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Capital Intensity and Corporate Tax Burden: Understanding the Non-Linear Dynamics



Authors

Bournakis, I[†] & Christopoulos, D^{*‡}

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[†]SKEMA Business School, France

[‡]Athens University of Economics and Business, Greece

Abstract

This paper investigates non-linear relationship between capital per worker and the effective corporate tax rate within a structural framework grounded in sectoral capital allocation. We develop a two-sector model that allows for heterogeneity in the capital–labour ratio and endogenous effective tax rates, and we examine how high capital-labour ratio regimes are lead to lower corporate tax liabilities, thus declining corporate tax revenues. Empirically, we employ a Logistic Smooth Transition Regression (LSTR) on firm-level panel data from six European countries addressing the potential endogeneity bias in the threshold variable (capital-labour) without relying on external instruments. The results reveal strong regime-dependent effects: while a linear specification suggests a uniformly positive association between the capital–labour ratio and tax liabilities, the threshold model identifies a reversal of this relationship in high-capital regimes. Our findings highlight the growing issue of uneven fiscal contributions and the policy challenge of mitigating fiscal asymmetries. Overall, the analysis emphasizes the need to incorporate sectoral capital dynamics and capital productivity into the design of corporate tax systems—particularly in the context of technological divergence and intensifying international tax competition.

1 Introduction

The growing capital intensity of firms—driven by technological progress and strategic investment—has reshaped the landscape of modern production and taxation. As businesses increasingly rely on capital to boost productivity, they often benefit from tax incentives and planning strategies that lower their effective tax burdens (K.A. Hassett and Hubbard 1996).¹ Most of this research (Arnold and Schwellnus 2008; Goda 2024) focuses on whether corporate taxation exerts an adverse effect on firms' investment choices, thereby slowing capital accumulation and productivity growth. In contrast, we depart from this traditional perspective by reversing the analytical direction: rather than asking how taxation affects capital formation, we examine how rising capital intensity itself influences corporate tax contributions, and what this implies for tax fairness, fiscal sustainability, and economic efficiency.

In a globalized economy, understanding the relationship between capital deepening and corporate tax liabilities is crucial. Firms increasingly possess the flexibility to shift profits, investments, and operations across borders to minimize their tax burden (Millot et al. 2020). Although capital accumulation typically enhances productivity and profitability, these gains do not necessarily translate into proportionally higher corporate tax payments. This disconnect poses an important policy challenge: how can tax systems encourage investment while safeguarding the integrity of the corporate tax base and promoting fiscal equity?

In the United States, corporate tax revenue has declined markedly over the past fifty years, even as income tax collections have remained stable or increased (Suárez Serrato and Zidar 2023). Indirect taxes—such as value-added tax (VAT)—have also taken on a growing role in many countries. Among OECD members, the share of corporate taxes in total tax revenue fell from 15% to around 9% over the past fifteen years, while the contribution of income taxes rose from 30% to 48% over the same period.

Meanwhile, the overall tax-to-GDP ratio rose from 24% in the early 1970s to 33% by the early 2020s (OECD 2024), indicating that a larger share of the fiscal burden has shifted onto households. This trend raises deeper concerns about tax equity in developed economies and point to a systematic structural shift in the tax burden—suggesting that capital-intensive growth may be decoupling from corporate tax responsibility.²

¹This literature has developed around two main hypotheses: the accelerator theory, which assumes that investment is a forward-looking variable whose current dynamics can be predicted by past output or demand conditions, and the user cost of capital theory (Jorgenson 1963), which emphasizes how tax policy parameters (such as depreciation allowances and statutory tax rates) influence firms' investment decisions (Maffini, Xing, and Devereux 2019; Devereux and Griffith 1999). The former framework provides stronger explanatory power in capturing short-term investment fluctuations in time-series analyses, while the latter offers deeper insight into how fiscal incentives and tax structures shape investment behaviour across firms and countries.

²Interestingly, the analogous pattern differs in developing countries. Bachas et al. (2022) establish a new stylized fact showing an increase in the effective tax rate in the post-1990 period in developing countries,

A large body of research has examined how corporate tax behaviour is interrelated with firm decisions about the broader allocation of economic activity in a globalised economic environment. Auerbach and Slemrod (1997) documented substantial shifts in the organizational structure of U.S. businesses, with many firms transitioning to pass-through entities to reduce their exposure to corporate taxation. These findings align with the notion that policy tax reforms often elicit behavioral responses that alter the effective tax base. Slemrod and Sorum (1984) emphasized the importance of globalization in enhancing tax competition, which in turn drives tax avoidance and complicates government efforts to sustain an equitable tax system in an increasingly interconnected global economy. As firms gain access to international markets, they are more likely to exploit cross-border tax differentials—through mechanisms of transfer pricing and income shifting. Firms headquartered in high-tax jurisdictions benefit disproportionately from such strategies, offering a plausible explanation for the declining trends in corporate tax contributions in the developed world (Desai and Dharmapala 2006).

As firms increase their investment and capital intensity, higher productivity generally translates into greater profitability. In a progressive tax system, this should, in principle, lead to higher average tax payments. However, empirical evidence does not always confirm this expectation. Saez (2001) points to the presence of non-linearities in how taxation interacts with economic fundamentals, indicating that a firm's average tax rate may vary systematically with capital intensity rather than remain constant.

Previous research has explored the non-linear relationship between capital supply elasticity and tax policy (Saez and Stantcheva 2016; Saez and Stantcheva 2018), often challenging the assumption of infinitely elastic capital supply that subsequently supports the theoretical result of a zero optimal capital tax rate (Chamley 1986; Judd 1985). However, much less is known about how capital accumulation—though central to productivity and profitability—affects corporate tax payments in practice. This study directly addresses this gap by investigating how rising capital intensity affects firms' effective tax burdens, with a critical focus on whether increased investment is matched by proportional growth in corporate tax contributions.

The relationship between capital intensity and effective corporate tax liabilities has far-reaching policy implications—particularly in the context of automation (e.g., artificial intelligence), labor market dynamics, and rising income inequality. As firms invest more heavily in capital to boost productivity, they often benefit from favorable tax treatments that reduce their effective tax rates. This can incentivize the substitution of capital for labor, especially when the two inputs are highly substitutable. The result is a decline in labor's share of income, weaker demand for labor, and slower wage growth. These effects are amplified in industries where the elasticity of substitution exceeds one, making capital accumulation more responsive to

mainly attributed to trade openness that boosted corporate output in these economies.

relative input costs—including tax advantages (Klump, Peter McAdam, and Willman 2007).

³ With reference to the above, Acemoglu and Restrepo (2019) show that capital-intensive sectors experience sharper declines in labor income shares, a trend that may worsen if fiscal policies disproportionately favor capital over labor.

In this context, understanding how effective tax rates evolve with capital deepening becomes critical. If tax systems unintentionally reward capital accumulation without commensurate tax contributions, they may reinforce economic imbalances while eroding the corporate tax base. Yet, promoting fiscal fairness must be balanced against the need to maintain a tax environment conducive to investment and growth.⁴ A well-designed tax system must therefore pursue both equity and efficiency—ensuring that firms contribute fairly while preserving neutrality in their investment decisions.

To investigate these dynamics, we develop a stylized two-sector model economy, distinguishing between low-capital (LC) and high-capital (HC) industries. The two-sector model is not adopted merely for modelling convenience; rather, it captures the structural asymmetries that shape firms' effective tax burdens. By distinguishing between low-capital and high-capital sectors, the model traces how capital mobility and technological heterogeneity translate into differential tax responses (Klump, Peter McAdam, and Willman 2007). Essentially, this framework provides a natural mechanism through which rising capital intensity in one sector can erode the aggregate tax base—even as total output expands—through profit-shifting capacity and the preferential tax treatment of capital (Saez and Stantcheva 2018; Devereux, Griffith, and Klemm 2002; Desai and Dharmapala 2006). Our framework is the first to show how capital concentration affects effective tax rates and how threshold effects can overturn the usual link between investment and tax contributions. We test the model's predictions with a Logistic Smooth Transition Regression (LSTR) in a data set of manufacturing firms from six European countries between 2001 and 2014. We uncover a non-linear tax response: while moderate capital accumulation increases tax payments, once capital per worker surpasses a certain threshold, further capital deepening leads to declining effective tax rates.

Our findings highlight the need for fiscal instruments that align corporate taxation with economic growth objectives while addressing crucial equity concerns as far as the distribution of tax burden among the society. Our model provides insights to policymakers for designing tax regimes that promote productive investment without undermining social welfare. This approach ensures that corporate taxation remains both efficient and equitable, fostering

³Antràs (2004) find that when capital and labor are poor substitutes, increasing capital intensity is more difficult and costly—a pattern observed in the U.S. economy.

⁴The decline in effective tax rates with rising capital intensity is often driven by a combination of profit-shifting strategies, the mobility of capital across jurisdictions, and preferential tax treatment for certain types of investment—particularly in high-tech or capital-intensive sectors

long-term economic stability and social coherence.

The paper is organized as follows. Section 2 develops the two-sector theoretical model with capital and labor mobility under corporate taxation. Section 3 outlines the econometric framework. Section 4 describes the firm-level panel dataset and presents the estimation results. Section 5 conducts jackknife sensitivity tests to assess the robustness of the baseline findings. Section 6 validates the theoretical model using elasticity estimates and simulation-based dynamics. Section 7 concludes with a discussion of policy implications derived from our analysis.

2 A Two Sector Model with Capital Mobility and Taxes

2.1 Model Set up

The model describes an economy with two sectors: a Low-Capital (LC) sector and a High-Capital (HC) sector. Capital and labor are mobile between sectors and reallocate in response to differences in marginal productivity and wages, respectively. Capital tends to flow toward the HC sector, which offers higher marginal returns often driven by greater technological sophistication (Acemoglu 2008). The government applies a uniform statutory corporate tax rate; however, the effective tax rate in the HC sector varies with capital concentration. This reflects the sector's greater capacity for profit shifting and access to preferential tax treatments. Both sectors produce output using a CES production function that incorporates capital, labor, and sector-specific productivity, where $i = LC, HC$.

$$Y_i = A_i [\alpha_i K_i^{\rho_i} + (1 - \alpha_i) L_i^{\rho_i}]^{\frac{1}{\rho_i}} \quad (1)$$

We express (1) in per capita terms as follows:

$$y_i = A_i [\alpha_i k_i^{\rho_i} + (1 - \alpha_i)]^{\frac{1}{\rho_i}} \quad (2)$$

where $k_i = K_i/L_i$, and the elasticity of substitution between inputs is $\sigma_i = 1/(1 - \rho_i)$.

After adding a time index, the total output in each sector is $Y_i(t) = y_i(t)L_i(t)$, and the total output in the economy is:

$$\begin{aligned} Y(t) &= Y_{LC}(t) + Y_{HC}(t) = y_{LC}(t)L_{LC}(t) + y_{HC}(t)L_{HC}(t) \\ &= \hat{L} [(1 - s(t))y_{LC}(t) + s(t)y_{HC}(t)] \end{aligned} \quad (3)$$

where $L_{LC}(t) + L_{HC}(t) = \hat{L}$ and $s(t) = \frac{L_{HC}(t)}{\hat{L}}$ is the labor share in the HC sector.

2.2 Capital Accumulation and Mobility Between Sectors

Capital accumulation in each sector depends on after-tax output per capita—calculated as $(1 - \tau_0)f(k_i)$, where τ_0 is the statutory tax rate—along with consumption per capita (c_i), depreciation (δk_i), and inter-sectoral capital mobility. Capital flows between sectors on the basis of marginal product of capital differences ($MPK_{LC} \neq MPK_{HC}$). We capture this by a one-sided adjustment term $m \cdot \max\{0, MPK_{HC} - MPK_{LC}\}$, where $m > 0$ represents the responsiveness of capital migration to differentials in marginal productivity of capital between LC and HC . Therefore, we can write specifically the accumulation of capital in the

i sector as:⁵

$$\dot{k}_{LC} = (1 - \tau_0)f_{LC}(k_{LC}) - c_{LC} - \delta k_{LC} - m \cdot \max\{0, MPK_{HC} - MPK_{LC}\} \quad (4a)$$

$$\dot{k}_{HC} = (1 - \tau_0)f_{HC}(k_{HC}) - c_{HC} - \delta k_{HC} + m \cdot \max\{0, MPK_{HC} - MPK_{LC}\} \quad (4b)$$

The reallocation of capital from the low-capital (LC) sector to the high-capital (HC) sector occurs when the marginal product of capital is higher in the latter, $MPK_{HC} > MPK_{LC}$. We further assume that the HC sector is characterized by higher technological sophistication—such as greater automation, advanced production processes, or better capital-augmenting innovations—which leads to persistently higher capital productivity. As a result, capital earns a higher marginal return in the HC sector, incentivizing its reallocation. For such movement to occur, capital and labor must be sufficiently substitutable; in particular, rising wages in the HC sector must induce firms to substitute capital for labor, thereby increasing the demand for capital.⁶

2.3 Labor Mobility

Labor moves across sectors in response to wage differentials, with equilibrium wages equal to the marginal product of labor in each sector.

$$w_i = MPL_i \quad (5)$$

The net rate of change of labor in the HC sector is given by:

$$\dot{L}_{HC} = \frac{dL_{HC}(t)}{dt} = \varphi(w_{HC}(t) - w_{LC}(t)) \quad (6)$$

where $\varphi > 0$ is the labor mobility parameter. Assuming fixed total labor supply $\hat{L}$, we have: $\dot{L}_{LC} = -\dot{L}_{HC}$.

2.4 Taxation

The government levies corporate taxes under a statutory progressive rate, τ_0 ,⁷ but in practice the effective burden diverges across sectors. In particular, firms in the high-capital (HC) sector often benefit from profit-shifting opportunities and preferential treatment of investment in advanced technologies (Devereux et al., 2008). Consequently, the effective tax rate in the

⁵A detailed derivation of MPK_i and sectoral capital accumulation is provided in 7.

⁶We have already assumed that capital is mobile across sectors, with no significant adjustment frictions or institutional barriers to reallocation.

⁷A progressive tax system imposes a higher tax rate on higher corporate income (profitability).

HC sector declines with relative capital deepening, modeled as

$$\tau_{HC} = \tau_0 - \beta z(t),$$

where $z(t)$ captures the relative capital–labor ratio between HC and LC sectors, and $\beta > 0$ measures the sensitivity of tax erosion to capital accumulation. Aggregate corporate tax revenue is therefore

$$T = \tau_0 Y_{LC} + (\tau_0 - \beta z(t)) Y_{HC}, \quad (7)$$

highlighting how sectoral asymmetries in capital intensity translate into an endogenous decline in the effective tax base.

The sufficient condition for 7 to decline during capital concentration in the HC sector is:

$$\tau_0 + (\tau_0 - \beta z) \left[\frac{dY_{LC}}{dt} + (\tau_0 - \beta z) \frac{dY_{HC}}{dt} \right] < \beta \frac{dz}{dt} (Y_{LC} + Y_{HC}) \quad (8)$$

which implies that total tax revenue falls when the loss of taxable output in the LC sector, $\frac{dY_{LC}}{dt}$, combined with the impact of a declining effective tax rate in the HC sector, $-\beta \frac{dz}{dt} Y_{HC}$, outweighs the output growth in the HC sector, $\frac{dY_{HC}}{dt}$. More intuitively, even if overall economic output increases, tax revenue can still decline if capital shifts rapidly into the HC sector—since tax advantages in this sector shrink the effective tax rate faster than output expands.

While 8 is sufficient to ensure a decline in total corporate tax revenue during capital deepening, it is not the only possible threshold. To further characterize the dynamics of corporate tax revenue, we derive a 9, which introduces a necessary condition for a non-linearity between capital deepening and corporate tax liabilities:

$$\tau_0 \frac{dY_{LC}}{dt} + (\tau_0 - \beta z) \frac{dY_{HC}}{dt} < \beta \frac{dz}{dt} Y_{HC} \cdot \frac{d^2 T}{dt^2} < 0 \quad (9)$$

Equations 8 and 9 highlight the non-linear dynamics in corporate tax revenue that are directly associated with the effective tax rate, $(\tau_0 - \beta z)$ in HC . Equation 9 presents a sufficient condition under which tax revenue begins to decline as capital intensity in the HC sector rises. This implies the existence of a threshold: tax revenues benefit from increases in k_i only up to a certain point. Beyond that, further increases in k_i —when subject to preferential tax treatment—no longer yield fiscal gains. Following the previous discussion, we formulate the first proposition:

Proposition 1: An increase in the tax sensitivity parameter β increases both the likelihood

and speed of a decline in corporate tax revenue during capital deepening in the HC sector.

Proof: Differentiate the necessary condition, 9 for a revenue decline with respect to β :

$$\frac{\partial}{\partial \beta} \left(\frac{d^2 T}{dt^2} \right) < 0 \quad (10)$$

As β increases, the term $\beta \frac{dz}{dt} Y_{HC}$ on the right-hand side of 9 grows faster, while the effective tax rate $(\tau_0 - \beta z)$ shrinks more rapidly, reducing the tax contribution from HC output. Thus, the inequality is more easily satisfied, and the decline in tax revenue accelerates. A higher β amplifies the responsiveness of revenue to capital intensity, making a downturn both more likely and more pronounced.

Proposition 2: A higher capital mobility parameter m between sectors increases the speed and likelihood of a decline in corporate tax revenue during capital reallocation.

Proof: From capital accumulation in (4) in the LC sector, an increase in m induces greater capital outflows from LC to HC , accelerating the decline of k_{LC} and reducing output Y_{LC} . This contraction lowers the taxable base in LC and diminishes its contribution to aggregate tax revenue. Simultaneously, the inflow of capital into the HC sector raises k_{HC} , which—via 7—reduces the effective tax rate in HC .

$$\tau_{HC} = \tau_0 - \beta z(t) \quad (11)$$

As a result, even though Y_{HC} grows, it is taxed at a progressively lower rate. Together, these effects increase the probability that sufficient condition in 8 is met, resulting in an overall decline in corporate tax revenue.

Proposition 3: If the elasticity of substitution in the HC sector, σ_{HC} , exceeds that in the LC sector, σ_{LC} , capital accumulation will disproportionately favor the HC sector. This raises the capital deepening ratio $z(t)$ and increases the likelihood of a lower effective tax rate in the HC sector.

Proof: From the CES production function (2), a higher elasticity of substitution σ_{HC} implies a lower ρ_{HC} , reducing the curvature of the HC sector's production function and making output more responsive to capital accumulation. Consequently, when $\sigma_{HC} > \sigma_{LC}$, capital inflows generate a larger increase in k_{HC} relative to k_{LC} , raising the capital-deepening ratio $z(t)$. As $z(t)$ rises, the effective tax rate in the HC sector $(\tau_{HC} = \tau_0 - \beta z)$ declines further, reducing corporate tax revenue.

3 Econometric Estimation

The propositions developed in section 2 highlight the mechanisms through which capital deepening, tax policy parameters, and sectoral characteristics interact to shape corporate tax outcomes. Equation (12) formalizes the non-linear relationship between capital deepening and corporate tax revenue. As capital intensity rises—particularly in the HC sector—effective tax rates may decline beyond a critical threshold, undermining overall tax contributions. We now turn to the econometric specification, where we test empirically this theoretical prediction.

3.1 A Logistic Smooth Transition Model

To identify non-linearities, we use a Logistic Smooth Transition Model (LSTM) that enables a gradual transition between regimes of the threshold variable—the log of the capital-labor ratio, k_{it} . For clarity, we now include the time subscript t , while suppressing the country index c for simplicity. Unlike typical Threshold Transition Models (B. Hansen 1999; Teräsvirta 1994), which shifts abruptly between regimes, the LSTM smoothly interpolates between the effects of different regimes based on the value of k_{it} . This feature is rather appealing, as it allows the model to account for scenarios in which changes do not occur instantaneously but instead unfold gradually over a range of values. The LSTM is written as:

$$\tau_{it} = \alpha_{0i} + \alpha_k k_{it} + \alpha_k^* f(k_{it}; \theta, \gamma) k_{it} + \alpha_{\mathbf{x}} \mathbf{x}_{it} + u_{it} \quad (12)$$

where, $f(k_{it}; \theta, \gamma) k_{it} = \frac{1}{1 + e^{-\gamma(k_{it} - \theta)}}$ is the smooth transition function; γ is the speed of transition between the two regimes, θ is the location parameter (i.e. the threshold value) of k_{it} , which influences the transition; where the vector $\mathbf{x} = (\delta + p)k_{it}$ collects the tax benefits from physical depreciation of capital and interest payments that potentially affect the effective tax rate, τ_{it} , of the firm. Parameter α_{0i} is an intercept and α_k is the coefficient of k_{it} in the lower regime. Parameter α_k^* captures the additional effect of k_{it} that varies with the transition function $f(k_{it}; \theta, \gamma) k_{it}$. The effect of k_{it} on τ_{it} in the upper regime is derived by: $\alpha_{\text{tot}} = \alpha_k^* + \alpha_k$. Finally, equation 12 includes a standard error term u_{it} with standard statistical properties.

Equation 12 implies that the effect of k_{it} on τ_{it} depends on whether k_{it} is above or below the critical value theta ($k_{it} < \theta$, low regime; $k_{it} > \theta$, high regime). Parameter γ governs the speed of transition between regimes. If $\gamma \rightarrow \infty$, the transition function $f(k_{it}; \theta, \gamma)$ converges to an indicator function $\mathbb{I}(k_{it} > \theta)$, resulting in an abrupt regime shift. If $\gamma \rightarrow 0$ then

$f(k_{it}; \theta, \gamma) \rightarrow 0.5$, which reduces the LSTR model to a linear specification:

$$\tau_{it} \approx \alpha_{0i} + \beta_k k_{it} + \alpha_x + u_{it}, \quad (13)$$

where $\beta_k = (\alpha_k + \alpha_k^*) \times 0.5$. Note that when $k_{it} = \theta$, the transition between regimes is symmetric and instantaneous.

3.2 Correcting for Endogeneity in the LSTM

While the main focus is to identify the non-linear responses of τ_{it} to changes in k_{it} , it is also important to acknowledge potential feedback effects in the above relationship. Higher corporate taxation payments can introduce distortions that may reduce private investment, decelerating capital deepening. (Auerbach and K. Hassett 1992).⁸ The existence of feedback effects between τ_{it} and k_{it} indicate endogeneity bias calling for a more systematic identification strategy of parameters, α_k and α_k^* in estimating equation 12.

To address endogeneity, one needs to identify the evolution of k_{it} exogenously. This typically requires the use of instruments ($instr_{it}$) that satisfy both the relevance condition, $corr(k_{it}, instr_{it}) \neq 0$, and the exogeneity condition, $E(instr_{it}, u_{it}) = 0$. Instruments such as technological shocks or regional factors that influence k_{it} may fail to meet the exogeneity condition, as they are likely correlated with unobserved determinants of τ_{it} . In the presence of weak instruments, the bias of instrumental variable (IV) estimators can exceed that of OLS, leading to spurious estimates and invalid inference (Stock, Wright, and Yogo 2002). To address these concerns, we apply the copula method, which augments the LSTR model with appropriately transformed variables to mitigate potential endogeneity in k_{it} (Dimitris Christopoulos, Peter McAdam, and Elias Tzavalis 2021; D. Christopoulos, P. McAdam, and E. Tzavalis 2023). The key advantage of the copula correction lies in its flexible representation of the dependence structure between the endogenous variable and the error term. Unlike traditional IV estimators, which are often susceptible to weak instrument bias, the copula approach eliminates the need for external instruments by capturing non-linear dependencies directly, as specified in Equation 12. Monte Carlo simulations demonstrate that the copula correction effectively removes bias in the estimation of the parameters θ , α_k , and α_k^* (Dimitris Christopoulos, Peter McAdam, and Elias Tzavalis 2021; D. Christopoulos, P. McAdam, and E. Tzavalis 2023). After correcting for endogeneity, specification 12 is written as:

⁸The literature on the distortionary effects of taxation is not limited to these findings, as Lee and Gordon (2005) also examines the feedback loop between taxes and investment in physical assets showing that higher corporate taxes have a long-term detrimental effect on investment by reducing after-tax returns on capital. These effects are also evident in dynamic general equilibrium models (Chamley 1986; Slemrod 1995), where tax policies interact with private sector decisions about capital accumulation.

$$\tau_{it} = \alpha_{0i} + \alpha_k k_{it} + \alpha_k^* f(k_{it}; \theta, \gamma) k_{it} + \alpha_{\mathbf{x}} \mathbf{x}_{it} + w_r z_{hit}^* + u_{it} \quad (14)$$

where $w_r = \sigma_h \rho_{ur z_r^*}$. Parameter $\rho_{ur z_r^*}$ represents the Pearson correlation coefficient between u_{it} and the standardized threshold variable $z_{rit}^* = \Phi^{-1}(F_k(k|G))$. In this expression, σ_h denotes the standard deviation of u_{it} in regime $r = \text{low, high}$. The variable G represents the regime, which is determined by the threshold k_{it} , while F_k is the marginal distribution function of k_{it} for the two regimes. Additionally, Φ^{-1} is the quantile function of this distribution. A detailed derivation of 14 is provided in D. Christopoulos, P. McAdam, and E. Tzavalis (2023).

4 Data and Estimation Results

4.1 Data

The data are taken from the European Firms in a Global Economy (EFIGE) and cover an unbalanced panel of 7819 manufacturing firms from France, Germany, Hungary, Italy, Spain and the UK. The sample predominantly comprises Small and Medium Enterprises (SMEs) between 10 and 250 employees and large firms with more than 250 employees over the period 2001-2014. The information provided in EFIGE include financial data from balance sheet and profit-loss accounts that are drawn from BvD Amadeus and they are combined with comprehensive survey information for 2008 (Altomonte et al. 2013). For the purposes of our analysis, we define the tax rate (τ_{it}) as follows:

$$\tau_{it} = \frac{\text{Tax payments}_{it}}{\text{Assets}_{it}}, \quad (15)$$

where *Tax payments* is the difference between *ebit* (earnings before interest, taxation and depreciation) and cash flow. Capital stock is defined as the book value of fixed capital assets, which primarily includes buildings, machinery, and fixed equipment. Labor is measured by the number of employees, while depreciation and interest payments are reported values from Amadeus, expressed as a percentage of total sales. Table 1 presents key summary statistics by country for k_{it} and τ_{it} .

Table 1: Summary Statistics by Country

country	k_{it}			τ_{it}		
	Mean	SD	N	Mean	SD	N
FRA	2.802	1.098	19,100	0.068	0.081	19,100
GER	3.502	1.227	2,717	0.103	0.098	2,717
HUN	2.992	1.275	1,090	0.066	0.057	1,090
ITA	3.680	1.237	29,741	0.076	0.122	29,741
SPA	3.425	1.241	29,584	0.069	0.055	29,584
UK	3.391	1.218	3,245	0.057	0.139	3,245

In brief, Italy and Germany exhibit, on average, the highest k_{it} , while France has the lowest. Tax rates are highest on average in Germany and Italy, with Germany also showing relatively high variability. The UK has the lowest mean τ_{it} but the greatest variation across observations. As sample sizes differ significantly—with Italy and Spain having the largest number of observations, and Hungary the smallest—this may affect the precision of these statistics. The notable differences in k_{it} and τ_{it} offer scope for exploring the differences in

attitudes toward corporate tax payments in relation to capital intensity across industries and countries. Table ?? shows summary statistics by industry.

4.2 Results from a Linear model

We begin by presenting country-level results from the linear specification (Equation 13), as shown in Table 2.

Table 2: Estimated Parameters by Country

Parameter	UK	Spain	Italy	Hungary	Germany	France
a_0	0.083*** (0.013)	0.092*** (0.001)	0.098*** (0.004)	0.083* (0.009)	0.101*** (0.010)	0.067*** (0.003)
a_k	0.005*** (0.002)	-0.001*** (0.0002)	0.0004 (0.0006)	-0.003*** (0.001)	0.002 (0.002)	0.005*** (0.000)
a_x	0.194*** (0.056)	0.006*** (0.0008)	0.017*** (0.002)	0.188*** (0.039)	0.208*** (0.029)	0.283*** (0.014)
AIC	-3630	-89339	-41196	-3203	-5027	-42900

Note: *p<0.1, **p<0.05, ***p<0.01. Standard errors in parentheses. All regressions include Two-digit NACE industry fixed effects and a time trend.

The coefficient α_k exhibits substantial heterogeneity across countries. It is positive for the UK, Germany, and France, suggesting that more capital-intensive firms in these countries face higher average tax rates. In contrast, the coefficient is negative for Spain, while for Italy and Hungary, no significant relationship between k_{it} and τ_{it} is identified. This preliminary cross-country variation in both the sign and significance of α_k indicates that a uniform marginal effect of k_{it} on τ_{it} does not provide an accurate representation of the true data generation process.

A formal test for non-linearity is conducted using a bootstrapped likelihood ratio (LR) statistic that accounts for potential endogeneity, following (D.Christopoulos, P.McAdam, and E. Tzavalis 2023). This test is based on estimating the following auxiliary regression, as proposed by (Luukkonen, Saikkonen, and Teräsvirta 1988):⁹

$$\tau_{it} = \phi_{0i} + \phi_k k_{it} + \phi_{k^2} k_{it}^2 + \phi_{k^3} k_{it}^3 + m_1 z_{1it}^* + m_2 z_{2it}^* + \omega_{it} \quad (16)$$

We test the null hypothesis $H_0 : \phi = 0$ against the alternative $H_1 : \phi > 0$. Under the null, the vector of ϕ parameters is jointly tested for significance at zero. Table 3 presents the

⁹Equation 16 is a third-order Taylor approximation around the origin of the linear function.

results by country for specification 16 indicating a rejection of the null hypothesis of a linear specification between k_{it} and τ_{it} for all countries. Consequently, the LSTM model—which allows the effect of α_k to vary across regimes—is the appropriate specification for our dataset.

Table 3: LR Test Bootstrapped p-values by Country

Country	Bootstrapped p-value
UK	0.0031
Spain	0.0001
Italy	0.0001
Hungary	0.0001
Germany	0.0001
France	0.0001

Note: The LR test specifies the null that parameters ϕ in 16 are jointly zero. The values reported are bootstrapped p-values of the LR test.

4.3 Results from Threshold Specification

Estimating the non-linear model in Equation 14 is challenging because standard optimization algorithms often struggle to find the global minimum of the objective function,

$$\min_{\theta, \gamma, \alpha_0, \alpha_k^\ell, \alpha_k^h, \alpha_x} \sum_{i,t} (\tau_{it} - \hat{\tau}_{it})^2,$$

where $\hat{\tau}_{it}$ is the predicted value from the model. This difficulty is especially pronounced when the model structure is characterized by multiple local minima. To address these challenges, we employ the grid search procedure of B. E. Hansen (2000). This method systematically explores a predefined range of values for the parameters of interest, θ and γ , allowing for a more thorough search of the parameter space. Within this process, the specification with the smallest sum of squared residuals in the objective function is identified as the best fit to the data providing the optimal set of values for θ and γ . Standard errors are computed using bootstrapping.

Turning to the results, we present estimates from specifications that treat k_{it} as both endogenous and exogenous (i.e., with and without the copula correction) in Tables 4 and 5, respectively, for comparability. Table 4 assumes that the threshold variable k_{it} evolves exogenously, which is admittedly restrictive given the potential correlation between k_{it} and unobserved determinants of τ_{it} .

4.4 Connecting Threshold Results to Cross-Country Evidence on Corporate Taxation

Broadly speaking, the results in Tables 4 and 5 are consistent with findings from the cross-country corporate taxation literature. The switch to a negative coefficient on α_k in the high-capital regimes indicates that higher investment levels do not necessarily translate into higher tax contributions. This pattern mirrors the results of Devereux, Griffith, and Klemm (2005) and Devereux, Griffith, and Klemm (2002), who show that while base broadening has offset statutory rate cuts for marginal investments, effective average tax rates on more profitable and mobile investments have declined due to international tax competition. Our findings also align with the firm-level evidence of Egger et al. (2009), which highlights substantial heterogeneity in effective tax rates across firms and countries. Furthermore, by uncovering the threshold at which the relationship between τ_{it} and k_{it} reverses, our results complement macro evidence on profit shifting, which shows that a large share of multinational profits is booked in low-tax jurisdictions, generating cross-country fiscal asymmetries (Tørsløv, Wier, and Zucman 2023).

4.5 Country Specific Results from Threshold Estimates

Table 4 shows insignificant links between k_{it} and τ_{it} in the upper regime for half of the countries, likely due to endogeneity bias. Since the endogenous threshold model provides a better fit and explanatory power based on AIC, we focus on the results from Table 5.

Table 4: Threshold Estimates by Country with Exogenous k_{it} , Equation 12

Parameter	UK	Spain	Italy	Hungary	Germany	France
γ	3.000 (2.8, 3.0)	1.700 (1.5, 1.9)	0.700 (0.6, 0.9)	0.900 (0.7, 1.0)	0.700 (0.6, 0.9)	1.200 (1.1, 1.4)
θ	1.896 (1.8, 2.1)	4.322 (4.1, 4.5)	2.090 (2.0, 2.2)	4.406 (4.2, 4.4)	4.885 (4.6, 4.8)	4.152 (3.9, 4.1)
α_0	0.107*** (0.015)	0.076*** (0.002)	0.020*** (0.005)	0.061*** (0.010)	0.070*** (0.012)	0.050*** (0.003)
α_k^ℓ	-0.032 (0.011)	0.007*** (0.001)	0.078*** (0.004)	0.008*** (0.003)	0.021*** (0.004)	0.014*** (0.001)
α_k^h	-0.000 (0.009)	-0.001*** (0.000)	0.006** (0.003)	-0.011*** (0.004)	-0.008 (0.005)	0.001 (0.001)
α_x	0.193*** (0.056)	0.007*** (0.001)	0.019*** (0.003)	0.219*** (0.040)	0.234*** (0.030)	0.303*** (0.015)
N^h	90	22	90	10	10	10
N	3245	29584	29741	1090	2717	19100
AIC	-3641	-89630	-41699	-3228	-5067	-43002

Note: *p<0.1, **p<0.05, ***p<0.01. Each regression includes two-digit NACE industry fixed effects and a time trend.

The estimates presented do not correct for endogeneity between τ_{it} and k_{it} . Bootstrapped confidence intervals for γ and θ are shown in parentheses below each estimate.

x is a composite variable of physical depreciation of capital and interest payments.

N^h is the percentage of observations in the upper regime. N denotes total sample size.

The linear model, Table 2 shows a positive coefficient for parameter α_k in four out of the six countries, indicating that, on average, an increase in k_{it} is associated with a higher effective tax rate, τ_{it} . When the framework allows the relationship between k_{it} and τ_{it} to vary across regimes—below and above a country-specific threshold θ —the scenario changes. The speed of transition is governed by the parameter γ , while α_k^ℓ and α_k^h capture the elasticities in the lower and upper regimes, respectively, in model 14. Overall, the relationship between k_{it} and τ_{it} is strongly regime-dependent. In several cases, the elasticity coefficients diverge sharply across regimes, indicating that k_{it} may either raise or reduce the effective tax rate, depending on whether the firm lies below or above the threshold θ .

Looking into individual countries, UK has a relatively low threshold ($\theta = 2.195$) and

moderate transition speed ($\gamma = 0.7$), which uncovers a meaningful shift in the tax response of the firm relative to its capital intensity. Below the threshold, $\alpha_k^\ell = -0.022$ the effect is negligible in statistical terms. However, once the threshold is surpassed, the effect intensifies sharply ($\alpha_k^h = -0.065$), suggesting that UK firms with higher k_{it} face considerably lower effective tax rates. This emphasises the growing ability of capital-rich firms to leverage depreciation allowances, tax deferrals, or exploit international tax planning opportunities.

Spain exhibits a different pattern. With a high threshold ($\theta = 4.182$) and faster transition ($\gamma = 1.2$), the initial elasticity is mildly positive ($\alpha_k^\ell = 0.005$), implying that early stages of capital accumulation may increase the tax burden—perhaps due to increased visibility to tax authorities or crossing statutory tax thresholds. However, once capital intensity exceeds the threshold, the elasticity becomes slightly negative ($\alpha_k^h = -0.003$), indicating that large, capital-intensive firms eventually enjoy marginal tax relief. Though modest, this change highlights how firm size and capital scale may influence tax incidence in complex ways.

Italy's results are particularly striking. With a high threshold ($\theta = 5.032$) and a very smooth transition ($\gamma = 0.1$), the country displays a dramatic reversal. In the lower regime, $\alpha_k^\ell = 0.147$, suggesting that capital accumulation is strongly associated with higher tax rates—possibly reflecting up-front investment taxes, limited deductions, or regulatory burdens for capitalizing firms. Yet, in the upper regime, the elasticity turns negative ($\alpha_k^h = -0.023$), indicating a shift in tax treatment once firms reach higher capital thresholds. This could signal preferential tax policies targeting large firms, or a non-linear effect of scale on tax optimization behavior.

For other countries, the pattern is more consistently negative across regimes. In Hungary, the elasticity shifts from $\alpha_k^\ell = 0.070$ to $\alpha_k^h = -0.092$, indicating a move from moderate tax increases at low capital levels to substantial tax reductions at high capital intensities. In Germany and France, k_{it} has no significant effect on τ_{it} below the threshold. However, once the threshold is exceeded, the elasticity turns negative: a 1% increase in k_{it} reduces the effective tax rate by about 4.6% in Germany and roughly 2% in France.

Table 5: Threshold Estimates by Country with Endogenous k_{it} , Equation 14

	UK	SPA	ITA	HUN	GER	FRA
γ	0.7 (0.1, 2.0)	1.2 (0.6, 2.0)	0.1 (0.1, 2.0)	0.1 (0.1, 2.0)	1.9 (0.1, 2.0)	0.5 (0.1, 2.0)
θ	2.195 (1.8, 4.8)	4.182 (3.8, 4.5)	5.032 (4.7, 5.0)	2.215 (1.4, 4.4)	3.873 (1.9, 4.8)	4.097 (1.8, 4.4)
α_0	0.416*** (0.121)	0.092*** (0.011)	-0.300*** (0.022)	0.131*** (0.053)	0.339*** (0.077)	0.148*** (0.021)
α_k^ℓ	-0.022 (0.016)	0.005*** (0.002)	0.147*** (0.007)	0.070*** (0.014)	-0.008 (0.010)	-0.001 (0.004)
α_k^h	-0.065*** (0.018)	-0.003*** (0.001)	-0.023*** (0.008)	-0.092*** (0.015)	-0.046*** (0.012)	-0.019*** (0.004)
α_x	0.201*** (0.054)	0.007*** (0.001)	0.019*** (0.002)	0.222*** (0.041)	0.236*** (0.034)	0.301*** (0.014)
Cop	0.085*** (0.025)	0.003 (0.002)	-0.067*** (0.004)	0.021** (0.011)	0.065 (0.016)	0.019*** (0.004)
N^h	86	26	12	28	39	11
N	3245	29584	29741	1090	2717	19100
AIC	-3651.21	-89630.70	-41732.40	-3242.08	-5082.22	-43022.70

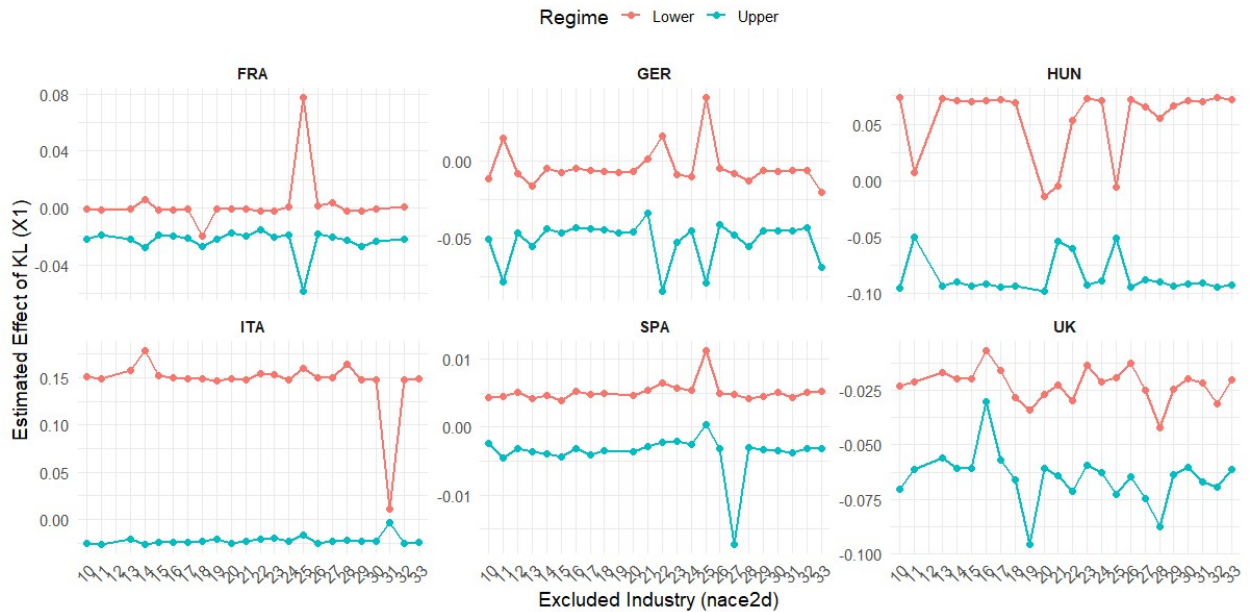
Note: *p<0.1, **p<0.05, ***p<0.01. Each regression includes two-digit NACE industry fixed effects and a time trend. The estimates presented do not correct for endogeneity between τ_{it} and k_{it} . Parametrically bootstrapped standard errors (SE) are in parentheses below the corresponding coefficients.

Bootstrapped confidence intervals for γ and θ are shown in parentheses below each estimate. x is a composite variable of physical depreciation of capital and interest payments. N^h is the percentage of observations in the upper regime. N denotes total number of observations.

5 Jackknife Sensitivity

To evaluate the robustness of the estimated effect of k_{it} on τ_{it} and test the influence of individual sectors, we conduct a jackknife sensitivity analysis at the country level. Specifically, we iteratively exclude one NACE 2-digit industry at a time and re-estimate the LSTAR model on the reduced sample. For each iteration, we re-optimize the threshold parameter θ and the transition parameter γ by minimizing AIC, ensuring consistency with the original estimation procedure. We then extract two regime-specific k_{it} coefficients: the marginal effect in the lower regime, and the total marginal effect in the upper regime (i.e., the sum of the baseline k_{it} coefficient and the interaction term with the transition function). This procedure yields a distribution of coefficient estimates for each country and enable us to assess both the stability and leverage of individual industries. The results are visualized in a faceted plot by country, Figure 1, with each line representing the evolution of the regime-specific k_{it} effects across jackknife iterations.

Figure 1: Jackknife Estimates of k_{it} : Lower vs. Upper Regimes

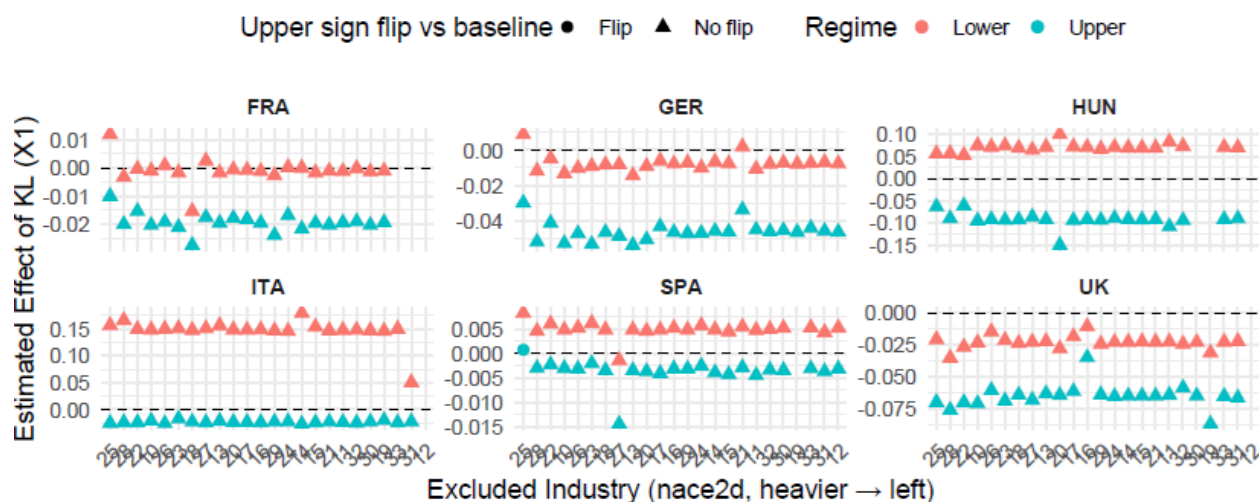


The cross-country evidence reveals a negative and statistically significant k_{it} effect in the upper regime (blue line), indicating that firms operating above the estimated capital-intensity threshold tend to face lower effective corporate tax rates. This effect is particularly stable in countries such as Italy and Hungary, where the upper-regime estimates remain robust to most industry exclusions. By contrast, the lower-regime estimates (red lines) are generally

smaller in magnitude. They remain negative with limited variation across jackknife iterations, suggesting a relatively uniform marginal tax response among low-capital-intensive firms.

Figure 1 further illustrates that upper-regime effects are stable in sign, with disturbances concentrated in the so-called “heavy-industry” sectors—notably Chemicals (NACE 20), Rubber & Plastics (NACE 22), Non-metallic Minerals (NACE 23), Basic Metals (NACE 24), and Fabricated Metals (NACE 25). Excluding these sectors occasionally produces sign reversals, especially in Germany, Spain, and the UK.

Figure 2: Jackknife Estimates of k_{it} : Lower vs. Upper Regimes (Excluding Heavy Industries)



Note: Each point excludes one NACE 2-digit industry (ordered by sample weight). Vertical dashed lines correspond to the exclusion of heavy-industry sectors—Chemicals (20), Rubber and Plastics (22), Non-metallic Minerals (23), Basic Metals (24), and Fabricated Metals (25). Blue lines represent upper-regime effects, while red lines correspond to lower-regime effects. Shaded areas mark instances of sign reversal relative to the baseline estimation.

Figure 2 displays the jackknife estimates after excluding heavy-industry sectors (Chemicals, Rubber and Plastics, Non-metallic Minerals, Basic and Fabricated Metals). Excluding these industries substantially stabilizes the upper-regime coefficients across all countries, reducing both variance and sign reversals relative to the baseline results. The smoother profiles, particularly in Germany and the UK, indicate that a small number of capital-intensive sectors were driving much of the volatility in the upper-regime estimates. This underscores that capital-intensive industries exert disproportionate influence on the upper-regime coefficients. Rather than signaling model fragility, this pattern reflects a structural feature of the data: the behavior of capital-intensive sectors above the estimated threshold is systematically distinct from that of other industries. By removing these sectors, the leverage of the upper-regime

coefficient diminishes, highlighting that tax-base sensitivity to capital deepening is concentrated in a narrow set of technologically advanced, highly capitalized industries. In this sense, the observed nonlinearity in tax responses emerges not as a statistical artifact but as an intrinsic property of the production structure in these economies.

Taken together, the jackknife results show that while a negative upper-regime k_{it} effect is a consistent feature in some countries (e.g., Italy and Hungary), it is not invariant to sectoral composition. In France, Germany, Spain, and the UK, the upper-regime k_{it} effect is close to zero or negative and remains robust across most industry exclusions. These findings highlight the influential role of “heavy” industries in shaping estimation outcomes and emphasize the importance of accounting for sector-specific dynamics when interpreting non-linear tax responses.

6 Validation of the Two-Sector Model: Elasticities, Transitions, and Simulations

This section evaluates the predictive power of the two-sector model presented in Section 2 by examining both the estimated elasticities and the simulation-based dynamics of effective tax rates. The aim of this model-based validation is to assess whether the theoretical predictions developed in Section 2—particularly the nonlinear relationship between k_{it} and τ_{it} —can account for the empirical patterns observed across a diverse set of countries. By linking empirical estimates to simulation-based validation, we conduct a comprehensive assessment of the model’s three core propositions: (i) tax responsiveness to capital accumulation, (ii) intersectoral capital mobility, and (iii) sectoral elasticity of substitution in production.

6.1 Elasticity Estimates and Transition Function Evidence

We begin by validating the model through direct estimation of regime-specific elasticities and transition functions, using Equation 14 to capture the empirical relationship between effective tax rates (τ_{it}) and capital intensity (k_{it}). These estimates provide a country-level perspective on how responsive τ_{it} is to changes in k_{it} , and whether this responsiveness differs between low- and high-capital regimes.

The results support Proposition 1, which states that higher values of β —the tax rate’s responsiveness to capital accumulation—should result in sharper reductions in effective tax rates at higher levels of capital intensity. In UK and Italy, we observe substantial regime-dependent shifts. For the UK, the lower-regime elasticity is statistically insignificant, while in the upper regime turns negative and economically meaningful ($\alpha^h = 0.065^{***}$). Italy shows a similar

reversal: a positive lower-regime elasticity ($\alpha^l = 0.147^{***}$), but a negative upper-regime elasticity ($\alpha^h = -0.023^{***}$). These figures align with theoretical predictions of a turning point beyond which k_{it} drives down effective tax rates.

Evidence for Proposition 2, concerning capital mobility (m), is provided by the shape of the estimated transition functions. France, Germany, Spain, and the UK display pronounced S-shaped transitions, indicating sharp nonlinear shifts between tax regimes. These transitions suggest high capital mobility, where firms rapidly respond to small differences in productivity or tax policy by reallocating capital-intensifying shifts in effective tax rates. In Spain, for example, the elasticity shifts from ($\alpha^h = 0.005^{***}$) to ($\alpha^h = -0.003^{***}$), a relatively small but statistically meaningful reversal, reflecting a heightened sensitivity of the tax base to capital movement.

In contrast, the estimated transition functions for Hungary and Italy are notably smoother and more gradual. This observation supports Proposition 3, which posits that lower elasticity of substitution in the HC sector (σ_{HC}) slows the reallocation of capital and dampens the responsiveness of tax rates. Such frictions attenuate the impact of capital deepening on tax rates and result in a more gradual shift between tax regimes.

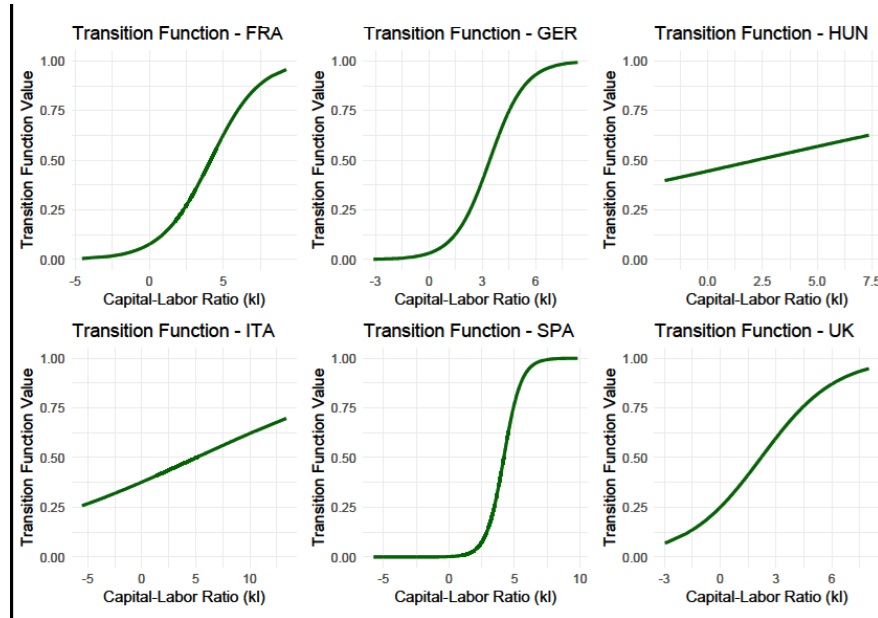


Figure 3: Capital-labor ratio (k_{it}) and transition function values

Figure 3 displays the transition functions for all countries, illustrating how k_{it} shapes the movement between tax regimes. In France, Germany, Spain, and the UK, the transition curves exhibit a clear **S-shaped pattern**, consistent with the model's prediction of threshold effects in capital deepening. These countries likely feature higher tax sensitivity parameters (β),

greater capital mobility (m), and possibly higher elasticity of substitution in the high-capital sector (σ_{HC}). Together, these factors amplify capital shifts toward the capital-intensive sector, causing τ_{it} to decline sharply once k_{it} passes a critical level.

In contrast, Hungary and Italy display flatter and more linear transition functions, suggesting a slower and more predictable reallocation of capital. From a theoretical perspective, these patterns indicate lower values of β , weaker capital mobility, or smaller productivity and substitutability differences between sectors. Consequently, the erosion of the tax base unfolds more gradually in these economies. Overall, the empirical transition curves support two of the model's key propositions: (a) economies with stronger capital and labor reallocation dynamics show abrupt tax transitions; and (b) the shape of the transition function directly is driven by the underlying structural and fiscal parameters governing tax sensitivity with respect to capital accumulation, inter-sectoral capital mobility, and within sector productivity differences.

6.2 Simulated Tax Rate Dynamics: Calibration and Model Fit

As an additional verification of model's theoretical propositions, we simulate the dynamics of τ_{it} using calibrated parameters derived from the empirical estimates. Specifically, we sample k_{it} values based on observed national distributions, thereby ensuring that simulations reflect realistic economic conditions.

Calibration proceeds in three steps. In step 1, we take the LSTAR estimates: $\hat{\alpha}_{0,c}$, $\hat{\alpha}_{k^\ell,c}$, $\hat{\alpha}_{k^h,c}$, $\hat{\alpha}_{x,c}$, $\hat{\theta}_c$, and $\hat{\gamma}_c$ (including the copula correction term) for each c from Table 5. We then set k_{it} to the country-level mean, while industry fixed effects and the time trend are set equal to zero for the simulation. In step 2, we draw ϕ from the empirical country-specific distribution of firm-level k_{it} (with replacement) to preserve the observed dispersion. We allow for 1000 draws per country. In step 3, for each draw ϕ and country c , we compute the following logistic transition function:

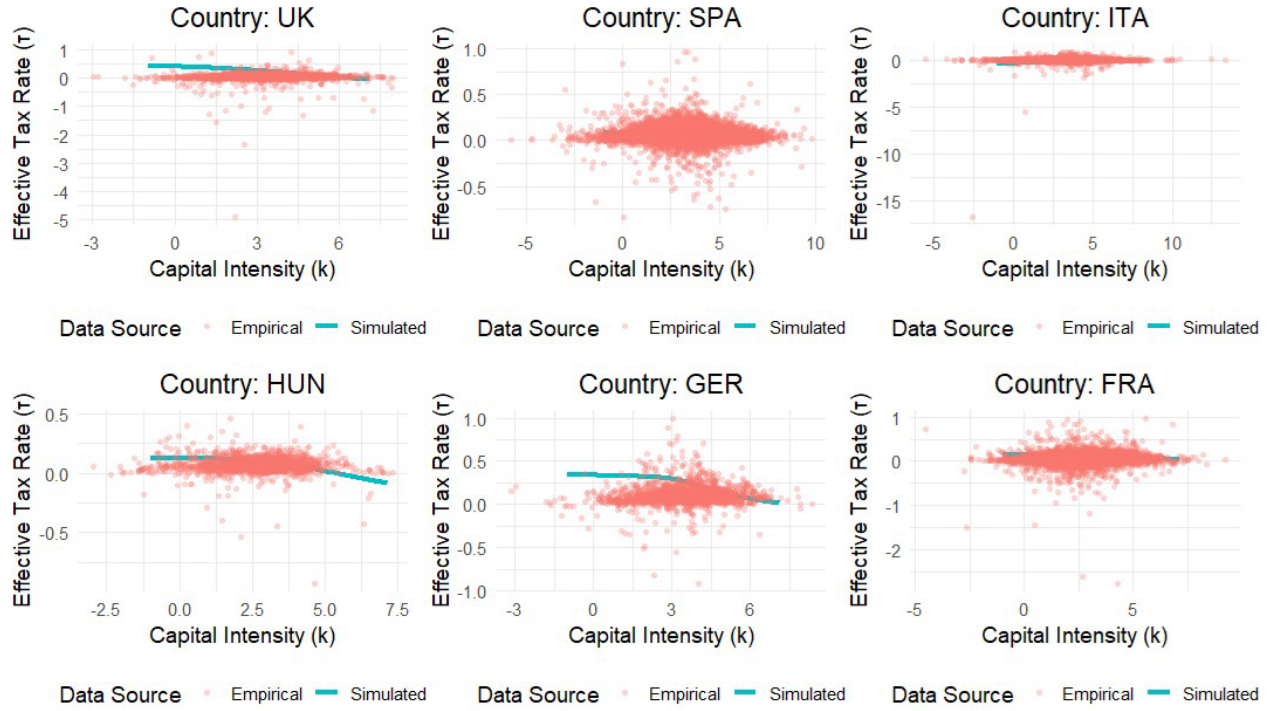
$$G_c(\phi; \hat{\theta}_c, \hat{\gamma}_c) = \left[1 + \exp \left\{ -\hat{\gamma}_c(\phi - \hat{\theta}_c) \right\} \right]^{-1}$$

and then evaluate the LSTAR equation

$$\hat{\tau}(k) = \hat{\alpha}_{0,c} + \left[\hat{\alpha}_{lk,c} + (\hat{\alpha}_{hk,c} - \hat{\alpha}_{lk,c}) G_c \left(k; \hat{\theta}_c, \hat{\gamma}_c \right) \right] k + \hat{\alpha}_{x,c} \hat{x}_c,$$

including the copula correction term. Figure 4 reports, for each country, the conditional mean of $\hat{\tau}(k)$ and the 5-95% bands across the 1000 draws. Calibration results for each country are depicted in the following graph.

Figure 4: Comparison of simulated and actual values for the τ_{it} - k_{it} relationship



In Spain, Hungary, and Germany, the simulated effective tax rate curves exhibit a clear downward trajectory as capital intensity increases—mirroring the nonlinear relationship predicted by the model. Notably, Spain’s simulated tax path successfully captures much of the dispersion and curvature found in the empirical data. Similar fidelity is observed for Hungary and Germany, where the simulations reproduce both the central tendency and the structural transitions between low- and high-capital regimes. These findings affirm the model’s ability to replicate real-world tax rate dynamics when calibrated with country-specific data.

In contrast, the simulations for the UK, Italy, and France yield flatter curves that remain close to zero across the full range of observed capital intensities. While this outcome is broadly consistent with the clustering of empirical tax rates near zero in these countries, the simulations fail to reproduce the more extreme or nonlinear features evident in the data. Italy’s empirical data include several outliers with highly negative effective tax rates, which the model does not capture. This mismatch might suggest the presence of country-specific factors—such as targeted tax credits, special economic zones, or aggressive profit-shifting strategies—that are not currently accounted for in the model’s framework.

Bringing together the results from the elasticity estimates and the simulation-based analysis reveals a consistent pattern: the model performs well in countries where structural features—capital mobility, tax responsiveness, and input substitutability—are dominant forces shaping tax

outcomes. In Spain, Germany, and Hungary, the theoretical mechanisms underpinning the model are clearly reflected in the data, and the simulated tax rate paths closely track empirical trends. This coherence provides strong support for the model's internal validity and external relevance.

However, the model is less successful in capturing the tax dynamics in Italy, the UK, and, to some extent, France, where either τ_{it} show limited variation or where extreme values challenge the model's assumptions. These discrepancies may stem from real-world complexities not fully incorporated into the model, such as: (a) multinational profit-shifting strategies and tax arbitrage not explicitly modelled; (b) weak enforcement mechanisms or inconsistently applied tax rules; (c) significant firm-level heterogeneity in tax compliance and financial structuring.

The combined evidence from elasticity estimates and tax rate simulations underscores the relevance of capital intensity, mobility, and substitutability in shaping effective corporate tax rates. At the same time, the observed inconsistencies in some national contexts highlight critical areas for refinement. A more nuanced integration of institutional and firm-specific characteristics will be essential to enhance the model's explanatory power and policy relevance across a broader range of economic settings.

7 Conclusion and Policy Implications

Our main contribution to the literature is to challenge the conventional wisdom of a uniformly positive effect of capital accumulation on corporate tax payments. To this end, we develop and empirically validate a model that allows for endogenous responses in capital accumulation and corporate tax burdens within an estimating framework that explicitly accounts for non-linearities. We demonstrate that the relationship between capital per worker and the effective tax rate is strongly non-linear. The positive association suggested by baseline linear models disappears once capital per worker endogenously exceeds a critical threshold. Beyond this point, the capital intensity–tax burden relationship becomes regime-dependent. In particular, the coefficients for the upper regime are significantly negative across all countries, indicating systematic erosion of the effective tax base at higher levels of capital intensity. This pattern is especially pronounced in Hungary, the UK, and Germany, though also evident in Italy and Spain. Robustness checks and sensitivity analyses confirm that these results are not driven by outliers or specification choices.

Our regime-specific findings highlight that firms may effectively reduce their tax liabilities through strategic planning, tax incentives, or deductions once capital deepening passes a critical threshold. This behavior underscores the importance of incorporating non-linear

effects when evaluating tax policies. The empirical confirmation of the key propositions in our theoretical framework forms a strong basis for several policy considerations. First, linear approaches are inappropriate for capturing the complex relationship between capital intensity and corporate tax liabilities. Second, tax systems in capital-abundant economies are highly sensitive to structural reallocations and sectoral shifts in productivity. Countries with high capital mobility and more elastic production technologies are especially prone to sharp tax base erosion, underscoring the need for fiscal frameworks that anticipate and mitigate the destabilizing effects of capital deepening. Third, corporate tax reforms should aim not merely to incentivize capital accumulation, but to promote productive and innovation-driven investment. The design of incentives and depreciation schemes should account for heterogeneity in firms' capital structures and their varying capacities to transform capital deepening into real productivity gains.

A key avenue for future research is to investigate the broader macroeconomic consequences of differential tax responses in high- versus low-capital intensity environments.

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Appendix A: Two Sector Model with Capital Mobility

Appendix A1: Derivation of MPK and Sectoral Capital Accumulation

This section shows the derivation of the MPK_i for a CES production function and the derivation of sector-specific capital accumulation. We first recall capital accumulation in each sector $i \in \{LC, HC\}$:

$$\dot{k}_{LC} = (1 - \tau_0)f_{LC}(k_{LC}) - c_{LC} - \delta k_{LC} - m \cdot \max\{0, MPK_{HC} - MPK_{LC}\} \quad (4.a)$$

$$\dot{k}_{HC} = (1 - \tau_0)f_{HC}(k_{HC}) - c_{HC} - \delta k_{HC} + m \cdot \max\{0, MPK_{HC} - MPK_{LC}\} \quad (4.b)$$

Each sector is characterized by a CES production function:

$$y_i = A_i [\alpha_i k_i^{\rho_i} + (1 - \alpha_i)]^{\frac{1}{\rho_i}} \quad (A1.1)$$

The marginal product of capital (MPK) derived from this production function is:

$$MPK_i = \frac{A_i \alpha_i}{K_i} \cdot k_i^{\rho_i} \cdot [\alpha_i k_i^{\rho_i} + (1 - \alpha_i)]^{\frac{1}{\rho_i} - 1} \quad (A1.2)$$

where notation of (A1.2) is the same as in section 2.1.

Substituting Equation (A1.2) into Equations (4.a) and (4.b), we obtain:

$$\begin{aligned} \dot{k}_{LC} = & (1 - \tau_0)f_{LC}(k_{LC}) - c_{LC} - \delta k_{LC} \\ & - m \cdot \max \left\{ 0, \frac{A_{HC}\alpha_{HC}}{K_{HC}} k_{HC}^{\rho_{HC}} [\alpha_{HC} k_{HC}^{\rho_{HC}} + (1 - \alpha_{HC})]^{\frac{1}{\rho_{HC}} - 1} \right. \\ & \left. - \frac{A_{LC}\alpha_{LC}}{K_{LC}} k_{LC}^{\rho_{LC}} [\alpha_{LC} k_{LC}^{\rho_{LC}} + (1 - \alpha_{LC})]^{\frac{1}{\rho_{LC}} - 1} \right\} \end{aligned} \quad (A1.3)$$

$$\begin{aligned} \dot{k}_{HC} = & (1 - \tau_0)f_{HC}(k_{HC}) - c_{HC} - \delta k_{HC} \\ & + m \cdot \max \left\{ 0, \frac{A_{HC}\alpha_{HC}}{K_{HC}} k_{HC}^{\rho_{HC}} [\alpha_{HC} k_{HC}^{\rho_{HC}} + (1 - \alpha_{HC})]^{\frac{1}{\rho_{HC}} - 1} \right. \\ & \left. - \frac{A_{LC}\alpha_{LC}}{K_{LC}} k_{LC}^{\rho_{LC}} [\alpha_{LC} k_{LC}^{\rho_{LC}} + (1 - \alpha_{LC})]^{\frac{1}{\rho_{LC}} - 1} \right\} \end{aligned} \quad (A1.4)$$

These expressions illustrate how sectoral differences in marginal productivities govern

inter-sectoral capital flows. When $MPK_{HC} > MPK_{LC}$, the reallocation term becomes positive in Equation (A1.4) and negative in Equation (A1.3), reflecting the directional flow of capital toward the more productive sector.

Proof of Sufficient Condition (Equation 11)

$$\frac{dT}{dt} = \frac{d}{dt} [\tau_{LC} Y_{LC} + (\tau_0 - \beta z(t)) Y_{HC}] \quad (17)$$

$$= \tau_{LC} \frac{dY_{LC}}{dt} + (\tau_0 - \beta z(t)) \frac{dY_{HC}}{dt} - \beta \frac{dz}{dt} Y_{HC} \quad (18)$$

Total taxes will fall if:

$$\tau_{LC} \frac{dY_{LC}}{dt} + (\tau_0 - \beta z(t)) \frac{dY_{HC}}{dt} < \beta \frac{dz}{dt} Y_{HC} \quad (19)$$

Proof of Necessary Condition (Equation 12)

From the above, the necessary condition is:

$$\frac{d^2 T}{dt^2} < 0 \quad (20)$$

Appendix B: Additional Summary Statistics

Summary Statistics by NACE 2-digit Industry

nace2d	k_{it}			τ_{it}		
	Mean	SD	N	Mean	SD	N
10	3.75	1.22	8,647	0.07	0.06	8,647
11	4.82	1.04	1,350	0.06	0.07	1,350
12	3.29	0.50	42	0.03	0.04	42
13	3.26	1.36	2,929	0.07	0.13	2,929
14	2.56	1.52	2,532	0.06	0.07	2,532
15	2.52	1.36	1,873	0.06	0.06	1,873
16	3.37	1.12	3,864	0.06	0.05	3,864
17	3.71	1.28	1,972	0.08	0.09	1,972
18	3.27	1.10	2,929	0.08	0.08	2,929
19	4.97	1.62	172	0.09	0.07	172
20	4.01	1.21	3,305	0.07	0.06	3,305
21	4.10	1.03	711	0.08	0.08	711
22	3.44	1.13	5,883	0.08	0.07	5,883
23	3.85	1.24	4,902	0.07	0.09	4,902
24	3.84	1.23	2,316	0.07	0.08	2,316
25	3.11	1.16	19,919	0.08	0.07	19,919
26	2.92	1.26	3,564	0.07	0.08	3,564
27	3.02	1.23	3,558	0.07	0.08	3,558
28	3.10	1.20	9,883	0.06	0.07	9,883
29	3.25	1.18	2,087	0.07	0.07	2,087
30	3.32	1.38	898	0.07	0.07	898
31	3.29	1.11	3,679	0.06	0.28	3,679
32	3.16	1.25	1,908	0.06	0.09	1,908
33	2.97	1.29	811	0.08	0.05	811

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Bennett School
of Public Policy

Bennett School for Public Policy
Alison Richard Building
7 West Road, Cambridge CB3 9DT

Email: enquiries@bennettschool.cam.ac.uk
bennettschool.cam.ac.uk

