rights over multinational firms' profits? Second, what should be the corporate income tax base? Third, is profit shifting good or bad? Fourth, what is the optimal tax rate? The question of the optimal tax rate is already the central focus of this paper. But the principle of benefit-based taxation can also be used to provide guidance on how to answer the other three questions.

5.1 Taxing Rights

Benefits-based taxation makes a direct link between the use of a specific government's public input and taxing rights it bestows on that government. If Firm A's profits are generated by the use of Government A's public inputs, then it gives Government A taxing rights over the profits generated using Government A's public input. But if Firm A's profits are not generated by the use of the public input of Government B, then what claim does Government B have over firm A's profits? Government B provides no benefits to Firm A.

Public inputs generate profits by their use in the production process. Therefore the use of the public input is reflected in the location of the profit-generating *production*. Public inputs are almost entirely immobile. I ignore the possibility of public goods with spillover effects for broad applicability and simplicity. Some works that consider this possibility include Koide (1985), Bjorvatn and Schjelderup (2002) and Bloch and Zenginobuz (2007). The use and benefit of the public good of Government B is limited to the geographical jurisdiction of Government B. The geographical jurisdiction of

Government B is the link between the benefits of the public input and the taxing rights of the government.

This implies that taxing rights of a government should be limited to profit-generating production taking place within its borders. This is a re-statement of the source principle of international taxation. The source principle of taxation is implemented by the territorial tax system. A territorial tax system does not tax foreign income. Instead, a territorial tax system will tax only profits generated from production within the country's borders, disregarding questions of firm ownership or firm nationality. In this sense, benefit taxation is a matter of cross-country equity. Benefit taxation makes a very clear statement about who should receive the returns to the public input (the government) and which country should be able to tax those returns (the country of production).

Benefits-based taxation provides strong normative support for the source-based principle of corporate taxation. Kane (2015) writes that "A more promising route is to rely on the distinguishing feature of whether the rent is a return on sovereign investment. This has the advantage that if we define the category in this way then the taxing right is clear. It should be allocated to only the sovereign that made the investment." Given the widespread views aligning with the benefit principle, it is unsurprising that the territorial tax system is the most common corporate tax system in the world today.

In contrast, the residence principle of taxation gives rise to a worldwide tax system that taxes profits made abroad. Focusing purely on economic efficiency, Devereux et al. (2015) show that a worldwide tax system is optimal whether you wish to achieve national or global optimality. This follows the classical results of international tax theory, which propose taxing the worldwide income of home multinational firms to ensure the global allocation of capital remains undistorted (Musgrave, 1963). But governments are disregarding this advice, moving towards territorial tax systems. Devereux et al. (2015) suggest it is either the lower administrative cost or the mobility of firm residence that is causing governments to shift to the territorial tax system.

The benefit principle provides a normative argument why taxing rights should not be assigned to where consumption takes place. With the existence of public inputs, the destination-based tax system transfers taxing power from the country of production to the country of consumption. Under the destination-based tax system, a government would not have taxing rights over the returns to its public input. The destination of final sale of a commodity only creates taxing rights to the extent that value is created in that country by the retail process. That is, the government should have the right to tax the profits of the retail sector to the extent that its profits rely on the public input. In practice, however, note that the profit margins of the retail industries are consistently among the lowest globally. This argument holds for the accounting services provided by tax havens—their taxing rights should extend only to the economic activity generated within that jurisdiction.

5.2 Tax Base

The central prediction of the classical benefit principle is that the tax should aim to capture benefits from (or returns to) the public input. It implies that in an ideal world, the corporate tax base should be narrowly defined as returns to the public input. A tax base narrowly defined as returns to the public input would imply a 100 percent tax rate and would be non-distortionary. This ideal is very difficult to achieve. Returns to the public input do not appear as a line item in the firm's income statement. There is no easy way to separate various forms of location-specific rents, or even to separate mobile rents from immobile rents (Graetz, 2000; Auerbach and Devereux, 2018). In fact, most tax systems do not separate rents from normal returns to capital.

In this paper, the tax base has been modelled as the sum of the normal and supernormal returns to equity capital. This reflects the standard corporate tax system across most countries. In this model, what would be the optimal corporate tax base? as is standard, I use α to reflect the corporate tax base where $0 \leq \alpha \leq 1$. However, this is a somewhat narrower definition than in the literature, where α tends to denote the deductibility of debt interest costs and returns to equity. Here, I focus on returns to equity only, considering whether these are deductible or not. If $\alpha = 1$, then the normal returns to equity are fully deductible from taxable income. If $\alpha = 0$ then the normal returns to equity are fully taxed as is standard. I insist the normal returns to equity accrue to the firm as happens in reality. Therefore the normal returns must be added back to the firm's total income after taxable income is calculated by deducting it. The firm's profit function is now:

$$\max_{k_i} \quad (1 - t_i)[\pi(k_i, G) - \alpha rk] + \alpha rk + r(K_i - k_i). \tag{27}$$

And the first-order condition for capital is now:

$$\frac{\partial \pi_i(k_i, G)}{\partial k_i} = r\frac{(1 - \alpha t_i)}{(1 - t_i)}. \tag{28}$$

In the case where $\alpha = 1$, this condition reduces to $\partial \pi_i(k_i, G)/\partial k_i = r$ and the corporate income tax does not have a distorting impact on the allocation of capital. Where $\alpha = 0$, we get the original first-order condition from Equation 2. This alters the final optimal tax formula substantially. Now $e^T = 0$, so that the corporate income tax has no behavioural impact on the profit of the firm. Holding the primitives of the firm's profit function constant, the optimal benefit-based tax rate would now be higher for all firms. The modified Samuelson condition in Equation 17 tells us that the optimal provision of public inputs would now be higher. This suggests fully offsetting the normal returns to equity would move us to a first-best Lindahl equilibrium by making the corporate income tax non-distorting.

This will not hold perfectly in reality due to the existence of unobservable firm-specific assets. These are also an important source of rents, particularly for multinational firms. The importance of the firm-specific asset dates back to Dunning (1988), and has recently been incorporated by both McKeehan and Zodrow (2017) and Auerbach and Devereux (2018). For a firm that can earn rents on such firm-specific capital in another jurisdiction, the corporate income tax remains distorting.

Consider a firm endowed with a limited quantity of an unobservable firm-specific asset $\bar{M}$ that is internationally mobile. The firm can invest m_i of that asset in the country under analysis or it can invest that asset overseas and earn a rate of return w. Because the asset is unobservable, there is no way to distinguish returns to the firm-specific asset and returns to the public input. The firm's income is given by:

$$\max_{k_i, m_i} \quad (1 - t_i)[\pi(k_i, m_i, G) - \alpha r k] + \alpha r k + r(K_i - k_i) + w(\bar{M} - m_i). \tag{29}$$

The firm's first-order condition for capital remains the same, but it now has to make a decision over the firm-specific asset:

$$(1 - t_i)\frac{\partial \pi_i(k_i, m_i, G)}{\partial m_i} - w = 0. \tag{30}$$

Theoretically, only a single distortion remains if returns to equity capital are fully deductible. The only potential offsetting feature is the second-order effect of m_i on k_i and vice-versa through the cross-partial derivatives (complementarity or substitutability of factors). Practically, however, the distortion is now limited to a very small number of firms, but likely large firms. And the distortion of the tax is limited to only one factor. And if the firm-specific asset is a good whose supply is not limited—like ideas, intellectual property, reputation—then there should be no distortion.

Therefore, we can at least propose that the benefit principle implies that the tax base should be narrowly defined. Since the purpose of the corporate tax under the benefit principle is not to tax capital owners, then the normal returns to capital should be excluded from the tax base. This would eliminate an economically significant distortion that plagues the use of the corporate income tax under existing tax regimes. Importantly, we know how to separate rents from the normal returns to capital. Many authors have dealt with this issue including Meade (1978); King (1987); Bond et al. (1996) and Bond and Devereux (2003). The cash flow tax, allowance for corporate equity or the rate of return allowance tax systems would achieve a tax on economic rent (Cnossen, 2018).

In the model, the tax base has been defined as accounting profits: normal returns to capital plus total rents, mobile and immobile. Narrowing the tax base would change the definition of the elasticity to be estimated since the definition of profits would change. It would not, however, alter the optimal tax formula itself or the key principles underlying the benefit principle. Policy reform to limit the base of the corporate income tax to rents is supported by the benefit principle of taxation.

5.3 Profit Shifting

An important question that has been taken for granted is whether there is actually a significant economic argument against profit shifting. Consider that the corporate tax distorts real economic activity. Profit shifting—by reducing corporate tax liability—limits the real economic distortion of the corporate tax. Profit shifting also reduces the tax burden on mobile factors and makes real investment decisions less sensitive to tax rates (Hong and Smart, 2010). Empirically, Suárez Serrato (2018) shows that closing profit shifting loopholes substantially increased the distorting effects of corporate taxation, as firms reduce investment and employment in non-haven countries. Liu and De Mooij (2018) find that multinational firms reduce domestic investment after the introduction of transfer pricing regulations, effectively increasing the corporate tax burden of the firm. So what is the economic argument against profit shifting?

Slemrod and Wilson (2009) model tax havens as 'parasites' in order to justify initiatives against them. As is standard, they assume that there is some cost to profit shifting. The firm optimises profit shifting behaviour where the benefit of shifting an extra dollar of profit is equal to the cost of shifting an extra dollar. Slemrod and Wilson

(2009) assume that the entirety of the cost of profit shifting is deadweight loss. However, as modelled by Devereux et al. (2008), if the cost of profit shifting is a probability of being caught and fined, this does not imply substantial deadweight loss. Further, Chetty (2009) clarifies that a government fine is not a deadweight loss, but simply a resource transfer from firm to government. Combining the inefficiency-reducing effects of profit shifting with limited deadweight costs resulting from profit shifting, it seems near impossible to justify the OECD/G20 Base Erosion and Profit Shifting Action Plan purely on efficiency grounds.

The OECD/G20 Base Erosion and Profit Shifting Action (2013) emphasises three key problems created by profit shifting. First, governments are faced with lower corporate tax revenue, particularly in developing countries. Second, individual taxpayers are forced to bear a greater portion of the tax burden as a result. Third, profit shifting creates unfair competition as some firms can shift profits to minimise their tax liability while others can not.

The benefit principle instead approaches the question from a normative perspective of fairness. If the purpose of paying corporate income tax is to support the provision of public inputs that are used to generate profits, then profit shifting is bad because it allows firms to escape contributing to the provision of the public input. Even more compelling is the insight that under the benefit principle, firms are not even paying tax out of their share of the returns to production—they are merely handing over the returns that should rightly accrue to the owner of the public input: the government. This casts profit-shifting multinationals not just as doing what is best for themselves, but as engaging in a socially egregious activity that undermines the fabric of modern capitalist society. Previous works have implicitly identified this underlying normative principle. Haufler and Schjelderup (1999) examine how multinationals' evasion of responsibility leads to under-provision of the public input. Pogge and Mehta (2016b) focus on how profit shifting allows multinational firms to escape contributing to the provision of wider public goods in developing countries—impoverishing them further.

The simple thesis that firms should contribute to the public input in accordance with the benefits they receive from that public input is a strong argument that profit shifting is normatively wrong. This thesis places responsibility for provision of the public input squarely on the firm. Using the benefit principle, the effect of profit shifting on global efficiency does not justify the inter-country inequity generated by profit shifting activity. The benefit principle implies that profit shifting is normatively bad.

6 Conclusion

I apply the normative principle of benefit taxation to corporate income tax. A benefit-based corporate tax satisfies both the public and policy perceptions of fairness. It also satisfies within-country and inter-nation notions of equity. It is also feasible, even in a small open economy, because it relies on taxing location-specific rents.

I propose an optimal corporate income tax rate using the Lindahl (1919) approach to benefit taxation. I modify the Lindahl thought experiment to incorporate the distortionary effects of corporate taxation. The optimal benefit-based corporate tax rate formula is a function of two estimable elasticities: the elasticity of profit with respect to the public input, and the elasticity of profit with respect to the net-of-tax rate. The formula tells a simple story about the optimal benefit-based tax. A higher public input elasticity of profit implies a higher optimal tax rate because those who benefit more will be willing to pay more for the public input. A higher net-of-tax elasticity of profit implies a lower optimal tax rate because a larger behavioural response to taxation implies greater distortion.

The benefit principle proves to be helpful in providing guidance in the design of the international corporate tax system. Three simple principles arise. First, a government should have taxing rights over firm profits generated using its public input. Benefit taxation endorses the source principle of international taxation. Second, the optimal tax base is the benefits generated by the public input. Narrowing the tax base to economic rents would improve both fairness and efficiency. Third, profit shifting is unfair even if efficiency-enhancing. Profit shifting allows firms to avoid contributing to the provision of public inputs.

Rather than taking the existence of the corporate income tax as given, I begin from first principles and seek a justification for the existence of the corporate income tax. I argue that benefit-based taxation can justify the existence of the corporate income tax, and therefore the corporate tax should be implemented on a benefit basis. To show that this is implementable, I provide a optimal benefit-based corporate tax rate formula, and apply it to public corporations in the United States.

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A Derivation of the Optimal Benefit-Based Tax Formula

I derive the government's optimal conditions for maximising profits under the benefit-based tax. The first-order condition with respect to the public input is:

$$\begin{aligned}
(1-t_i)\frac{d\pi_i(k_i^*,g_i)}{dg_i} + \lambda\left(t_i\frac{d\pi_i(k_i^*,g_i)}{dg_i} - \tau_i\right) &= 0 \\
(1-t_i)e_i^G\frac{\pi_i}{g_i} + \lambda\left(t_i e_i^G\frac{\pi_i}{g_i} - \tau_i\right) &= 0 \\
(1-t_i)e_i^G\frac{\pi_i}{g_i} + \lambda\left(e_i^G - \frac{\tau_i g_i}{t_i\pi_i}\right) &= 0 \\
e_i^G\frac{(1-t_i)}{t_i} + \lambda\left(e_i^G - 1\right) &= 0 \\
\left(\frac{e_i^G}{1-e_i^G}\right)\left(\frac{1-t_i}{t_i}\right) &= \lambda. \qquad (31)
\end{aligned}$$

Note that this uses the government's firm-specific budget constraint to simplify $\tau_i g_i / t_i \pi_i = 1$. The first-order condition with respect to the net-of-tax rate is:

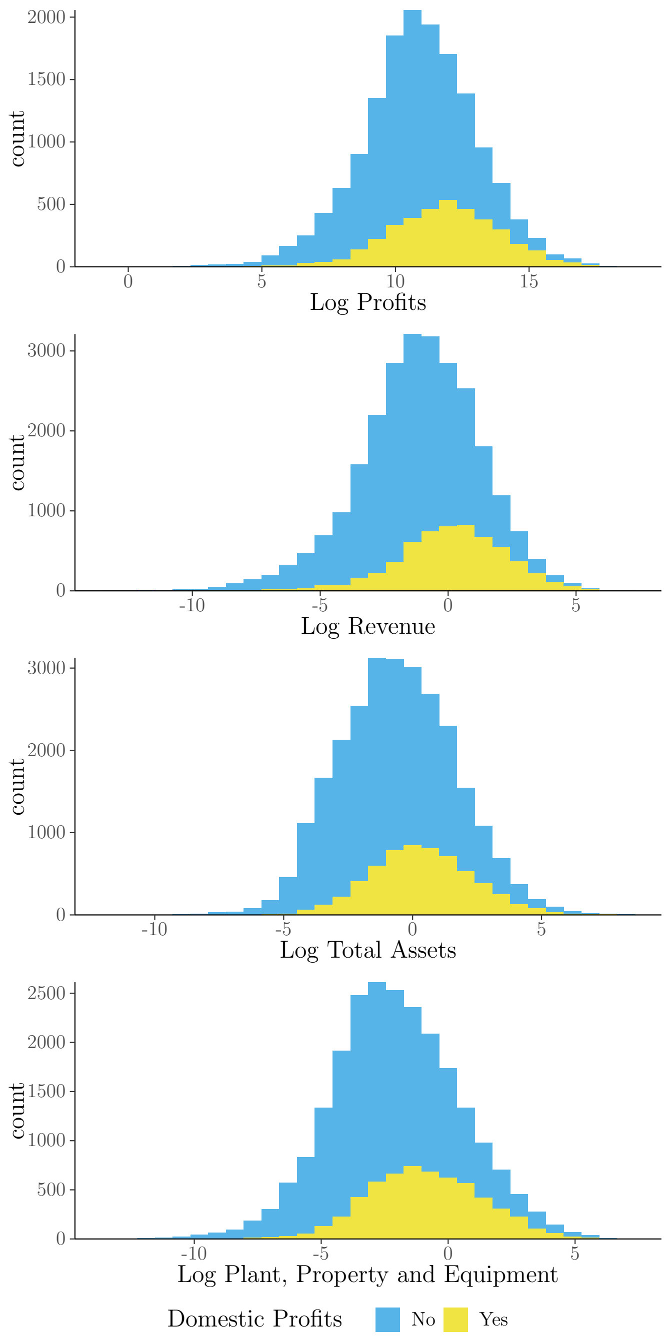
$$\begin{aligned}
\pi_i(k_i^*,g_i) + (1-t_i)\frac{\partial\pi_i(k_i^*,g_i)}{\partial(1-t_i)} + \lambda\left(-\pi_i(k_i^*,g_i) + t\frac{\partial\pi_i(k_i^*,g_i)}{\partial(1-t_i)}\right) &= 0 \\
\pi_i(k_i^*,g_i) - \pi_i(k_i^*,g_i)e_i^T + \lambda(-\pi(k_i^*,g_i) + \pi(k_i^*,g_i)e_i^T\frac{t_i}{1-t_i}) &= 0 \\
1 + e_i^T + \lambda\left(-1 + e_i^T\left(\frac{t_i}{1-t_i}\right)\right) &= 0 \\
\lambda &= \frac{1+e_i^T}{1-e_i^T\left(\frac{t_i}{1-t_i}\right)}. \qquad (32)
\end{aligned}$$

Combining these two conditions:

$$\begin{aligned}
\left(\frac{e_i^G}{1-e_i^G}\right)\left(\frac{1-t_i}{t_i}\right) &= \frac{1+e_i^T}{1-e_i^T\left(\frac{t_i}{1-t_i}\right)} \\
\frac{1-t_i}{t_i}\left(1-e_i^T\left(\frac{t_i}{1-t_i}\right)\right) &= (1+e_i^T)\left(\frac{1-e_i^G}{e_i^G}\right) \\
\frac{1-t_i}{t_i} - \frac{e_i^T t_i(1-t_i)}{t_i(1-t_i)} &= (1+e_i^T)\left(\frac{1-e_i^G}{e_i^G}\right)
\end{aligned}$$

$$
\begin{aligned}
\frac{1-t_i-e_i^T t_i}{t_i} &= (1+e_i^T)\left(\frac{1-e_i^G}{e_i^G}\right) \\
\frac{1-t_i(1+e_i^T)}{t_i(1+e_i^T)} &= \left(\frac{1-e_i^G}{e_i^G}\right) \\
\frac{1}{t_i(1+e_i^T)} &= 1+\left(\frac{1-e_i^G}{e_i^G}\right) \\
\frac{1}{t_i(1+e_i^T)} &= \left(\frac{e_i^G+1-e_i^G}{e_i^G}\right) \\
\frac{1}{t_i(1+e_i^T)} &= \left(\frac{1}{e_i^G}\right) \\
\frac{e_i^G}{1+e_i^T} &= t_i^* \qquad (33)
\end{aligned}
$$

B Additional Results



All values are deflated using the seasonally adjusted Consumer Price Index with 1982-1984=100. These are average real values for each firm.

Figure 5: Histograms of Average Differences Between Firms Reporting Domestic Profits or Not

Table 4: First-Stage Regression Results for Estimate of Tax Elasticity

	$\Delta \ln(1-\tau)$					
	1 Year		2 Year		3 Year	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \ln(1-\tau^P)$	0.996***	0.998***	0.995***	0.998***	0.995***	0.998***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Base-Year Profit	Log	Spline	Log	Spline	Log	Spline
Observations	109,216	109,216	98,932	98,932	90,850	90,850
R^2	0.924	0.944	0.964	0.975	0.975	0.982

Notes: The dependent variable is the actual marginal net of tax rate, while the regressor is the predicted marginal net of tax rate. Standard errors in parentheses. Standard errors are clustered at the firm level. Regressions include firm-level fixed effects. Statistical significance is given by *** p< 0.01, ** p< 0.05, and * p< 0.1.

Table 5: Estimate of Tax Elasticity using Sample of Firms Reporting Domestic Profits

	1 Year		2 Year		3 Year	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \ln(1-\tau)$	1.141***	1.197***	0.851***	0.879***	0.907***	0.880***
	(0.316)	(0.318)	(0.225)	(0.216)	(0.284)	(0.288)
Base-Year Profit	Log	Spline	Log	Spline	Log	Spline
Observations	4,849	4,849	3,685	3,685	2,805	2,805
R^2	0.600	0.610	0.722	0.727	0.798	0.801

Notes: Standard errors in parentheses. Standard errors are clustered at the firm level. Regressions include firm-level fixed effects. Statistical significance is given by *** p< 0.01, ** p< 0.05, and * p< 0.1.

Table 6: First-Stage Regression Results for Estimate of Tax Elasticity using Sample of Firms Reporting Domestic Profits

	$\Delta \ln(1-\tau)$					
	1 Year		2 Year		3 Year	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \ln(1-\tau^P)$	1.002***	1.000***	1.003***	1.000***	1.004***	1.000***
	(0.002)	(0.001)	(0.004)	(0.001)	(0.004)	(0.000)
Base-Year Profit	Log	Spline	Log	Spline	Log	Spline
Observations	4,849	4,849	3,685	3,685	2,805	2,805
R^2	0.976	0.984	0.992	0.996	0.997	0.998

Notes: The dependent variable is the actual marginal net of tax rate, while the regressor is the predicted marginal net of tax rate. Standard errors in parentheses. Standard errors are clustered at the firm level. Regressions include firm-level fixed effects. Statistical significance is given by *** p< 0.01, ** p< 0.05, and * p< 0.1.