Estimating Bargaining-related Tax Advantages of Multinational Firms: Online Appendix (Not for Publication)

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A Alternative Models and Extensions

A.1 Tax competition in the bargaining model

In the main text, we have considered the foreign country to be passive, i.e., foreign tax authorities do not respond to lower effective tax rates in France. Still, firms might be able to simultaneously negotiate with the French and other foreign governments about their respective deductions. We extend our stylized model to account for this parallel negotiation (tax competition in terms of tax deductions).

In this extension ETR_i' is determined endogenously within the model. Moreover, we allow for different profit opportunities in foreign countries, which might offset the tax-driven reasons to relocate. We denote the possible profits in the foreign country by $\pi_i\sigma$, where $\sigma > 0$. σ subsumes all profit losses and gains aside from the fixed relocation costs. For example, the wages in the foreign country might be lower or environmental regulations stricter, which would affect pre-tax profits.

Given this notation the optimal French deductions for firm i can be written as:

$$D_i^\star = \min\left[\underset{D_i}{\operatorname{argmax}}\left[\left(\tau\left(\pi_i\sigma - D_i\right)\right)^\alpha\left(\left(1-\tau\right)\pi_i\sigma + \tau D_i - F_i - \left(1-\mathrm{ETR}_i'\right)\sigma\pi_i\right)^{1-\alpha}\right], \pi_i\right], \tag{1}$$

in which we will consider the foreign ETR_i' to be endogenous. Analogous to Equation (3) in the main text, we derive the expression for the optimal French effective tax rate under consideration of the possible (gross) profit changes σ in the foreign country,

$$\mathrm{ETR}_i = \max\left[\alpha\left(1 - \sigma + \sigma\mathrm{ETR}_i' + \frac{F_i}{\pi_i}\right), 0\right]. \tag{2}$$

Given that the foreign $\mathrm{ETR}_i' \leq 1$, the optimal effective tax rate for a firm i in the country of interest is decreasing in σ. The more profitable a relocated firm would be, the higher the tax deductions the tax authority in the country of interest is willing to grant.

The optimal foreign deductions in turn can be written as

$$D_i'^\star = \min\left[\underset{D_i}{\operatorname{argmax}}\left[\left(\tau\left(\pi_i\sigma - D_i\right)\right)^\alpha\left(\left(1-\tau\right)\pi_i\sigma + \tau D_i - F_i - \left(1-\mathrm{ETR}_i\right)\pi_i\right)^{1-\alpha}\right], \pi_i\right], \tag{3}$$

where we assume that the bargaining power of both governments is identical and equal to α and that tax authorities will not pay any non-tax subsidies to firm i, i.e., deductions cannot be greater than total profits and hence the effective tax rate must be positive.

Firm i's (hypothetical) effective tax rate in the foreign country is then given by

$$\mathrm{ETR}_i' = \max\left[\frac{\tau\left(\pi_i\sigma - D_i'^\star\right)}{\pi_i\sigma}, 0\right] = \max\left[\frac{\alpha}{\sigma}\left(\left(1-\sigma\right) + \mathrm{ETR}_i - \frac{F_i}{\pi_i}\right), 0\right]. \tag{4}$$

The foreign (hypothetical) effective tax rate of a firm i increases with σ. The easier profits can be transferred or generated in the foreign country, the less deductions the foreign tax authority is willing to grant to attract the company.[1] Fixed relocation costs have exactly the opposite sign, i.e., high relocation costs require higher foreign tax deductions to attract firm i.

In a Nash equilibrium no tax authority wants to change its ETR_i, thus we substitute Equation (2) in Equation (4) and obtain

$$\mathrm{ETR}_i' = \max\left[\alpha\frac{\alpha-1}{1-\alpha^2}\frac{1}{\sigma}\left((\sigma-1)\frac{F_i}{\pi_i}\right), 0\right]. \tag{5}$$

$\sigma - 1$ is always less than or equal to zero and the optimal foreign ETR_i' in our tax negotiation setting is zero. Intuitively, the foreign tax authority is indifferent between attracting a firm to relocate into its jurisdiction by deducting all profits and the firm not relocating at all. Given $\mathrm{ETR}_i' = 0$, the optimal French effective tax rate is

$$\mathrm{ETR}_i = \alpha\left((1-\sigma) + \frac{F_i}{\pi_i}\right). \tag{6}$$

The equilibrium effective tax rate of a firm i in the country of interest only depends on the bargaining power α, the fixed relocation costs F_i, profits π_i, and the transferability of profits σ. The higher is σ the lower is the effective tax rate for a firm i in the country of interest. The slope of the ETR schedule does not depend on σ, it only shifts the ETR schedule vertically. It can be straightforwardly shown that statements (i), (ii) and (iv) of the Proposition in the main text also hold under international tax competition and are independent of σ.[2] For symmetric countries in terms of σ and F_i the effective tax rate for firms already located in a country will be the same in both countries and given by Equation (6).

A.2 Employment and tax revenues: Cobb Douglas

In this extension, we assume that the government tries to simultaneously maximize employment and tax revenues, which have equal weights in a Cobb Douglas function. Thus, the objective function of the government becomes:

$$\tau\left(\pi_i - D_i\right)E_i, \tag{7}$$

where E_i is the domestic employment in firm i. The objective function the government gives equal weight to job creation and tax revenues. Thus, the government must trade-off between tax revenues and employment. Similar to Melitz (2003), we assume that employment is positively related to (net) profits. Specifically, we model employment as

$$E_i = \frac{\pi_i D_i}{1+\tau}, \tag{8}$$

where π_i are the realized (rather than declared) gross profits and firms only employ less than the optimal (maximum) number of workers due to profit taxation. Thus, ceteris paribus, employment declines with higher statutory tax rates τ, while higher deductions D_i increase employment.

[1] We assume that $F_i/\pi_i \leq \alpha + ETR_i$.

[2] Note that the foreign tax authorities cannot commit to an $\mathrm{ETR}_i = 0$. Thus, firms face a similar problem as in Janeba (2000): once firm i has relocated, the foreign government would want to increase its tax rate. However, we abstract from this problem at this point, as bilateral tax negotiations are not the focus of this paper.

The solution to the Nash bargaining problem is then

$$D_i^\star = \underset{D_i}{\operatorname{argmax}} \left[\tau \left(\pi_i - D_i\right) \frac{\pi_i D_i}{1+\tau}\right]^\alpha \left[(1-\tau)\,\pi_i + \tau D_i - \left(1 - \mathrm{ETR}_i'\right)\pi_i + F_i\right]^{1-\alpha}. \tag{9}$$

Solving this equation yields the following first order condition:

$$\alpha \left[\tau \left(\pi_i - D_i\right) \frac{\pi_i D_i}{1+\tau}\right]^{\alpha-1} \frac{\tau}{1+\tau}\left(\pi_i^2 - 2\pi_i D\right)\left[(1-\tau)\,\pi_i + \tau D_i - \left(1 - \mathrm{ETR}_i'\right)\pi_i + F_i\right]^{1-\alpha} + (1-\alpha)\,\frac{\tau}{1+\tau}\pi_i D_i \left(\pi_i - D_i\right) = 0. \tag{10}$$

This first order condition can then be solved for the optimal deductions:

$$D_i^\star = -\left(\frac{Z_i}{\pi_i} - \frac{\tau\pi_i}{2}\right)\frac{1}{(1+\alpha)\,\tau} + \left(\left(\left(\frac{Z_i}{\pi_i} - \frac{\tau\pi_i}{2}\right)\frac{1}{(1+\alpha)\,\tau}\right)^2 + \frac{Z_i}{(1+\alpha)\,\tau}\right)^{\frac{1}{2}}, \tag{11}$$

where $Z_i = \alpha\pi_i\left(\left(ETR_i - \tau\right)\pi_i + F_i\right)$. Comparative statics yield the same results as the simple model in the previous section of this appendix. The firm's ETR declines with gross profits π_i, the statutory tax rate τ, the potential foreign ETR_i', and the costs of relocation, F_i. Once the government considers employment in its objective function, the ETR schedule shifts downward relative to the schedule suggested in Section 3 in the main text. This indicates that some tax revenues will be forgone in favor of higher employment. Nevertheless, the functional form is very similar.

A.3 Constrained Nash bargaining

We can also turn to a constrained Nash bargaining setup, where the government maximizes tax revenues, but considers the fact that lower profits will diminish employment in a firm, E_i, in its objective function. We assume that employment in a firm is proportional to (gross) profits. In turn, gross profits depend on the possible deductions and the statutory tax rate, i.e., creating higher profits (and employment) is more valuable for the firm if the net profits are higher. We use a similar functional form as in Section A.2 in which:

$$E_i \propto \pi_i = \frac{S_i D_i}{1+\tau}, \tag{12}$$

where profits increase in deductions and decline in the statutory tax rate τ, and S_i gives the sales potential of the firm.

Substituting this relationship into the Nash bargaining function yields

$$D_i^\star = \underset{D_i}{\operatorname{argmax}} \left[\tau\left(\frac{S_i D_i}{1+\tau} - D_i\right)\right]^\alpha \left[(1-\tau)\,\frac{S_i D_i}{1+\tau} + \tau D_i - \left(1 - \mathrm{ETR}_i'\right) S_i + F_i\right]^{1-\alpha}. \tag{13}$$

Note that in the Nash bargaining we consider the effect of the deductions, D_i, on the now endogenous gross profits of firms in the second square bracket, i.e., lower deductions have a positive effect of gross profits in the home country, while the expression, $(1 - \mathrm{ETR}_i')S_i$, already reflects the optimal profit potential after relocation.

Solving the constrained Nash bargaining problem yields

$$D_i^\star = \frac{(1 - ETR_i)\, S_i - F_i}{(1-\tau)\,\frac{S_i}{1+\tau} + \tau}. \tag{14}$$

Comparative statics yield the same results as the simple model in Section 3 in the main text, i.e., $\partial D_i^\star/\partial S_i > 0$, $\partial D_i^\star/\partial F_i < 0$, $\partial D_i^\star/\partial \mathrm{ETR}_i < 0$, and $\partial D_i^\star/\partial \tau > 0$. This model extension indicates that the intuition of the main model may prevail even if the maximization problem of the government does not only involve tax revenues but additionally accounts for firms' employments, yielding qualitatively similar results to the much simpler benchmark version of the model.

A.4 Counterfactual model without bargaining

Assume that tax authorities do not bargain with any firm and treat all firms equally. Firms still can ask for advance tax rulings which are provided at good faith by tax authorities interpreting the tax code. Tax rulings are prone to a random error, which is independent of the MNE status, but possibly depending on the pre-tax profits of the firm. Thus, firms face (everything else equal) different ETRs independent of their MNE status. Given that the fixed relocation costs of MNEs are lower than of NEs, we would expect that MNEs need more favorable draws, i.e., higher deductions, to be convinced to stay in France (given low tax foreign countries) than NEs. Thus, we would expect to see lower ETRs due to a selection effect based on the lower relocation costs of MNEs. We can formalize the argument by writing the difference in the ETRs between MNEs and NEs for a given pre-tax profit as

$$\mathrm{ETR}_{\mathrm{NE}} - \mathrm{ETR}_{\mathrm{MNE}} = \tau \frac{\pi_i - D_{\mathrm{NE}}}{\pi_i} - \tau \frac{\pi_i - D_{\mathrm{MNE}}}{\pi_i} = \tau \frac{D_{\mathrm{MNE}} - D_{\mathrm{NE}}}{\pi_i}. \tag{15}$$

Because MNEs select on more favorable draws on average, whereby $D_{\mathrm{MNE}} > D_{\mathrm{NE}}$, the ETR of MNEs is on average below the ETR of NEs. However, the difference in ETRs decreases in pre-tax profits. The ETR gap declines as the fixed costs for bigger firms become less important in their respective location decision. However, we observe that the ETR gap increases with firm size in the data, i.e., the footlooseness effect in our bargaining setting is most dominant in the highest quintile of the gross profit distribution. We take this as evidence that footlooseness in tax bargaining is an important and relevant factor to explain the ETR differences between MNEs and NEs.

B Alternative productivity estimations

B.1 Measuring productivity by the Solow-type TFP residual

One alternative approach is to estimate productivity via the total factor productivity residual, ϵ_{it}, in a regression of log firm output, $\ln(y_{it})$, on log employment, $\ln(l_{it})$, and log total capital, $\ln(k_{it})$, of the form:

$$\ln(y_{it}) = \alpha \ln(l_{it}) + \beta \ln(k_{it}) + \epsilon_{it}. \tag{16}$$

When using the estimated TFP residual in the entropy balancing of Section 4.4 in the main text and repeating the estimation underlying Table 7 in the main text on all entities, we obtain the estimation results summarized in Table OA.1.

Table OA.1: BALANCED: ESTIMATION OF THE FRENCH ETR SCHEDULE – SOLOW-TYPE TFP RESIDUALS FOR PRODUCTIVITY

Variable		Coef.
$\ln(\widetilde{\pi})$	(ω_1)	-33.16^{***}
		(12.08)
$\ln(\widetilde{\pi})^2$	(ω_2)	12.21^{**}
		(5.75)
$\ln(\widetilde{\pi})^3$	(ω_3)	-1.50^{*}
		(0.85)
$\widetilde{\text{MNE}}$	(μ)	-7.13
		(10.71)
$\widetilde{\text{MNE}} \times \ln(\widetilde{\pi})$	(ϑ_1)	9.77
		(15.62)
$\widetilde{\text{MNE}} \times \ln(\widetilde{\pi})^2$	(ϑ_2)	-4.73
		(7.10)
$\widetilde{\text{MNE}} \times \ln(\widetilde{\pi})^3$	(ϑ_3)	0.57
		(1.01)
Constant	(υ)	59.69^{***}
		(7.84)
F-statistic		19.78
Observations		4,661

*Standard errors in parentheses obtained through bootstrapping. ***, **, and * indicate levels of statistical significance at 1, 5, and 10 percent, respectively. F-statistic is for the joint significance of all MNE effects.*

Profits of MNEs are about 4.78 percentage points (with a standard error of 0.35) higher than those of comparable NEs using the balancing procedure with the Solow-type TFP residual as a productivity measure. The average size and footlooseness effect amount to 0.49 and 4.14 percentage points, respectively. The ETR schedule using the TFP residual is very similar to the one using productivity based on Levinsohn and Petrin (2003). The overall effect of 4.63 percentage points is again mainly driven by the credible footlooseness of MNEs. This is due to the relatively small additional profits, $\widehat{\delta}$, of about 8.91 percentage points (with a standard error of 2.86).

B.2 Productivity estimation following Olley and Pakes (1996)

Another approach to estimating productivity is to follow Olley and Pakes (1996). Instead of using material costs as a proxy as in Levinsohn and Petrin (2003), Olley and Pakes (1996) use investment and consider firm entry and exit. The implied log-linear production function has the following form:

$$y_{it} = \varphi_0 + \varphi_l \ln(l_{it}) + \varphi_k \ln(k_{it}) + \varphi_{it} + \zeta_{it}, \tag{17}$$

where y_{it}, l_{it}, and k_{it} are the gross revenue, labor, and capital of firm i at time t, respectively. Again the error term consists of a transmitted productivity term $\chi_{it} = \chi_{it}(k_{it}, m_{it})$ that follows a first-order Markov process (known to the firm) and an error term that is uncorrelated with the input choice, ζ_{it}. Using the interaction of capital and investment (the first difference of capital) as a proxy for the unobservable productivity term allows the identification of firm-level productivity. Additionally, Olley and Pakes (1996) include a probit estimation to control for entry and exit.

Applying the corresponding productivity estimates in the entropy balancing exercise, we can repeat the estimation underlying Table 7 in the main text on all entities. Table OA.2 presents the estimation regarding the ETR schedule.

Table OA.2: Balanced: Estimation of the French ETR schedule – Olley and Pakes (1996) productivity

Variable		Coef.
$\ln(\widetilde{\pi})$	(ω_1)	-44.05^{***}
		(6.56)
$\ln(\widetilde{\pi})^2$	(ω_2)	18.03^{***}
		(3.62)
$\ln(\widetilde{\pi})^3$	(ω_3)	-2.38^{***}
		(0.61)
$\widetilde{\text{MNE}}$	(μ)	-7.17
		(4.89)
$\widetilde{\text{MNE}} \times \ln(\widetilde{\pi})$	(ϑ_1)	11.30
		(8.14)
$\widetilde{\text{MNE}} \times \ln(\widetilde{\pi})^2$	(ϑ_2)	-6.05
		(4.22)
$\widetilde{\text{MNE}} \times \ln(\widetilde{\pi})^3$	(ϑ_3)	0.85
		(0.68)
Constant	(υ)	64.04^{***}
		(3.67)
F-statistic		20.99
Observations		4,661

*Standard errors in parentheses obtained through bootstrapping. ***, **, and * indicate levels of statistical significance at 1, 5, and 10 percent, respectively. F-statistic is for the joint significance of all MNE effects.*

With the Olley-Pakes productivity estimates, the average French MNE has profits that are 5.11 (standard error of 1.75) percentage points higher $(\widehat{\delta})$ than those of NEs. This leads to a very small size effect of 0.56 percentage points. The footlooseness effect in turn amounts to 3.31 percentage points and is the main driver of the overall effect of 3.87 percentage points.

C Propensity score matching approach

In this section, we present results based on traditional inverse propensity score weighting regression which is consistent with propensity score matching in estimating average treatment effects (see Wooldridge, 2007). For estimating the propensity score (of being an MNE), the same covariates as with entropy balancing in the main text are used. The estimation of the latter follows Becker and Ichino (2002). We estimate the propensity score for being an MNE based on a logit model and stratify firms in blocks according to that score. The associated weights are then used to construct inverse probability weights, and these weights replace the entropy balancing weights as used in the main text in otherwise identical regressions. This procedure yields the ETR schedules in the left-hand panel of Figure OA.1.

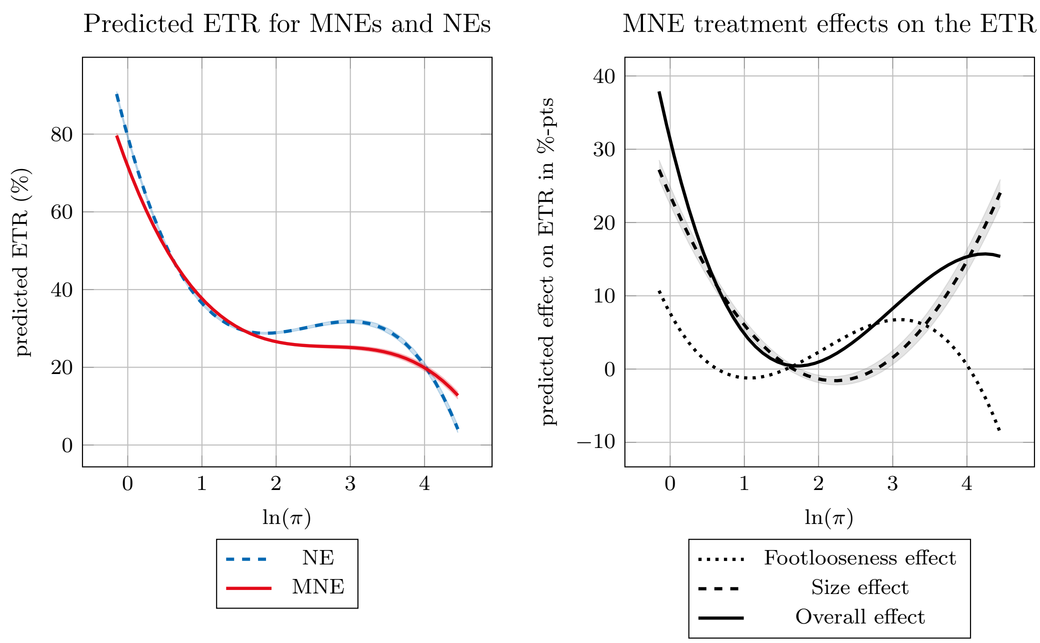

Figure OA.1: Balanced: Estimation of the French ETR schedule – propensity score matching

Table OA.3: Propensity Score Matching - After-weighting Covariate Means: Comparison of treated and controls

Variable	NE Mean	NE SD	NE Min	NE Max	MNE Mean	MNE SD	MNE Min	MNE Max	Difference in means	T-test
Revenues	0.00492	0.00236	0	0.01743	0.00664	0.00278	0.00096	0.01728	−0.00172	21.71
Productivity	1.79353	0.87743	0	8.06513	2.44818	1.10130	0.32783	9.31398	−0.65466	21.61
Employees	1.36624	0.78031	0	5.96694	1.85673	0.89858	0	5.18515	−0.49049	18.83
Capital	0.00407	0.00217	0	0.01803	0.00563	0.00266	0.00087	0.01888	−0.00156	21.05
Labor costs	0.00438	0.00216	0	0.01544	0.00595	0.00252	0.00083	0.01635	−0.00156	21.54
Exports	0.00009	0.00014	0	0.00094	0.00016	0.00017	0	0.00080	−0.00007	14.90
Debt	0.00001	0.00014	0	0.00574	0.00005	0.00041	0	0.01207	−0.00003	4.11
Intangibles	0.00002	0.00008	0	0.00185	0.00003	0.00019	0	0.00377	−0.00002	3.74

Furthermore, we estimate the additional profits an MNE can generate based on Equation (11) in the main text using the same inverse propensity score weights. According to this procedure, MNEs' profits are ceteris paribus 41% higher (with a standard error of 0.04) than ones of NEs. The associated footlooseness and size effects are summarized in the right-hand panel of Figure OA.1.

In general, the results are qualitatively similar to those based on entropy-balancing weighting. However, any difference to the approach in the main text speaks in favor of entropy-balancing weighting. One significant source of that difference is the large degree of unbalancedness of the covariates, as is documented in Table OA.3.

D Tax payments over total assets

Parts of the accounting literature would suggest suggest that firms seek to minimize tax payments over total assets, rather than effective tax rates, as total assets are always strictly positive, more stable over time, and generally harder to shift between different entities. Firms should, therefore, consider their net returns on assets as follows:

$$\frac{\pi_{it}^{net}}{A_{it}} = \frac{\pi_{it}\left(1 - ETR_{it}\right)}{A_{it}} = \frac{\pi_{it}}{A_{it}} - \frac{T_{it}}{A_{it}}, \tag{18}$$

where T_{it} are tax payments, π_{it} and π_{it}^{net} are before- and after-tax profits, respectively, and A_{it} are total assets of firm i and year t. Clearly, higher tax payments over assets decrease the profitability of a firm and can be separated from fluctuating pre-tax profits. Nevertheless, in our sample, assets and pre-tax profits are highly (positively) correlated. Even after conditioning on firm- and time-fixed effects, an increase in pre-tax profits by 1 percentage point, leads to an increase in total assets by 0.15 percentage points with standard deviation 0.07. The subsequent analysis, whose results are presented in Figure OA.2, produces qualitatively similar results to when we use tax payments over total assets rather than effective tax rates.

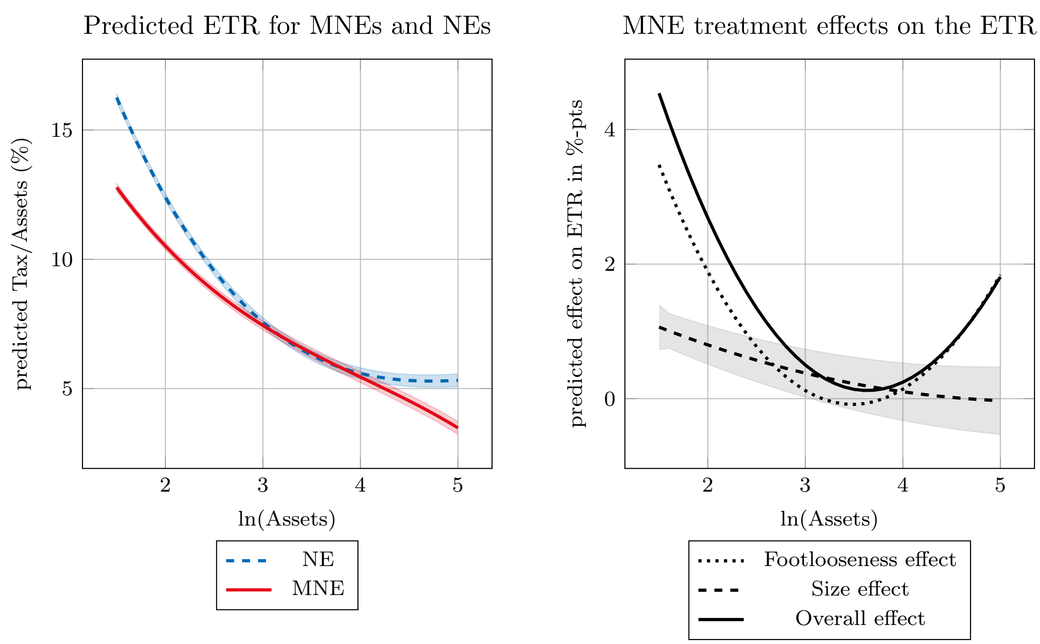

Figure OA.2: Balanced: Predicted ETR and treatment effect on the ETR – Tax/Assets

However, because tax payments over total assets do not have a readily available economic interpretation – the numerator is a flow and the denominator is a stock –, we prefer the analysis with effective tax rates.

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