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Working Paper The Sufficient Statistics Approach Applied to International Tax Policy

CESifo Working Paper, No. 11810

Provided in Cooperation with: Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Zoutman, Floris (2025) : The Sufficient Statistics Approach Applied to International Tax Policy, CESifo Working Paper, No. 11810, CESifo GmbH, Munich

This Version is available at: https://hdl.handle.net/10419/316924

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Impressum:

CESifo Working Papers ISSN 2364-1428 (electronic version) Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute Poschingerstr. 5, 81679 Munich, Germany Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de **Editor: Clemens Fuest** https://www.cesifo.org/en/wp An electronic version of the paper may be downloaded · from the SSRN website: www.SSRN.com www.RePEc.org • from the RePEc website: https://www.cesifo.org/en/wp · from the CESifo website:

The Sufficient Statistics Approach Applied To International Tax Policy*

Floris T. Zoutman[†]

April 11, 2025

Abstract

This paper extends the sufficient statistics approach to study international tax policy. International policy differs from domestic policies because i.) from the perspective of domestic policy makers the welfare weight on foreign agents lies below that of domestic agents, and ii.) behavioral changes by foreign agents have (general equilibrium) spillover effects on the domestic economy that are welfare relevant. I develop a tax model in which a domestic firm produces output by combining domestic and foreign inputs. Production also depends on the aggregate level of the foreign input, thereby generating a production externality. Factor prices are determined in general equilibrium by the interplay between the firm's demand for factors and the supply provided by foreign and domestic private agents. The firm is taxed based on its factor inputs and factor prices but can avoid taxation using a costly tax avoidance technology. The cost of avoidance partly depends on investment in tax administration. Welfare is defined as a weighted sum of tax revenue and the surpluses of private domestic and foreign agents. I examine the welfare effects of marginal increases in both the tax rate and tax administration. These effects decompose into contributions to the production and fiscal externality and to transfers between domestic agents and the government, as well as between foreign and domestic agents. The sufficient statistics needed for welfare analysis are the elasticity of taxable income, the elasticity of factor prices, and the elasticity of the foreign input with respect to the policy variable of interest.

JEL Codes: H26, F23

Keywords: International Tax Policy; Sufficient Statistics; Welfare Effects; Withholding Tax

^{*}For helpful discussions I would like to thank Kristoffer Berg, Evelina Gavrilova, Etienne Lehmann and Mohammed Mardan. In addition, I am grateful to the Research Council of Norway for funding under grant number 300955. *NHH Norwegian School of Economics: Department of Business Management Science, NoCeT and CESifo

1 Introduction

The sufficient statistics approach pioneered by Feldstein (1999) has become a cornerstone of policy evaluation in public finance. Its appeal lies in bridging the gap between complex optimal-tax models and reduced-form empirical methods, thereby linking empirical estimates to theoretical policy analysis (Chetty, 2009b).

Thus far, this focus has been predominantly on domestic policies. However, many public policies yield international consequences. For instance, numerous countries impose withholding taxes on foreign income, and recent interest in tariffs on imports has surged. Moreover, corporate taxes are known for generating international spillovers, as firms and investors operate globally. Additionally, initiatives such as the OECD BEPS action plan and policies like FATCA target international tax avoidance and evasion. Consequently, the research question addressed in this paper is: How can the welfare impacts of international (tax) policy be evaluated using sufficient statistics?

The welfare implications of international policies differ from domestic ones for at least three reasons. First, domestic policy makers often assign a lower welfare weight to foreign actors compared to domestic individuals and companies, making transfers from foreign to domestic parties desirable. Second, behavioral changes by foreign agents can create general equilibrium spillover effects through price adjustments affecting domestic actors. Third, foreign participation in the domestic economy may lead to production externalities, such as knowledge spillovers.

I contribute to the literature by building an optimal-tax model that combines domestic and foreign actors. I consider a domestic company which produces output by combining a domestic and a foreign input, for instance combining domestic labor with foreign capital. Factor prices are determined on a competitive market between the firm's demand for input, and domestic and foreign input factor suppliers. I allow for a production externality which drives a wedge between the social and the private return to the foreign input. I allow for a wide variety of policy settings requiring only that the firm's tax burden is a function of the amount of foreign and domestic inputs it employs, and of their respective factor prices.

This general formulation covers two principal cases. The first is a withholding tax or tariff on the foreign inputs, determined by the product of the input's quantity and its price. The second is a corporate tax that levies taxes on the firm's profits while disallowing cost deductions for the foreign input. I further incorporate tax avoidance by allowing for a tax avoidance technology, counterbalanced by government investments in tax administration in the spirit of Keen and Slemrod (2017). Welfare is measured as a weighted sum of tax revenue, profits of the firm, and the surplus of the suppliers of the domestic and foreign input. I explore how variation in the tax rate and tax administration affects welfare.

Policy variation influences welfare through three channels. First, it affects externalities, which can be divided into fiscal externalities — the tax revenue losses from behavioral responses (Hendren, 2016) — and production externalities. Second, policy variation causes transfers between domestic agents, foreign agents, and the government, the magnitude and direction of which depend partly on general equilibrium effects on prices. Third, policies may entail direct costs, such as increased spending on tax administration.

Three elasticities are crucial for assessing the welfare impacts of policy variations: (i) the elasticity of taxable income under (counterfactual) constant factor prices, (ii) the elasticity of factor prices, and (iii) the elasticity of the foreign input with respect to the policy variable. The first captures the impact on the fiscal externality, while the second and third account for the distributional burden via price adjustments and production externalities, respectively.

Related Literature The sufficient statistics approach to policy analysis was pioneered in Feldstein (1999). He shows that the elasticity of taxable income with respect to the net-of-tax rate is a sufficient statistic for determining the welfare effects of income taxation. The reasoning is based on an envelope-argument. In competitive markets the income tax distorts the behavior of market participants. However, their utility loss is second order. Only the fiscal externality generates a first-order welfare loss, and the fiscal externality is proportional to the elasticity of taxable income.

His argument has been extended to a variety of policies, and settings in Chetty (2009a,b) who respectively considers a setting in which income taxes generate spillovers to other tax bases, and policies different from income taxation such as unemployment insurance. Hendren (2016) provides the broadest generalization of the sufficient statistics approach, by showing that the policy elasticity, i.e. the effect of any policy on tax revenue, is a sufficient statistic for welfare analysis, as it directly captures the fiscal externality. Other key contributions that I build on in this paper are Keen and Slemrod (2017) which adapts the Feldstein (1999)-model by allowing the government to invest in stricter tax administration, and Devereux et al. (2014) which considers sufficient statistics in the context of corporate taxation.¹ So far the focus has mostly been on domestic applications.²

There exists a large literature that investigates the effect of international policies such as tariffs (e.g. Fajgelbaum et al. (2020); Grossman et al. (2024) for recent contributions) and international tax policy (e.g. Mongrain et al., 2023; Chodorow-Reich et al., 2024), but these studies rely on

¹Other recent contributions are Kleven (2021) who considers the case where sufficient statistics are themselves functions of policy, and Hendren and Sprung-Keyser (2020) who contribute by extending the sufficient statistics tradition into a unified, empirically driven Marginal Value of Public Funds framework, which measures the net present value of a policy's benefits and costs for direct cross-policy welfare comparisons.

 $^{^{2}}$ To my knowledge the only exception is a recent working paper by Berg (2025) who considers taxation of shareholder and corporate income, and allows pass-through of the burden of the corporate tax to international investors.

structural models rather than sufficient-statistics formulations for their welfare analysis. While structural models provide detailed insights into welfare effects, the sufficient-statistics approach focuses on a few key, directly estimable elasticities, offering a more straightforward connection to reduced-form empirical work.

2 Model

I consider an economy with a unit mass of firms whose behavior can be represented by a representative domestic firm. The representative firm transforms a foreign input k, along with a domestic input factor l into an output denoted by y. The canonical example is the case where k represents foreign capital, and l represents domestic labor, and I will use this terminology going forward, but I will sometimes comment on other use-cases. I introduce an externality by allowing production to depend on the aggregate amount of foreign capital employed in the economy, K, in the spirit of Romer (1986). Since each firm in the economy is assumed to be small, employing additional capital in a single firm has a negligible effect on aggregate capital. However, an increase in aggregate foreign capital affects productivity for all firms. This production process is formalized in a production for the representative firm given by:

$$y = F(k, l, K).$$

I make some assumptions on the production function to arrive at an internal equilibrium with (weakly) downwards sloping factor demand curves. The production function is increasing and concave in production factors, F_k , F_l , $-F_{kk}$, $-F_{ll} > 0$. In addition, I assume that the company faces (weakly) decreasing returns to scale for a given level of aggregate capital in the economy, $tF(k, l, K) \ge F(tk, tl, K)$ for all $t \ge 1$.

I allow the externality from foreign investment to either be positive or negative, $F_K \leq 0$. This is consistent with theoretical models, which consider both positive technological spillovers from foreign investment to domestic firms, as well as potential negative effects related to foreign competition, and with empirical studies that find support for both mechanisms (e.g. Markusen and Venables, 1999; Aitken and Harrison, 1999).

I normalize the price of output y to unity, such that y serves as the numeraire commodity in the model. The cost of firms depends on the rental rate for foreign capital r and the wage rate w. Factor prices are determined in a competitive equilibrium as described in the next subsection.

The government levies a tax of which the statutory burden falls on the firm. If the company is fully compliant its tax burden depends on the production factors it employs, and on their respective rental rates. To formalize this, let b denote broad income (i.e. taxable income under

full compliance). Broad income is given by:

$$b \equiv B(r, w, k, l, K).$$

To ensure the existence of an equilibrium I assume that $B(\cdot)$ is twice-differentiable. The tax rate that applies is denoted by τ .

This setup is sufficiently general to represent a large variety of tax settings. I will mainly focus on two cases that are relevant from an international tax policy perspective. Case 1 concerns a withholding tax on foreign income.

Case 1 A withholding tax on foreign income:

$$B(\cdot) = rk,\tag{1}$$

where the product between r and k represents the income that flows abroad. Most countries in the world levy withholding taxes on income that goes to foreign investors such as dividends and interests. For instance, the US raises a 30 percent withholding tax on dividends of shares held by foreign entities.³

Case 1 can also represent a tariff. In that case, k represents an input commodity used by the firm in production, and r represents the import price. With tariffs, it is perhaps less natural to consider externalities, but this is just a special case of the model in which $F_K = 0$.

Case 2 describes a corporate income tax:

Case 2 A corporate income tax with an input cost allowance for domestic labor :

$$B(\cdot) = F(k, l, K) - wl, \qquad (2)$$

Note that the tax base allows deductibility of cost associated with the domestic labor, but not for the cost of foreign capital following the typical setup of the corporate income tax.

I consider only taxes that apply to firms, ignoring taxes that fall on foreign investors or domestic workers. In the context of international taxation, it is reasonable to make this assumption, since

 $^{^{3}}$ In some cases those foreign entities can then deduct the withholding taxes they pay in their home jurisdiction. In that case, the burden of the tax can be shifted from the domestic firm to the foreign investor, and onwards to a foreign government similar to the spillovers discussed in Tørsløv et al. (2023). The analysis below continues to apply to this case, as long as the welfare weight the domestic government places on foreign investors is the same as the weight placed on foreign governments.

in most cases firms are either directly taxed (as is the case for the corporate tax), or they act as a withholding agent for the tax.

Firms have access to a costly tax-avoidance technology allowing them to reduce reported income by a fraction e. Hence, taxable income is given by $z \equiv (1 - e)b$. The cost of tax avoidance is given by $C(e, \alpha)$, where α is the strength of tax administration. I assume the cost of avoidance is convexly increasing in the fraction avoided, $C_e, C_{ee} > 0$. In addition, a stronger tax administration increases the cost of avoidance, $C_{e\alpha} > 0$. I follow Keen and Slemrod (2017) by interpreting C_{α} as the marginal increase in compliance cost when tax administration increases.

Firms maximize profits by choosing the optimal demand for input factors, and the fraction of income avoided e. Firms act as price-takers thus taking factor prices r, w, and the aggregate amount of capital employed within the country K as given. Combining all elements I arrive at the firm's maximization problem:

$$\pi(r, w, K; \tau, \alpha) \equiv \max_{k,l,e} F(k, l, K) - rk - wl - \tau(1 - e)B(r, w, k, l) - C(e, \alpha),$$
(3)

which describes the firm's surplus as a function of factor prices, aggregate capital and policy.

Foreign investors provide capital at opportunity cost H(k), which is assumed to be increasing and (weakly) convex. They take the capital-rental rate r as given. Hence, the surplus of foreign investors is given by:

$$v(r) \equiv \max_{k} rk - H(k).$$
(4)

This formulation can capture the case of a small open economy, in which the opportunity cost to investment for foreign investors is the world interest rate r^W , such that the the opportunity cost of supplying capital is given by $H(k) = r^W k$. In that case, foreign capital is only supplied if the rental rate $r \ge r^W$. For a large open economy, or when there are frictions in the market for capital, H(k) is strictly convex, and the supply of foreign capital is upward sloping in r.

Labor is supplied at opportunity cost L(l) which is also assumed to be increasing and convex. The surplus of workers is thus given by:

$$u(w) \equiv \max_{l} wl - L(l).$$
(5)

2.1 Equilibrium and Key Definitions

Equilibrium is attained when the demand for production factors equals supply, and the aggregate amount of foreign capital employed equals the amount of capital employed by the representative firm, k = K. The equilibrium depends on the policy parameters τ , α . I use functional notation

to denote equilibrium values. For instance, $k(\tau, \alpha)$ denotes the equilibrium amount of foreign capital employed in the economy.

In the sufficient statistics literature optimal-tax formulas are expressed in terms of elasticities. I will introduce these elasticities here. The 'regular' type of elasticity that appears in my model is:

$$E(m,\phi) \equiv \frac{\partial m(\tau,\alpha)}{\partial \phi} \frac{\phi}{m(\tau,\alpha)} \quad \text{for} \quad \phi \in \{1+\tau,\alpha\}, m \in \{r,w,k\}$$
(6)

where *m* represents an endogenous price or quantity variable in the model, and ϕ is a placeholder for either the gross-of-tax rate $1 + \tau$ or tax administration, α .⁴

The three key elasticities of this type that are important in this paper are the elasticity of the rental rate with capital, $E(r, \phi)$, the wage rate of workers $E(w, \phi)$ and the elasticity of foreign capital employed $E(k, \phi)$.

The other type of elasticity that plays a role is the elasticity of taxable income with respect to policy, ignoring the mechanical effect of factor prices r, w, and aggregate capital K on the tax base (henceforth, the elasticity of taxable income under constant factor prices):

$$E(z,\phi)|_{d(r,w,K)=0} \equiv \frac{\partial z}{\partial \phi}|_{d(r,w,K)=0} \frac{\phi}{z}.$$
(7)

⁵To understand why the elasticity of taxable income under constant factor prices is a key statistics note that changes in taxable income can be decomposed into i.) changes in decision variables of the company l, k, e, ii.) changes in variables that the from the perspective of the firm are exogenous, r, w, K. The fiscal externality of policy variation is the effect of policy variation on the tax base that results from behavioral changes by the firm (Hendren, 2016; Kleven, 2021). Since

$$\frac{\partial z}{\partial \phi} = \frac{\partial \left((1-e)B(\cdot) \right)}{\partial \phi},$$

$$= -B\frac{\partial e}{\partial \phi} + (1-e)\left(B_r\frac{\partial r}{\partial \phi} + B_w\frac{\partial w}{\partial \phi} + B_k\frac{\partial k}{\partial \phi} + B_l\frac{\partial l}{\partial \phi} + B_K\frac{\partial k}{\partial \phi}\right)$$

Ignoring the mechanical effect of a change in factor prices simply drops the first two terms in parenthesis. That is,

$$\frac{\partial z}{\partial \phi}|_{d(r,w,K)=0} = \frac{\partial z}{\partial \phi} - (1-e) \left(B_r \frac{\partial r}{\partial \phi} + B_w \frac{\partial w}{\partial \phi} + B_K \frac{\partial k}{\partial \phi} \right). \tag{8}$$

⁴Note that I normalize elasticities relative to the gross-of-tax rate $1 + \tau$ rather than the net-of-tax rate $1 - \tau$ which is more commonly used in the sufficient statistics literature (e.g. Feldstein, 1999). The reason is that the statutory burden of the tax lies on the side of firms, which are on the demand-side of the factor market. For demand-side taxes it is more natural to normalize by the gross-of-tax rate, since the first-order conditions of the firm-optimization problem (3) will depend on the price inclusive of taxes.

⁵To find the elasticity under constant factor prices note that the total derivative of z with respect to policy ϕ depends on factor prices and aggregate capital because broad income $B(\cdot)$ is itself a function of these. Hence the derivative of z with respect to the policy instruments can be decomposed as follows.

r, w, K are not determined by the firm's behavior, they do not contribute to the fiscal externality. Hence, their effect on taxable income is irrelevant for the purpose of the fiscal externality. Instead, changes in r, w, K are relevant because they generate transfers from the government to the firm, and from foreign investors to domestic agents. I show this formally in the next section.

It is also common in the sufficient statistics literature to make extensive use of the envelope properties of the value functions of the agents in the model. I derive these first for equilibrium profits of the firm which is defined as:

$$\Pi(\tau, \alpha) = \pi \left(r(\tau, \alpha), w(\tau, \alpha), K(\tau, \alpha); \tau, \alpha \right).$$

 $\Pi(\cdot)$ has the following partial derivatives:

$$\Pi_{\tau} = \pi_{\tau} + \pi_{r} \frac{\partial r}{\partial \tau} + \pi_{w} \frac{\partial w}{\partial \tau} + \pi_{K} \frac{\partial K}{\partial \tau},$$

$$= - \underbrace{z}_{\text{Mechanical Transfer to Government}} \underbrace{-\underbrace{(k + \tau(1 - e)B_{r})\frac{\partial r}{\partial \tau} - (l + \tau(1 - e)B_{w})\frac{\partial w}{\partial \tau}}_{\text{GE Transfer to government/workers/foreign investors}} + \underbrace{(F_{K} - \tau(1 - e)B_{K})\frac{\partial k}{\partial \tau}}_{\text{Production Externality}},$$

$$\Pi_{\alpha} = \pi_{\alpha} + \pi_{r} \frac{\partial r}{\partial \alpha} + \pi_{w} \frac{\partial w}{\partial \alpha} + \pi_{K} \frac{\partial K}{\partial \alpha}$$

$$= - \underbrace{C_{\alpha}}_{\text{Marginal Compliance Cost}} \underbrace{-\underbrace{(k + \tau(1 - e)B_{r})\frac{\partial r}{\partial \alpha} - (l + \tau(1 - e)B_{w})\frac{\partial w}{\partial \alpha}}_{\text{GE Transfer to government/workers/foreign investors}},$$

$$\underbrace{(F_{K} - \tau(1 - e)B_{K})\frac{\partial k}{\partial \alpha}}_{\text{Production Externality}},$$
(10)

where in the second step I applied the envelope theorem on equation (3) to find the partial derivatives of $\pi(\cdot)$. The effect of a change in tax policy on equilibrium profits, Π_{τ} , consists of three distinct terms. First, an increase in the tax rate mechanically transfers income from the firm to the government, proportional to taxable income *z*. In most of the sufficient statistics literature, this is the only effect of a change in tax policy on the welfare of private agents, since i.) prices are assumed constant, and ii.) competitive markets are assumed to be efficient. In this setting a second effect arises because the factor prices can change as a result of the change in tax policy. If the firm is able to shift part of the tax burden to the input factors, $\frac{\partial r}{\partial \tau} < 0$ and/or $\frac{\partial w}{\partial \tau} < 0$ this reduces the impact of the tax reform on firm profitability, as incidence is then shared between the firm and its factor suppliers. Hence, in that case the tax increase is less harmful to firm profitability. Further,

changes in factor prices affect the tax base. For instance, if a corporate tax (Case 2) reduces the equilibrium wage rate this increases taxable income generating a transfer from the firm to the government. Third, a change in tax policy affects the amount of foreign capital employed in the company. This generates a first-order effect on profitability through the externality F_K . The reason this term shows up is that in a competitive equilibrium the firm employs too little (too much) capital if the externality is positive (negative). Hence, if tax policy reduces the amount of capital employed in the firm, $\frac{\partial k}{\partial \tau} < 0$, tax policy exacerbates (alleviates) the pre-existing distortion. Further a change in foreign capital employed may affect the tax base, thus transferring additional funds from the firm to the government (or vice versa).

An increase in tax administration α does not result in a mechanical transfer of income from the company to the government, but does mechanically affect compliance cost. Otherwise, the effects of variation in α on factor prices, and the production externality are analytically similar to variation in the tax rate.

Even though the statutory burden of the tax lies with the firm, foreign capitalists, and domestic suppliers of inputs can be affected by changes in policy, if the policy affects factor prices. Formally, let $V(\tau, \alpha) \equiv v(r(\tau, \alpha))$ denote the equilibrium surplus of foreign capitalists, and let $U(\tau, \alpha) \equiv u(w(\tau, \alpha))$ denote the surplus from domestic workers. In that case, by applying the envelope theorem to (4) and (5) I arrive at:

$$V_{\phi} = k \frac{\partial r}{\partial \phi} \quad \text{for} \quad \phi \in \{1 + \tau, \alpha\}, \tag{11}$$

$$U_{\phi} = l \frac{\partial w}{\partial \phi} \quad \text{for} \quad \phi \in \{1 + \tau, \alpha\}, \tag{12}$$

where ϕ serves as a placeholder for either of the two policy variables. Equation (11) and (12) show that both foreign investors and domestic workers are only affected by policy changes to the extent that the factor price of their respective inputs are affected.

3 Welfare Analysis

Welfare is defined as the weighted sum of i.) government revenue, ii.) firm profits, iii.) worker surplus, and iv.) surplus of the foreign investment. Government revenue is the difference between tax revenue, and administrative cost:

$$T(\tau, \alpha) \equiv \tau z(\tau, \alpha) - a(\alpha).$$

I normalize the weight on tax revenue to 1, and denote by g the monetized weight on the surplus of both domestic agents (i.e. the firm and the worker). $0 \le g_f < g$ is the welfare weight on the

foreign investor, such that domestic surplus is weighted more heavily than foreign surplus. It makes sense to assume that $g \le 1$, such that in equilibrium tax revenue is weighted more heavily than private surplus. With these welfare weights in place, the welfare function is given by:

$$W(\tau, \alpha) = T(\tau, \alpha) + g\left(\Pi(\tau, \alpha) + U(\tau, \alpha)\right) + g_f V(\tau, \alpha).$$
(13)

Following the sufficient statistics literature, my objective is to evaluate the effect of marginal changes in policy on welfare. To that end, the partial derivatives of (13) are given by:

$$W_{\tau} = z + \tau \frac{\partial z}{\partial \tau} + g \left(\Pi_{\tau} + U_{\tau} \right) + g_f V_{\tau}, \qquad (14)$$

$$W_{\alpha} = \tau \frac{\partial z}{\partial \alpha} - a_{\alpha} + g \left(\Pi_{\alpha} + U_{\alpha} \right) + g_f V_{\alpha}, \qquad (15)$$

Proposition 1 rewrites the welfare effects in terms of sufficient statistics:

Proposition 1 Equation (14) and (15) can be written in terms of sufficient statistics as follows:

$$\frac{W_{\tau}}{z} = \underbrace{\frac{\tau}{1+\tau}E(z,1+\tau)|_{d(r,w,K)=0}}_{\Delta Fiscal \ Externality} + \underbrace{\frac{gF_{K}k}{(1+\tau)z}E(k,1+\tau)}_{\Delta Production \ Externality} E(k,1+\tau) + \underbrace{(1-g)}_{Mechanical \ Transfer} + \underbrace{\frac{(1-g)\tau}{1+\tau}\left(\frac{B_{r}r}{b}E(r,1+\tau) + \frac{B_{w}w}{b}E(w,1+\tau) + \frac{B_{K}k}{b}E(k,1+\tau)\right)}_{GE \ Transfer \ to \ Government} - \underbrace{\frac{(g-g_{f})rk}{(1+\tau)z}E(r,1+\tau)}_{\Delta Direct \ Cost \ of \ Admin} + \underbrace{\frac{\tau}{\alpha}E(z,\alpha)|_{d(r,w,K)=0}}_{\Delta Fiscal \ Externality} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{\Delta Production \ Externality} + \underbrace{\frac{(1-g)\tau}{\alpha}\left(\frac{B_{r}r}{b}E(r,\alpha) + \frac{B_{w}w}{b}E(w,\alpha) + \frac{B_{K}k}{b}E(k,\alpha)\right)}_{GE \ Transfer \ to \ Abroad} - \underbrace{\frac{(1-g)\tau}{\alpha}\left(\frac{B_{r}r}{b}E(r,\alpha) + \frac{B_{w}w}{b}E(w,\alpha) + \frac{B_{K}k}{b}E(k,\alpha)\right)}_{GE \ Transfer \ to \ Abroad} - \underbrace{\frac{(1-g)\tau}{\alpha z}E(r,\alpha)(17)}_{GE \ Transfer \ to \ Government} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(r,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(r,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha z}E(k,\alpha)}_{GE \ Transfer \ to \ Abroad} + \underbrace{\frac{gF_{K}k}{\alpha$$

Proof. See the Appendix for the derivation.

Equations (16) expresses the welfare effect of variation in the tax rate τ relative to taxable income z, $\frac{W_r}{z}$. This effect can be decomposed into a change in the fiscal and production externality, and the various transfers that are induced by changes in the tax rate. The effect of policy variation on the fiscal externality is proportional to the elasticity of taxable income under constant factor

prices, $E(z, 1 + \tau)|_{d(r,w,K)=0}$, whereas the effect on the production externality is proportional to the elasticity of foreign capital, $E(k, 1 + \tau)$. The transfers can be further decomposed into a mechanical transfer that is independent of any elasticity, and transfers that arise because tax policy affects the factor prices, and the level of aggregate capital employed in the economy. These effects are welfare relevant because i.) I allow the tax base to depend on factor prices, and aggregate capital, and hence, a change in them affects how much money is transferred from firms to the government, and ii.) the factor price for foreign capital affects how much of the burden of the tax is shifted on to foreign investors.

The welfare effects of tax administration (17) looks very similar. The main difference is that a change in tax administration does not generate a mechanical transfer, but instead comes with direct cost associated to government expenditure on tax administration, and to firms' compliance cost. Similar to the case of variation in the tax rate, welfare analysis of variation in tax administration relies on four elasticities that assess the effect of tax administration on taxable income, input prices and foreign capital.

Apart from the elasticities, equation (16) and (17) rely on a number of additional variables. These can be subdivided into three categories. The first are the welfare weights g and g_f which are necessary for any form of policy evaluation, and are sometimes themselves considered part of the sufficient statistics (see e.g. Chetty, 2009b). The second are statistics that are naturally available to researchers that estimate the required elasticities, or are part of the tax code. For instance, a researcher interested in jointly estimating the elasticity of taxable income, the elasticity of factor prices and the elasticity of foreign capital with respect to policy ϕ , $E(z, \phi), E(r, \phi), E(w, \phi), E(k, \phi)$, should be able to infer the average value of z, r, w, k from summary statistics. Finally, the statistics that are potentially more difficult to come by are those that relate to the cost of tax administration $a(\alpha)$, the cost of tax compliance, $C(e, \alpha)$, and the derivative of production with respect to foreign capital $F_K(k, l, K)$. With respect to tax administration, a logical normalization is to select $a(\alpha) = \alpha$. That is, the level of tax administration α equals the cost invested in administration. It is more difficult to estimate the cost of tax compliance, but this is an active area of research (e.g. Benzarti, 2020). Finally, there exists extensive research on externalities associated with FDI which can be used to inform the value of $F_K(k, l, K)$ (e.g. Aitken and Harrison, 1999).

Two special cases of Proposition 1 may be of particular interest to applied researchers. First, it can sometimes be appropriated to set the welfare weight on domestic agents equal to one, g = 1. This assumption could be justified if there exists another sufficiently flexible tax instrument that can distribute funds domestically, and that is selected optimally.⁶ In a domestic context, the

⁶For instance, a welfare maximizing lump-sum tax/transfer to workers equalizes the weight of private surplus of workers to that of the government.

presence of such instruments imply that tax-induced changes in factor prices are irrelevant for optimal-tax analysis, since the government can always use its instruments to offset the welfare effects of changes in factor price (see Saez and Zucman, 2023; Jacquet and Lehmann, 2025 for a more detailed discussion). However, from (16) and (17) it is clear that even if g = 1 the elasticity factor price elasticity $E(r, \phi)$ remains relevant for welfare analysis, since this elasticity determines how much of the burden of policy variation is shifted to foreign parties.

Another interesting special case is a small open economy, such that domestic policy does not affect the rental rate for foreign capital, $E(r, \phi) = 0$. In that case, the elasticity of the wage rate, $E(w, \alpha)$ remains a crucial variable for policy variation when the tax base depends on w, $B_w \neq 0$.

The only setting in which the elasticity of taxable income is a sufficient statistic for welfare analysis is if i.) there exists sufficiently flexible domestic instruments to ensure the irrelevance of changes in domestic input prices, ii.) the policy reform occurs in a small open economy, and iii.) no externalities are associated with the foreign input, $F_K = 0$. In that case, equations (16) and (17) simplify to the expressions derived in Keen and Slemrod (2017) in a domestic context.

Below I apply Proposition 1 to Case 1 and 2. For these specific cases I simplify by focusing purely on domestic welfare, $g_f = 0$.

3.1 Sufficient Statistics with a Withholding Tax

In case of a withholding tax (Case 1) the optimal policy conditions (16) and (17) simplify to:

$$\frac{W_{\tau}}{z} = (1-g) + \frac{\tau}{1+\tau} E(z, 1+\tau)|_{d(r,w,K)=0} + \frac{gb}{(1+\tau)z} \frac{F_K}{r} E(k, 1+\tau) + \left(\frac{\tau z - g(\tau z + b)}{(1+\tau)z}\right) E(r, 1+\tau),$$
(18)

$$\frac{W_{\alpha}}{z} = -\frac{a_{\alpha} + gC_{\alpha}}{z} + \frac{\tau}{\alpha} E(z,\alpha)|_{d(r,w,K)=0} + \frac{gb}{\alpha z} \frac{F_{K}}{r} E(k,\alpha) + \left(\frac{\tau z - g(\tau z + b)}{\alpha z}\right) E(r,\alpha).$$
(19)

where I have substituted in $B_r = k$, $B_w = 0$, rk = b which follows directly from Case 1 and re-ordered the terms by grouping on elasticities.

Note that in equations (18) and (19) tax the wage elasticity $E(w, \phi)$ is not necessary for policy evaluation. The reason is that in Case 1 the tax base is independent of the wage rate, and hence, a change in w does not trigger a transfer from the firm to the government (or vice versa). The wage rate only matters for transfers between the worker and the firm, but I have assumed that these have an equal welfare weight, and hence, such a transfer is welfare-neutral. Since neither the wage rate w nor the amount of employment l appear in equations (18) and (19) it follows that it is

possible to evaluated the welfare effects of a withholding tax on foreign income without assessing its impact on the labor market.

3.2 Sufficient Statistics with a Corporate Tax

Next I consider case the case of a corporate tax (Case 2). The main differences between the corporate tax, and the withholding tax are i.) that the tax base depends negatively on the wage rate w since wage payments are tax deductible, $B_w = -l$, ii.) the tax base depends on aggregate foreign capital through the production function, $B_K = F_K$, and iii.) the tax base is independent of foreign capital, $B_r = 0$. Substituting these restrictions into (16) and (17) I arrive at:

$$\frac{W_{\tau}}{z} = (1-g) + \frac{\tau}{1+\tau} E(z, 1+\tau)|_{d(r,w,K)=0} + \left(\frac{(\tau z + g(b-\tau z))F_K k}{(1+\tau)bz}\right) E(k, 1+\tau) - \frac{(1-g)\tau lw}{(1+\tau)b} E(w, 1+\tau) - \frac{grk}{(1+\tau)z} E(r, 1+\tau),$$
(20)

$$\frac{W_{\alpha}}{z} = -\frac{a_{\alpha} + gC_{\alpha}}{z} + \frac{\tau}{\alpha}E(z,\alpha)|_{d(r,w,K)=0} + \left(\frac{(\tau z + g(b - \tau z))F_{K}k}{\alpha z b}\right)E(k,\alpha) - \frac{(1 - g)\tau lw}{\alpha b}E(w,\alpha) - \frac{grk}{\alpha z}E(r,\alpha).$$
(21)

As can be seen from both (20) and (21) the labor market implications of a corporate tax reform cannot be ignored in the case of corporate taxation, since the expressions depend on the elasticity of the wage rate $E(w, \phi)$. The reason is that the wage rate is part of the tax base. An increase in the wage rate transfers funds from the government to the firm, as it reduces taxable income.

4 Conclusion

My analysis reveals that the number of sufficient statistics necessary for welfare analysis in a international context is typically larger than for domestic policy. Usually, the elasticity of taxable income is not sufficient for analysis of the welfare effect. The reasons are that i.) foreign actors are weighted differently from domestic actors, ii.) general equilibrium effects are often more difficult to ignore, and iii.) foreign investment may come with externalities to the domestic economy. Having said that, many of the elasticities that appear in Proposition 1 have already been estimated in previous work. For example, in the context of corporate taxation the elasticity of corporate income with respect to the corporate tax rate has been estimated in various papers $E(z, 1 + \tau)$ (for instance Devereux et al., 2014 for the UK). Similarly, there exists a large literature linking the corporate tax rate to the wage rate $E(w, 1 + \tau)$ (e.g. Suárez Serrato and Zidar, 2016 for the US)

and Fuest et al., 2018, for Germany) and the elasticity of investment (e.g. Chodorow-Reich et al., 2024 for the US and Link et al., 2024 for Germany). Finally, Chodorow-Reich et al. (2024) also estimate the effect of corporate tax reform on the cost of capital, $E(r, 1 + \tau)$.⁷ One reason that such empirical studies are feasible is that observability is not a large concern. Most international tax policy is mediated through large multinational companies. New and existing regulation requires these companies to produce large amounts of data that researchers can tap into. Hence, the main empirical challenge is to estimate all relevant elasticities on the basis of a single source of identifying variation.

A Derivation of Optimal-tax formulas

Starting from the government's first-order conditions (14) and (15), and substituting in the envelope conditions (9)-(12) I arrive at:

$$\begin{split} W_{\tau} &= \tau \frac{\partial z}{\partial \tau} + g(F_{K} - \tau(1 - e)B_{K})\frac{\partial k}{\partial \tau} + (1 - g)z - g(k + \tau(1 - e)B_{r})\frac{\partial r}{\partial \tau} - \\ & g(l + \tau(1 - e)B_{w})\frac{\partial w}{\partial \tau} + gl\frac{\partial w}{\partial \tau} + g_{f}k\frac{\partial r}{\partial \tau}, \\ W_{\alpha} &= \tau \frac{\partial z}{\partial \alpha} - a_{\alpha} + g(F_{K} - \tau(1 - e)B_{K})\frac{\partial k}{\partial \alpha} - gC_{\alpha} - g(k + \tau(1 - e)B_{r})\frac{\partial r}{\partial \alpha} - \\ & g(l + \tau(1 - e)B_{w})\frac{\partial w}{\partial \alpha} + gl\frac{\partial w}{\partial \alpha} + g_{f}k\frac{\partial r}{\partial \alpha}. \end{split}$$

Now substitute in (8) for $\frac{\partial z}{\partial \phi}$ and simplify:

$$\begin{split} W_{\tau} &= \tau \frac{\partial z}{\partial \tau} |_{d(r,w,K)=0} + gF_{K} \frac{\partial k}{\partial \tau} + (1-g)z + (1-g)\tau(1-e)B_{r} \frac{\partial r}{\partial \tau} + \\ & (1-g)\tau(1-e)B_{w} \frac{\partial w}{\partial \tau} + (1-g)\tau(1-e)B_{K} \frac{\partial k}{\partial \tau} + (g_{f}-g)k \frac{\partial r}{\partial \tau}, \\ W_{\alpha} &= -a_{\alpha} - gC_{\alpha} + \tau \frac{\partial z}{\partial \alpha} |_{d(r,w,K)=0} + gF_{K} \frac{\partial k}{\partial \alpha} + (1-g)\tau(1-e)B_{r} \frac{\partial r}{\partial \alpha} + \\ & (1-g)\tau(1-e)B_{w} \frac{\partial w}{\partial \alpha} + (1-g)\tau(1-e)B_{K} \frac{\partial k}{\partial \alpha} + (g_{f}-g)k \frac{\partial r}{\partial \alpha}. \end{split}$$

⁷Recent research has also focused on the effect of changes in tax administration. For instance, Bustos et al. (2022) studies a change in corporate tax administration in Chile. Casi et al. (2023) study a Danish enforcement reform in the context of a dividend-withholding tax.

Substituting in the elasticities from equation (6) and (7) and $1 - e = \frac{z}{b}$ which follows from the definition of z I arrive at :

$$\begin{split} W_{\tau} &= \frac{\tau z}{1+\tau} E(z,1+\tau)|_{d(r,w,K)=0} + \frac{gF_{K}k}{1+\tau} E(k,1+\tau) + (1-g)z + \\ &\qquad \frac{(1-g)\tau z}{1+\tau} \left(\frac{B_{r}r}{b} E(r,1+\tau) + \frac{B_{w}w}{b} E(w,1+\tau) + \frac{B_{K}k}{b} E(k,1+\tau)\right) \\ &\qquad \frac{(g_{f}-g)rk}{1+\tau} E(r,1+\tau), \\ W_{\alpha} &= -a_{\alpha} - gC_{\alpha} + \frac{\tau z}{\alpha} E(z,\alpha)|_{d(r,w,K)=0} + \frac{gF_{k}k}{\alpha} E(k,\alpha) + \end{split}$$

$$\frac{(1-g)\tau z}{\alpha} \left(\frac{B_r r}{b} E(r,\alpha) + \frac{B_w w}{b} E(w,\alpha) + \frac{B_K k}{b} E(k,\alpha) \right) + \frac{(g_f - g)rk}{\alpha} E(r,\alpha).$$

To get to the (16) and (17) in the text divide both sides of the expression by z.

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