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Abstract

We analyze how interactions between corporate taxation and corporate governance affect shareholder capital. Using a model with strategic interaction between managers and outside shareholders, we hypothesize that, while an increase in the corporate tax rate decreases shareholder capital, an increase in tax enforcement attenuates this effect. The tax effect is less severe if firms have a more dispersed ownership structure. Empirically, using a large panel of European firm-level data, we find support for these hypotheses.

JEL-Code: G320, H250, H260.

Keywords: corporate taxation, corporate governance, managerial diversion, shareholder capital, tax enforcement.

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1 Introduction

In the neoclassical sense, corporate taxation can be viewed as a transfer from shareholders to the government. Chen et al. (2010) claim that the "government (federal, state and local) takes a greater than one-third share of a firm's pre-tax profits" (p.41). Desai et al. (2007) highlight that "the state, thanks to its tax claim on cash flows, is de facto the largest minority shareholder in almost all corporations" (p.592). Further, Hellwig (2000) puts it as follows: "The political system may be seen as a stakeholder in its own right. At one level, there is an immediate financial interest, ranging from a concern about corporate income taxes to campaign contributions and, more generally, the ability to induce corporations to finance activities that the politician wants to get off the governments budget" (p.123f).

According to this view, taxation would decrease investment by outside shareholders, whereas tax evasion and avoidance could benefit shareholders and have a positive effect on investment. However, it completely abstracts from informational asymmetries between different stakeholders within the firm (corporate governance problem). With such an asymmetry between managers and outside shareholders, taxation could also constrain managers in their ability to divert money away from the firm, thereby affecting the incentives of outsiders to invest in the firm positively.[1] In this sense, corporate taxation could complement the role of debt in Jensen's (1986) Free Cash-Flow Theory. Hence, there may not only be a (negative) neoclassical, but also a (positive) corporate governance channel through which taxation affects investment and firm value.

Whereas recent studies focus on firm value in analyzing these competing channels of corporate taxation, our attention to nonlisted firms allows us to analyze how interactions between ownership structure and corporate taxation affect the decision to invest in shareholder capital. Indeed, for listed firms the market price is believed to perfectly adjust to taxation, diversion and other factors, leaving the investment volume unaltered. For nonlisted firms, both price and volume are affected, and we find the evidence of the latter in our sample.

[1] For a description of how managerial diversion happens in reality, see e.g. Desai et al. (2007), Desai and Dharmapala (2008) or Desai and Moel (2008). Note that perquisite consumption would have similar implications in our theoretical model. However, empire building or pet projects would not.

Theoretically, we use a generalized version of a model we set up in Krämer and Lipatov (2012), in which managers and outside shareholders strategically decide on the levels of diversion and investment, respectively. In line with the model, we hypothesize the following: first, an increase in corporate taxation decreases the amount of shareholder funds. We also derive the conditions under which this decrease is lower if corporate governance problems are more pronounced. Second, the amount of shareholder capital is positively related to the detection probability of managerial diversion. Again, we derive the conditions under which an increase in the detection probability lowers the negative effect of taxation. Lastly, higher costs of managerial diversion lead to an increase in shareholder capital.

To test these hypotheses, we employ fixed-effects estimations to a large panel of European firm-level data. In doing so, we use the ownership structure of firms to proxy their corporate governance environment. We find evidence for all of the described hypotheses. Precisely, for the whole sample of firms, shareholder capital decreases by about $9,800€$ if the corporate tax rate increases by 1 p.p. This negative effect is lower if firms have no shareholder owning more than 50% of the firm, highlighting the role of corporate governance for the effect of corporate taxation. Also, tax enforcement reduces the negative effect of taxation. We interpret this as a clear indicator for the presence of a corporate governance problem. Indeed, in the absence of such a problem, weak enforcement per se should render any effect of tax obsolete. Since the opposite happens in our data, there must be an additional mechanism through which enforcement interacts with taxation. Managerial diversion may serve as such a mechanism.

Lastly, shareholder capital is lower for firms with dispersed ownership, pointing to a negative impact of managerial diversion opportunities on investment.

Only recently, a small but growing literature attempts to incorporate problems related to corporate governance into tax research. First, Desai et al. (2007) show that corporate taxation affects firm value positively if the corporate governance system is weak and tax enforcement exceeds a certain threshold. Desai and Dharmapala (2009) analyze the impact of tax evasion on firm value. They find a value-increasing effect only for firms with institutional owners and attribute this to the larger monitoring possibilities of such owners. Finally, Krämer and Lipatov (2012) analyze the impact of managerial diversion opportunities on shareholder value and find that corporate taxation benefits firms for which a corporate governance problem is more

prevalent.[2] Against this background, our analysis shows that the corporate governance channel of taxation is not restricted to firm value or other performance measures, but also affects the level of investment in shareholder capital.

Second, our study is linked to recent papers in capital structure research attempting to disentangle the effect of corporate taxation for firms with different corporate governance structures. Stöckl and Winner (2010) find a stronger impact of corporate taxation for large firms and explain this with a positive relation between diversification and firm size. However, Overesch and Voeller (2010) find the opposite and rationalize this with larger informational asymmetries between different stakeholders in large corporations. Desai et al. (2004), Hebous and Weichenrieder (2010) and Schindler and Schjelderup (2010) focus on an international setting and show that wholly-owned multinational affiliates react stronger to shifts in the corporate tax rate, as compared to their partially-owned counterparts. These "costs of shared ownership" can be attributed to diverging interests between the multinational parent company and domestic owners. Krämer (2012a) finds that costs of shared ownership do not entirely depend on internationality, but are also present in domestic affiliates and stand alone firms. This may be due to larger monitoring possibilities of large shareholders forcing managers to use interest deductibility provisions more efficiently. Finally, Krämer (2012b) finds that the adjustment of leverage to corporate taxation is weaker for family firms than for nonfamily firms, independent of whether these firms are listed or not. Our results relate to this literature in showing that interactions between corporate taxation and corporate governance are not restricted to overall leverage, but also affect issued share capital.

The rest of the paper proceeds as follows. Section 2 describes the setup of the model and derives hypotheses from it. Section 3 first delivers a description of the data. Based on this, it comments on the identification technique and presents empirical results. Finally, Section 4 concludes.

[2] Additionally, Koethenbürger and Stimmelmayr (2010) take a welfare perspective and analyze the impact of deductibility provisions in an agency framework. They show that welfare is reduced if the tax system fully exempts the return on investment from taxation.

2 The Model

2.1 Model setup

To derive our theoretical predictions, we consider a simple game with 2 players, which is a generalized version of the model employed in Krämer and Lipatov (2012). Managers maximize their rents[3] choosing the proportion of diversion:

$$\left(\lambda\left(1-D\right)\left(1-t\right)+\left(1-p-pst\right)D\right)v\left(k\right)-\gamma c\left(D\right), \tag{1}$$

where D is the proportion of diversion, λ is the share of managers in shareholder capital (offered to them as a part of an optimal incentive contract, for example), t is the tax rate, p is the probability to be audited, s is a surcharge rate to pay when caught diverting. Note that in this formulation the fine is proportional to the amount of evaded tax. We have also considered the cases in which (i) the fine is proportional to the amount of diversion and (ii) the fine is lump-sum. In both cases, our qualitative results remain robust. In particular, we are able to formulate the same hypotheses for empirical testing.

Note that tax audits (we use the term "tax enforcement" in the remainder of the paper) serve here to detect managerial diversion. We share this assumption with the literature in the field (e.g. Desai et al 2007); our results are preserved if there is an imperfect correlation between tax fraud detection and managerial diversion detection.

Further, $v\left(k\right)$ is the value of the firm as a function of the capital invested, and c is the cost of diversion. Here, $\gamma\in\left(0,+\infty\right)$ reflects the ease of diverting resources from shareholders to managers. $c\left(D\right)$ is a convex strictly increasing function with $c\left(0\right)=0$, $v\left(k\right)$ is a concave strictly increasing function with $v\left(0\right)=0$.

Shareholders maximize their after-tax after-diversion income choosing the level of investment in shareholder capital k:

$$\left(\left(1-\lambda\right)\left(1-D\right)+pD\right)\left(1-t\right)v\left(k\right)-k. \tag{2}$$

[3]We assume that when caught, the managers as shareholders do not get back the amount they diverted from themselves. An alternative interpretation would be that the managers do not get their bonuses if caught diverting. We thank Sebastian Krautheim for this interpretation.

We choose to model shareholders as a strategic player, because we want to focus on nonlisted firms. Unlike listed firms, they typically have a very limited number of shareholders who can act coordinated and take the managerial diversion into account. Tax and auditing policy are exogenous to our model. The fine is paid to the government and shareholders do not benefit from it.

The best response of the managers is implicitly given by

$$(1 - p(1 + st) - \lambda(1 - t))\, v(k) = \gamma c'(D). \tag{3}$$

The best response of the shareholders is defined by

$$(1 - \lambda + D(p - 1 + \lambda))(1 - t)\, v'(k) = 1. \tag{4}$$

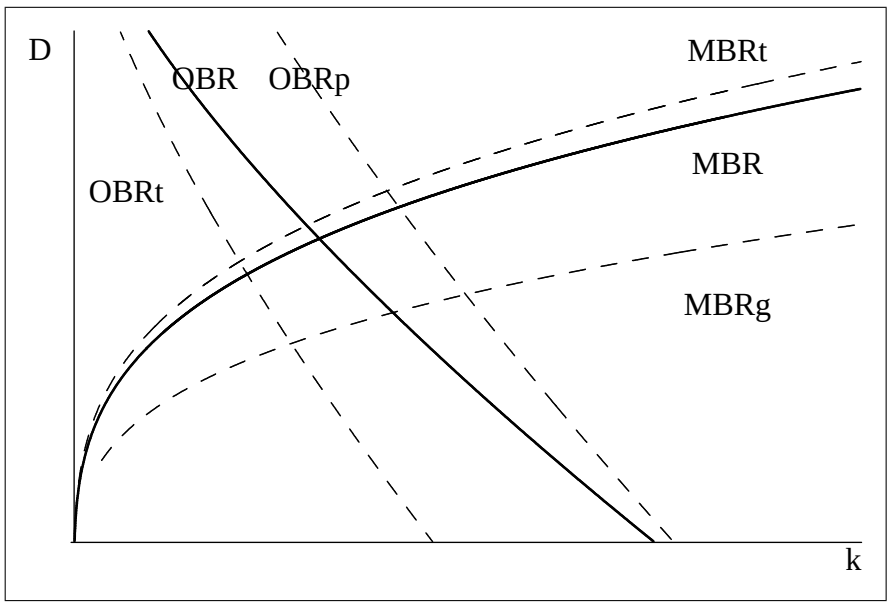
The marginal cost of investment is unity by assumption; it must be equal to the marginal benefit (lhs).

The intersection of the best responses defines a Nash equilibrium (D^*, k^*) of our game. In the following, we look at the effects of parameters on equilibrium investment k^*.

2.2 Comparative statics

To derive our hypotheses, we plot the equilibrium as an intersection of the curves described by (3)-(4). We see that the managers' best response curve (MBR) is positively sloped (since $1 - p(1 + st) > \lambda(1 - t)$ is a necessary condition for interior equilibrium existence). The shareholders' best response curve (OBR) is negatively sloped, if $1 - p > \lambda$, and, in line with Desai and Dharmapala (2008), we assume throughout that this restriction holds.

Figure 1: Best responses.



Raising the diversion difficulty γ directly increases the marginal cost of diversion. From (3) we see that $c'(D)$ and hence D has to decrease in order to compensate for this increase. MBR then shifts downwards to MBRg. As a result, the equilibrium value of capital goes up. This allows us to formalize the following hypothesis:

Hypothesis 1 Higher costs of diversion are associated with higher shareholder capital.

Raising the tax rate t increases the marginal benefit of diversion (there is no tax on diverted funds), so from (3) D has to increase, shifting MBR upwards to MBRt. At the same time, the marginal benefit of investment also decreases, so from (4) $v'(k)$ has to go up and hence k has to go down. OBR shifts left to OBRt. The equilibrium value of capital goes down, which leads to

Hypothesis 2 A higher corporate tax rate is associated with lower shareholder capital.

Raising the detection probability p decreases the marginal benefit of diversion. From (3) D has to decrease, shifting MBR downwards to MBRg. At

the same time, the marginal benefit from investment increases (resources detected as diverted are returned to the shareholders), so k has to go up. Thus, OBR moves right to OBRp. As a result, the equilibrium value of capital goes up. The following hypothesis obtains:

Hypothesis 3 A higher detection probability is associated with higher shareholder capital.

All three hypotheses are derived analytically in the appendix. As they feature our empirical analysis, we are also interested in the cross-effects of (i) tax rate and diversion difficulty; (ii) tax rate and tax enforcement.

As we have seen above, higher diversion difficulty is associated with higher shareholder capital and lower diversion. The pure scale effect implies that for a higher stock of capital, the effect of the corporate tax is amplified. At the same time, since the effect of the tax is stronger with higher diversion and the diversion is reduced by higher costs, the effect of the corporate tax is inhibited. If the effect through k dominates the effect through D, we have the following hypothesis:

Hypothesis 4 The negative effect of a corporate tax increase is amplified by the difficulty to divert.

The analytical derivation of this hypothesis is not straightforward, and we present it in the appendix under further restrictions.

Finally, the cross-effect of the detection probability p also depends on whether the scale effect via shareholder capital or the effect through diversion dominates. If the effect through D dominates the effect through k, we can state the following:

Hypothesis 5 The negative effect of a corporate tax increase is inhibited by tax enforcement.

Note that assuming a constant elasticity of shareholder capital to the capital tax rate, we can control for the scale effect by employing a log-log specification (using logarithms of shareholder capital and corporate tax rate instead of their levels) in our estimation. To preview our empirical results, we do not find a significant effect of the difficulty in diversion on the corporate tax effect, but we do find a significant negative (consistent with our theoretical prediction) effect of tax enforcement via diversion on the corporate tax effect on shareholder funds.

3 Empirical analysis

3.1 Data and descriptive statistics

To test the hypotheses from our theoretical considerations, we use AMADEUS, a database provided by Bureau van Dijk. AMADEUS contains firm-level information for 40 European countries. For every firm included in AMADEUS, data is available on a timeline of 10 years. Hence, the big advantage of AMADEUS is that it allows us to use time- and cross-country variation in tax rates. However, one disadvantage is that ownership data is not available as a time-series, but, for each firm, only for the year of the last available account.

In order to obtain a homogeneous sample, we restrict the data to non-listed corporations from the EU 27 countries. Further, we exclude financial firms and inactive firms, i.e. bankrupt or dissolved firms, mergers or demergers, firms in liquidation or firms for which the situation is unknown. We merge this data with statutory corporate tax rates[4], an index measuring tax enforcement as well as other country characteristics we obtain from different sources.[5]

We use two related dependent variables: issued share capital and shareholder funds. The former includes authorized capital, whereas the latter adds undistributed profits and capital reserves to the analysis. We view this as an appropriate way to measure investment by shareholders.

We proxy managerial diversion by an index measuring ownership concentration. The idea behind is that large owners are able to monitor mangers more effectively. Ownership data is only available to us as a cross-section. To circumvent this problem, we allocate firms to two broad ownership categories. Taking a look at Table 1, firms in class $A + B$ have no shareholder with an ownership percentage above 50%, whereas firms in class $C + D$ have such a shareholder. Hence, whereas there may be shifts in ownership over time, it is rather improbable that variation in ownership pushes firms across

[4]The use of statutory tax rates rather than average effective tax rates is motivated by severe endogeneity problems that the latter instruments cause. This happens because effective tax rates are largely determined by previous and current decisions.

[5]We take data on GDP per capita and Population from the World Bank World Development Indicators (WDI), Harmonized long-term interest rates from the European Central Bank and Market capitalization (% of GDP) as well as Domestic credit to private sector (% of GDP) from the World Bank.

the categories.[6] To further reduce this probability, we restrict our attention to the last six years of observations for each firm in our analysis.[7]

Table 1: Independence indicator.

String	Basic description	Ownership category
A	A company with known recorded shareholders none of which has more than 25% of direct or total ownership.	$A+B$
B	A company with known recorded shareholders none of which has an ownership percentage over 50%, but one or more of which have an ownership percentage above 25%)	
C	A company with a recorded shareholder which has a total or calculated total ownership over 50%	$C+D$
D	A company with a recorded shareholder which has a direct ownership of more than 50%	

Consistent with previous studies (see e.g. Desai et al. 2007), we use an index provided in the Global Competitiveness Reports from 1997 until 2002 (the data is for $1996-2001$) to measure tax enforcement. The index is based on a survey asking respondents to assess the magnitude of tax evasion in their country on a scale from 1 to 7, where tax evasion is decreasing with increasing numbers in the index. In line with seminal papers on tax evasion (see e.g. Allingham and Sandmo 1972, Yitzhaki 1974), we assume a negative relation between tax enforcement and tax evasion, and a positive relation between tax enforcement and the detection probability p from our model. Given that the index is not available for the whole time-span of our analysis, for each country we average the values for the available years and allocate this average to all years.

In the following paragraphs we describe the variables we use to control for firm-and country-specific factors that are likely to affect the investment decision of outside shareholders.[8]

[6] Several recent papers argue that shifts over time are not a serious concern in this context, as this misclassification is likely to bias the results towards zero (see e.g. Budd et al. 2005, Dharmapala and Riedel 2012)

[7] Ideally, we would like to distinguish between manager-owned firms and those where managers own only a small share of the firm. However, our data does not allow us to do so.

[8] For a survey on relevant firm-level variables, see Shleifer and Vishny (1997)

Part of the literature focuses on the reputation of firms as one of the main drivers leading outside investors to part with their money (see e.g. Kreps 1990, Eaton and Gersowitz 1981, Bulow and Rogoff 1989 and Diamond 1989, 1991). The argument is that reputation is a prerequisite for managers to assure that they can raise funds on capital markets in the future. In this context, dividend payments and the repayment of short-term loans are identified as well-suited instruments. We do not have any of these variables at hand. However, we control for tangibility, defined as $\frac{\text{Tangible fixed assets}}{\text{Total assets}}$, and firm age and interpret these variables as signals of stability in the investment decision of outside shareholders.

Leverage, defined by $\frac{\text{Loans+Creditors+Long term debt}}{\text{Total assets}}$, can affect shareholder investment in several ways. According to Jensen's (1986) Free Cash-Flow Theory, debt serves as a monitoring device and constrains managers in opportunistic behavior at the expense of outside shareholders. The decrease in the agency problem could then lead to an increase in investment by shareholders. Further, firms with higher leverage are more likely to default on their repayment obligations (see e.g. Kraus and Litzenberger 1983). As debt has a prior claim over equity, this could have a negative effect on reputation and decrease outside investment. A related line of argumentation is that high leverage could lead to underinvestment problems (Scott 1977). Investment projects with a positive net present value decrease default risk, which benefits creditors of the firm. As equity holders are residual claimants, they bear the whole costs of investment, but get only part of the return.[9]

At the country level, we account for several variables capturing the economic environment of the included countries. Besides GDP per capita and country size, we include data on government bond yields with a maturity of 10 years. This variable captures the investors' reservation return in the decision to invest in a firm. Second, we control for market capitalization (% of GDP) to measure the development of financial markets in the included countries. Lastly, we include the domestic credit granted to the private sector (% of GDP) to control for the financial situation of the private sector.

In order to correct for outliers which are generally present in AMADEUS, we delete the upper and lower 0.5% of observations for all firm-level variables we use in the analysis. Table 2 shows definitions for all variables we use, Table 3 reports descriptive statistics, and Table A1 in *Appendix A* shows, for each

[9] We do not include firm size as a firm-level control, as there may be problems of reverse causality with this variable.

country, the number of observations as well as available years.[10] Concerning Table 3, one remarkable thing is that the amount of shareholder capital differs significantly for firms from the different ownership classes, whereas there are no significant differences in other firm-level variables. Precisely, shareholder funds are nearly half as large for firms with dispersed ownership $(A + B)$, compared to firms with concentrated ownership $(C + D)$.

[10]The tax enforcement index is not available for Estonia, Latvia, Lithuania and Romania, while observations for Cyprus and Malta fall out of the sample entirely as a result of data cleaning.

Table 2: Definition of variables.

Variables	Definition
Capital	Issued share capital$_{it}$
Funds	(Issued share capital+ undistributed profits+ capital reserves)$_{it}$
DummyAB	$d_i = \begin{cases} 1 \text{ if Independence indicator=A,B} \\ 0 \text{ otherwise} \end{cases}$
Tangibility	$\frac{\text{Tangible fixed assets}_{it}}{\text{Total assets}_{it}}$
Age	Account date$_{it}$- Year of incorporation$_i$
Leverage	$\frac{\text{Loans}_{it}+\text{Creditors}_{it}+\text{Long term debt}_{it}}{\text{Total assets}_{it}}$
Tax	Statutory corporate tax rate$_{it}$
Enforcement	Survey rating, Global Competitiveness Report; Question asked: "In your country, tax evasion is minimal" (1: strongly disagree, 7: strongly agree).Based on the following questions: 1996 - 2.11, 1997 – 2.10, 1998 – 2.10,1999 – 3.09, 2001 – 6.11.
GDP per capita	GDP per capita$_{it}$
Country size	Size of the population$_{it}$
Interest rate	Harmonized long term interest rate (10-year government bond yield)$_{it}$
Market cap	$\frac{\text{Market capitalization}_{it}}{\text{GDP}_{it}}$
Private credit	$\frac{\text{Domestic credit to private sector}_{it}}{\text{GDP}_{it}}$

Table 3: Descriptive statistics.

Variable	Full sample	Observations	A+B	Observations	C+D	Observations
Capital (in millions)	.94 (3.07)	2,663,920	.62 (2.2)	787,625	1.08 (3.37)	1,876,295
Funds (in millions)	3.55 (10.1)	2,663,920	2.57 (7.72)	787,625	3.96 (10.91)	1,876,295
DummyAB	.3 (.46)	2,663,920	1 (0)	787,625	0 (0)	1,876,295
Tangibility	.24 (.26)	2,663,920	.25 (.25)	787,625	.23 (.26)	1,876,295
Age	17.19 (14.87)	2,663,920	16.18 (13.68)	787,625	17.61 (15.33)	1,876,295
Leverage	.33 (.28)	2,663,920	.36 (.28)	787,625	.32 (.28)	1,876,295
Tax	.31 (.05)	2,663,920	.31 (.06)	787,625	.32 (.05)	1,876,295
Enforcement	3.61 (.83)	2,663,920	3.47 (.83)	787,625	3.67 (.81)	1,876,295
GDP per capita (in thousands)	31.5 (10.77)	2,663,920	29.31 (10.95)	787,625	32.42 (10.56)	1,876,295
Country size (in millions)	42.04 (24.6)	2,663,920	38.91 (24.49)	787,625	43.36 (24.53)	1,876,295
Interest rate	.04 (.01)	2,659,058	.04 (.01)	786,120	.04 (.01)	1,872,938
Market cap	.77 (.35)	2,663,920	.72 (.35)	787,625	.79 (.35)	1,876,295
Private credit	1.17 (.42)	2,663,920	1.17 (.44)	787,625	1.17 (.41)	1,876,295

For each variable, the table reports the mean and standard deviation (in parentheses).

Finally, Table 4 translates the Hypotheses into expectations on the sign of variables.

Table 4: Expectations on the signs of variables.

Variables	Expected sign
DummyAB	−
Tax	−
Enforcement	+
Tax×DummyAB	+
Tax×Enforcement	+

3.2 Identification technique and estimation results

To test Hypotheses 1-5, we estimate the following regression equations:

$$\begin{aligned} y_{it} &= \beta_0 + \beta_1 t^c_{ct} + \beta_2 t^c_{ct} d_{iAB} + \beta_3 t^c_{ct} p_i + \\ &\quad \boldsymbol{\beta}_4 \mathbf{f}_{it} + \boldsymbol{\beta}_5 \mathbf{c}_{it} + \boldsymbol{\beta}_6 \mathbf{g}_i + \boldsymbol{\beta}_7 \mathbf{t}_t + \varepsilon_{it}, \end{aligned} \tag{5}$$

$$\begin{aligned} y_{it} &= \beta_0 + \beta_1 t^c_{ct} + \beta_2 d_{iAB} + \beta_3 t^c_{ct} p_i \\ &\quad + \boldsymbol{\beta}_4 \mathbf{f}_{it} + \boldsymbol{\beta}_5 \mathbf{c}_{it} + \boldsymbol{\beta}_6 \mathbf{h}_c + \boldsymbol{\beta}_7 \mathbf{i}_i + \boldsymbol{\beta}_8 \mathbf{t}_t + \varepsilon_{it}, \end{aligned} \tag{6}$$

where i, c and t are firm-, country- and year indices, and
y_{it} = issued share capital (shareholder funds) for firm i in year t
t^c_{ct} = corporate tax rate in country c in year t
d_{AB} = dummy indicating the ownership class the firm is allocated to
p_i = detection probability for managers of firm i
$\mathbf{f}_{it}$ = firm-level variables for firm i in year t
$\mathbf{c}_{it}$ = country-level variables for firm i in year t
$\mathbf{g}_i$ = vector of firm dummies
$\mathbf{h}_c$ = vector of country dummies
$\mathbf{i}_i$ = vector of industry dummies
$\mathbf{t}_t$ = vector of year dummies
ε_{it} = error term for firm i in year t

In (5), we control for firm- and year fixed effects, which allows us to test Hypothesis 2. However, due to the time-invariance of ownership and tax enforcement, we can only include these variables as interactions with t^c_{ct} to

test Hypotheses 4 and 5. Conversely,(6) allows us to test Hypothesis 1, since it includes country-, industry- and year fixed effects only. Note that, using (5) and (6) does not allow us to reliably test Hypothesis 3, as p_i does not vary at the country level.

Table 5 reports a first set of estimation results, where we refer to equation (5). The R^2 for all specifications lies between .9 and .93, which is very high and can be explained by the way it is computed.[11]

[11] Despite the fact that we control for firm- and year-fixed effects, STATA computes the R^2 for the whole, not demeaned sample.

Table 5: Ownership, taxation and investment I - firm-fixed effects.

	1	2	3	4	5	6	7	8
Dependent	Capital	Capital	Capital	Capital	Funds	Funds	Funds	Funds
Tax	-.98** (.02)	-8.07*** (.00)	-7.49*** (.00)	-7.67*** (.00)	-2.1 (.36)	-22.88** (.04)	-21.62** (.04)	-6.86 (.33)
Tax × Enforcement		2.05*** (.00)	1.08*** (.00)	1.8*** (.00)		5.33*** (.00)	5.49** (.04)	2.01 (.28)
Tax × DummyAB		1.11*** (.00)	1.89*** (.00)	1.8*** (.00)		5.84*** (.00)	5.37*** (.00)	6.35*** (.00)
Tangibility	.18*** (.00)	.18*** (.00)	.17*** (.00)	.17*** (.00)	-.04 (.83)	-.06 (.73)	-.06 (.72)	-.25*** (.00)
Age	.02 (.19)	.01 (.35)	.02** (.02)	.03* (.05)	.13** (.01)	.12** (.02)	.13** (.02)	.25** (.01)
Leverage	-.11*** (.00)	-.11*** (.00)	-.11*** (.00)	-.1*** (.00)	-1.91*** (.00)	-1.91*** (.00)	-1.9*** (.00)	-1.6*** (.00)
GDP per capita	-.003 (.65)	.003 (.63)	.001 (.77)	-.003 (.53)	.04* (.09)	.05** (.01)	.05** (.01)	.02 (.48)
Country size	.02** (.04)	.03*** (.00)	.04*** (.00)	.06* (.02)	.06 (.23)	.1* (.09)	.1 (.36)	.04 (.79)
Interest rate			1.79 (.59)	-.94 (.72)			9.86 (.44)	2.33 (.83)
Market cap			.05 (.32)	-.11 (.22)			.08 (.75)	-.47 (.31)
Private credit			-.07 (.17)	-.06 (.53)			-.08 (.85)	.02 (.98)
Observations	2,663,920	2,663,920	2,659,058	1,840,315	2,663,920	2,663,920	2,659,058	1,840,315
Adjusted R^2	.93	.93	.93	.94	.9	.9	.9	.92
Years	1999-2009	1999-2009	2001-2009	1999-2006	1999-2009	1999-2009	2001-2009	2001-2006

All variables are as defined in Table 2. All regressions control for firm- and year fixed effects. Standard errors are clustered at the country-year level,. p-values are reported in parentheses, and ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively

Specification 1 lends support to Hypothesis 2. A 1 p.p. increase in the corporate tax rate leads to a decrease in shareholder funds of appeox. $9,800$ €. Quantitatively, this amounts to 0.9% of mean shareholder funds for firms with concentrated ownership, and 1.6% for firms with dispersed ownership. Tangibility and age enter positively, but only the former is significant. However, this points to the importance of reputation for the investment decision even for nonlisted firms. Further, leverage is significantly negative. This may be due to the fact that the positive influence of debt as a monitoring device is overcompensated by increased bankruptcy risk and the underinvestment problem discussed .

In the next step, we include ownership and tax enforcement as interactions with the corporate tax rate. As our approach focusses on the linear regression equation (5), the marginal corporate tax effect can be computed as

$$\frac{\partial y}{\partial t^c} = \beta_1 + \beta_4 \overline{d_{AB}} + \beta_5 \overline{p}, \tag{7}$$

where the upper bar indicates evaluation at the mean. Column 2 shows that both Hypotheses 4 and 5 are confirmed, while Hypothesis 2 still receives support. Using the descriptive statistics reported in Table 3, the marginal tax effect for the whole sample now amounts to approx. $-.34$. However, from this Table, it is not possible to calculate the tax effect for firms from the different ownership classes separately, as the tax coefficient is for $C + D$ firms, while the tax/enforcement interaction refers to the whole sample. Nevertheless, it becomes clear that the negative influence of corporate taxation is significantly lower for firms from ownership class $A + B$. In these firms, a large shareholder is missing, so monitoring is presumably lower and the corporate governance problem is more prevalent. Further, an increase in tax enforcement lowers the negative effect of taxation, showing the positive influence of additional monitoring by the tax authority. Overall, the positive and significant coefficients for the tax interaction terms identify what we call the corporate governance channel of corporate taxation.[12]

In column 3, we add three more country-specific variables to the analysis. All three are believed to affect the magnitude of investment in share capital in certain ways. However, the main result just described remains robust even if we control for these factors. This is also the case if we skip observations

[12] The results are robust to the inclusion of further tax-interactions with institutional variables such as the La Porta et al. (2006) anti-self-dealing index or the Transparency International corruption index.

from the years $2007-2009$ to check whether the financial crisis of those years affects the results (column 4).

In the last four columns, we use do not use issued share capital, but total shareholder funds as the dependent variable. Also here, Hypotheses 2, 4 and 5 are confirmed. Whereas in specification 5, the corporate tax effect is negative but insignificant, adding the tax interaction terms in specification 6 shows that is significantly negative at least for firms with concentrated ownership. Further, tax enforcement reduces the negativity of the corporate tax effect.

In Table 6, we perform the same regressions, but choose a log-log specification. Thus, we have to interpret the coefficients as elasticities, which allows us to get rid of the scale effect that enters through issued share capital. We see that the direction of effects remains robust to this change in functional form.

However, the coefficient of intersection of ownership concentration and tax substantially loses significance. Thus, according to our theoretical model the effect through diversion is insignificant for difficulty in diversion, but significant and consistent with theoretical prediction for tax compliance. Note that this result is impossible to obtain in a simple neoclassical model, as the tax effect should be weakend by lax enforcement, as outlined in introduction. Since we observe the opposite, something beyond the simple story must be going on in the data, and we suggest that this is the effect through divertion. Thus, our "scale-free" result from log-log specification provides indirect evidence of the importance of divertion in our sample.

Table 6: Ownership, taxation and investment II - firm fixed effects & log-log specification.

	1	2	3	4	5	6	7	8
Dependent	log(Capital)	log(Capital)	log(Capital)	log(Capital)	log(Funds)	log(Funds)	log(Funds)	log(Funds)
log(Tax)	-.3** (.01)	-2.06*** (.00)	-1.88*** (.00)	-2.04*** (.00)	-.54*** (.00)	-1.88*** (.00)	-1.9*** (.00)	-1.9** (.04)
log(Tax)×Enforcement		.54*** (.00)	.5*** (.00)	.5*** (.00)		.42** (.01)	.47*** (.00)	.46* (.05)
log(Tax)×DummyAB		.06* (.07)	.06* (.08)	.05 (.19)		.04 (.4)	.06 (.11)	.02 (.7)
Tangibility	.28*** (.00)	.27*** (.00)	.27*** (.00)	.28*** (.00)	.24*** (.00)	.24*** (.00)	.24*** (.00)	.19*** (.00)
Age	.07*** (.00)	.06*** (.00)	.05*** (.00)	.08*** (.00)	.11*** (.00)	.11*** (.00)	.1*** (.00)	.15*** (.00)
Leverage	.001 (.95)	.002 (.91)	.003 (.88)	-.004 (.87)	-.48*** (.00)	-.48*** (.00)	-.49*** (.00)	-.42*** (.00)
GDP per capita	-.01 (.18)	-.004 (.65)	-.01 (.33)	-.01* (.05)	-.002 (.8)	.002 (.72)	.002 (.73)	-.01 (.17)
Country size	.02** (.02)	.03*** (.00)	.03** (.02)	.06*** (.00)	.04** (.01)	.05*** (.00)	.007 (.67)	.01 (.64)
Interest rate			.93 (.78)	-2.94 (.23)			-5.32 (.13)	-6.72* (.05)
Market cap			.13* (.07)	-.14** (.03)			.17** (.04)	-.1 (.43)
Private credit			-.06 (.27)	-.02 (.63)			.24*** (.00)	.4*** (.00)
Observations	2,556,722	2,556,722	2,551,922	1,766,631	2,522,109	2,522,109	2,517,606	1,739,864
Adjusted R^2	.96	.96	.96	.96	.9	.9	.9	.92
Years	1999-2009	1999-2009	2001-2009	2001-2006	1999-2009	1999-2009	2001-2009	2001-2006

All variables are as defined in Table 2. All regressions control for firm and year fixed effects. Standard errors are clustered at the country-year level,. p-values are reported in parentheses, and ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

In Table 7, we apply equation (6) and hence control for county-, industry- and year-fixed effects to test Hypothesis 1. All specifications show that shareholder capital is indeed lower if diversion opportunities are higher, i.e. if ownership falls in the category $A + B$. In particular, the coefficients for DummyAB show that issued share capital (total shareholder funds) for these firms is roughly 50% (70%) of the average of the whole sample. Table 8 shows that also here the results are robust to choosing a log-log specification.

Table 7: Ownership, taxation and investment III - country- and industry fixed effects.

Variables	1	2	3	4	5	6	7	8
Dependent	Capital	Capital	Capital	Capital	Funds	Funds	Funds	Funds
Tax	-1.24* (.05)	-6.1*** (.00)	-6.18*** (.00)	-6.7* (.02)	-3.86 (.19)	-21.62*** (.00)	-24.28*** (.00)	-19.52* (.06)
Tax×Enforcement		1.47*** (.00)	1.6*** (.00)	1.41** (.04)		5.37** (.01)	6.51** (.01)	3.51 (.15)
DummyAB		-.44*** (.00)	-.44*** (.00)	-.44*** (.00)		-1.02*** (.00)	-1.02*** (.00)	-1*** (.00)
Tangibility	.68*** (.00)	.71*** (.00)	.71*** (.00)	.72*** (.00)	1.26*** (.00)	1.33*** (.00)	1.34*** (.00)	1.37*** (.00)
Age	.01*** (.00)	.01*** (.00)	.01*** (.00)	.01*** (.00)	.09*** (.00)	.09*** (.00)	.09*** (.00)	.09*** (.00)
Leverage	-.27** (.02)	-.26** (.02)	-.26** (.02)	-.2 (.13)	-2.26*** (.00)	-2.25*** (.00)	-2.26*** (.00)	-1.89*** (.00)
GDP per capita	.01* (.05)	.01*** (.00)	.01** (.01)	.02 (.11)	.04** (.01)	.06*** (.00)	.07*** (.00)	.07* (.09)
Country size	.12*** (.00)	.13*** (.00)	.09*** (.00)	.15*** (.00)	.41*** (.00)	.44*** (.00)	.3** (.01)	.49** (.01)
Interest rate			2.05 (.54)	3.44 (.38)			-10.26 (.59)	7.1 (.69)
Market cap			.04 (.58)	.27 (.1)			.06 (.89)	1,18 (.11)
Private credit			.21** (.01)	.23 (.12)			.99 (.89)	1.04 (.13)
Observations	2,663,920	2,663,920	2,659,058	1,840,315	2,663,920	2,663,920	2,659,058	1,840,315
Adjusted R^2	.07	.08	.08	.08	.11	.11	.11	.11
Years	1999-2009	1999-2009	2001-2009	1999-2006	1999-2009	1999-2009	2001-2009	2001-2006

All variables are as defined in Table 2.All regressions control for country, industry- and year fixed effects. Standard errors are clustered at the country-year level,.

p-values are reported in parentheses, and ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 8: Ownership, taxation and investment IV - country- and industry fixed effects & log-log specification.

Variables	1	2	3	4	5	6	7	8
Dependent	log(Capital)	log(Capital)	log(Capital)	log(Capital)	log(Funds)	log(Funds)	log(Funds)	log(Funds)
log(Tax)	-.39** (.01)	-1.96*** (.00)	-1.85*** (.00)	-1.77*** (.00)	-.6** (.01)	-2.14*** (.00)	-2.06*** (.00)	-1.68** (.01)
log(Tax)×Enforcement		.5*** (.00)	.49*** (.00)	.4** (.01)		.49*** (.00)	.54*** (.00)	.33* (.07)
DummyAB		-.33*** (.00)	-.33*** (.00)	-.32*** (.00)		-.19*** (.00)	-.19*** (.00)	-.2*** (.00)
Tangibility	.82*** (.00)	.84*** (.00)	.84*** (.00)	.87*** (.00)	.73*** (.00)	.75*** (.00)	.75*** (.00)	.79*** (.00)
Age	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.03*** (.00)	.03*** (.00)	.03*** (.00)	.03*** (.00)
Leverage	.17 (.22)	.18 (.2)	.18 (.19)	.25 (.15)	-.75*** (.00)	-.74*** (.00)	-.75*** (.00)	-.59** (.01)
GDP per capita	.006 (.21)	.01*** (.00)	.01** (.02)	.02** (.01)	.01 (.31)	.01** (.03)	.01* (.09)	.01* (.07)
Country size	.08** (.01)	.09*** (.00)	.06** (.01)	.12*** (.00)	.11*** (.00)	.12*** (.00)	.05** (.03)	.11*** (.00)
Interest rate			2.35 (.49)	2.58 (.42)			-1.61 (.75)	.71 (.85)
Market cap			.06 (.46)	.05 (.66)			.13 (.28)	.12 (.35)
Private credit			.1 (.18)	.01 (.9)			.43*** (.00)	.4*** (.00)
Observations	2,556,722	2,556,722	2,556,722	1,766,631	2,522,109	2,522,109	2,517,606	1,739,864
Adjusted R^2	.24	.24	.24	.24	.25	.25	.25	.26
Years	1999-2009	1999-2009	2001-2009	2001-2006	1999-2009	2001-2009	2001-2009	2001-2006

All variables are as defined in Table 2.All regressions control for country, industry- and year fixed effects. Standard errors are clustered at the country-year level,.

p-values are reported in parentheses, and ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

The reported results refer to a sample of firms which belong to 772 different industries (where we applied NACE Rev.2 4-digit industry codes to arrive at this number). Hence, as another robustness test, we also check whether the described results remain valid if we reduce this heterogeneity among firms. Tables A2 and A3 report descriptives and estimation results for a sample of manufacturing firms. Taking a look at these tables, it becomes clear that the results just described are robust to this restriction on the data.

4 Conclusion

We have analyzed the effect of corporate taxation and its interactions with corporate governance on shareholder capital. Focussing on a simple game between managers and shareholders, we got unambiguous results for a rather general specification of firm value and cost of diversion functions. In particular, shareholder capital increases with an increase in costs of diversion or auditing probability. Conversely, it decreases with an increase in the corporate tax rate.

Our empirical results lend support to these hypotheses. We found a negative corporate tax effect on shareholder capital, this effect being weaker in firms with less concentrated ownership. More importantly, tax enforcement attenuates the negative effect of taxation. We interpret this finding as pointing out the presence of corporate governance problems, as in their absence, stricter enforcement should strengthen the negative tax effect. Lastly, in line with our theoretical prediction, shareholder capital is increasing in the costs of diversion.

In this regard, the paper is the first one which analyzes the impact of interactions between corporate governance and corporate taxation on the level of investment in shareholder capital. Hence, it extends the literature by showing that the effect of such interactions is not restricted to firm value or other performance measures. Further, by indicating that tax-governance interactions affect shareholder capital as an integral part of capital structure, it also contributes to the literature on the capital structure effects of corporate taxation.

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5 Appendix A

Table A1: Number of observations and year availability by country.

Countries	Observations (full sample)	Available years (full sample)	Observations (manufact. firms)	Available years (manufact. firms)
Austria	69,965	2000-2009	11,824	2002-2009
Belgium	70,942	1999-2009	16,791	1999-2009
Bulgaria	22,301	2000-2009	7,513	2000-2009
Czech Republic	1293,194	2000-2009	31,678	2000-2009
Denmark	53	2004-2008	4	2004-2006
Finland	19,221	2000-2009	4,891	2000-2009
France	534,622	1999-2009	108,410	1999-2009
Germany	242,512	2000-2009	55,864	2000-2009
Greece	85,759	2000-2009	23,000	2000-2009
Hungary	196	2003-2008	59	2003-2008
Ireland	32,064	1999-2009	6,854	2000-2009
Italy	147,109	1999-2009	53,238	2000-2009
Luxembourg	5,864	2000-2008	683	2001-2008
Netherlands	130,129	1999-2009	26,618	1999-2009
Poland	72,647	2000-2009	24,428	2000-2009
Portugal	155,840	2000-2008	40,704	2000-2008
Slovakia	25,079	2000-2008	7,318	2000-2008
Slovenia	7,840	2003-2008	2,797	2003-2008
Spain	525,754	1999-2009	116,095	2000-2009
Sweden	125,766	2000-2009	22,067	2000-2009
United Kingdom	267,063	1999-2009	56,957	1999-2009
Total	2,663,920	1999-2009	617,793	1999-2009

Table A2: Robustness: descriptive statistics - manufacturing firms.

Variable	Full sample	Observations	A+B	Observations	C+D	Observations
Capital (in millions)	1.31 (3.56)	617,793	.73 (2.17)	186,052	1.56 (3.99)	431,741
Funds (in millions)	4.55 (11.15)	617,793	2.96 (7.74)	186,052	5.24 (12.27)	431,741
DummyAB	.3 (.46)	617,793	1 (0)	186,052	0 (0)	431,741
Tangibility	.27 (.21)	617,793	.3 (.21)	186,052	.26 (.21)	431,741
Age	20.59 (16.36)	617,793	19.25 (14.96)	186,052	21.17 (16.89)	431,741
Leverage	.34 (.25)	617,793	.36 (.26)	186,052	.33 (.25)	431,741
Tax	.31 (.06)	617,793	.31 (.06)	186,052	.32 (.05)	431,741
Enforcement	3.51 (.85)	617,793	3.33 (.82)	186,052	3.58 (.86)	431,741
GDP per capita (in thousands)	30.32 (10.89)	617,793	27.49 (10.75)	186,052	31.54 (10.71)	431,741
Country size (in millions)	41.81 (24.54)	617,793	37.83 (24.34)	186,052	43.53 (24.43)	431,741
Interest rate	.04 (.01)	616,449	.04 (.01)	185,628	.04 (.01)	430,821
Market cap	.73 (.35)	617,793	.67 (.34)	186,052	.76 (.35)	431,741
Private credit	1.14 (.43)	617,793	1.13 (.46)	186,052	1.14 (.42)	431,741

For each variable, the table reports the mean and standard deviation (in parentheses).

Table A3: Robustness: ownership, taxation and shareholder capital - manufacturing firms.

Variables	1	2	3	4	5	6	7	8
Dependent	Capital	Capital	log(Capital)	log(Capital)	Funds	Funds	log(Funds)	log(Funds)
Tax	-8.92*** (.00)	-8.87*** (.00)			-33.34** (.02)	-41.16*** (.00)		
log(Tax)			-1.69*** (.00)	-1.99*** (.00)			-1.22** (.01)	-2.09*** (.00)
Tax×Enforcement	2.28*** (.00)	2.3*** (.00)			7.82** (.03)	10.6*** (.00)		
log(Tax)×Enforcement			.44*** (.00)	.53*** (.00)			.25** (.04)	.54*** (.00)
DummyAB		-.76*** (.00)		-.54*** (.00)		-1.62*** (.00)		-.3*** (.00)
Tax×DummyAB	1.34** (.01)				8.73*** (.00)			
log(Tax)×DummyAB			.03 (.53)				-.03 (.47)	
Tangibility	.18*** (.00)	1.25*** (.00)	.34*** (.00)	1.33*** (.00)	.03 (.93)	1.16*** (.00)	.37*** (.00)	.87*** (.00)
Age	.04** (.01)	.01*** (.00)	.06*** (.00)	.02*** (.00)	.16** (.03)	.09*** (.00)	.08*** (.00)	.02*** (.00)
Leverage	-.17*** (.00)	-.26* (.08)	-.03 (.18)	.34** (.04)	-2.87*** (.00)	-3.84*** (.00)	-.64*** (.00)	-.85*** (.00)
GDP per capita	.003 (.58)	.02** (.01)	-.01 (.34)	.02** (.01)	.03 (.21)	.07** (.01)	-.001 (.84)	.01 (.1)
Country size	.02 (.14)	.09** (.01)	.01 (.41)	.05* (.07)	.28* (.06)	.52*** (.00)	-.002 (.9)	.05** (.02)
Interest rate	1.66 (.66)	8.45** (.04)	.35 (.91)	6.01 (.1)	.94 (.95)	1.87 (.91)	-6.39* (.05)	-.95 (.82)
Market cap	.05 (.51)	.04 (.71)	.11 (.14)	.1 (.34)	.12 (.7)	.2 (.63)	.18** (.04)	.21* (.06)
Private credit	-.14** (.03)	.27** (.02)	-.08 (.18)	.14 (.11)	-1.14** (.04)	.33 (.49)	.05 (.48)	.34*** (.00)
Observations	616,449	616,449	603,369	603,369	616,449	616,449	593,658	593,658
Adjusted R^2	.94	.09	.96	.26	.91	.12	.92	.26
Fixed effects	firm, year	country, year, industry	firm, year	country, year, industry	firm, year	country, year, industry	firm, year	country, year, industry

All variables are as defined in Table 2. In columns 1-3, standard errors are clustered at the country-year level, while in column 4, clustering occurs at the country level.

p-values are reported in parentheses, and ***, ** and * indicates significance at the 1%, 5% and 10% levels, respectively.

6 Appendix B

6.1 Linearization around the equilibrium

To analyze the equilibrium, define $dV := \begin{pmatrix} dD & dk \end{pmatrix}^T$ the column-vector of differentials of endogenous variables, and $dP := \begin{pmatrix} d\gamma & dt & dp \end{pmatrix}^T$ the column vector of differentials of parameters. We totally differentiate the system (3)-(4) to study the effects of marginal changes in γ, t and p:

$$\mathbf{D}dV = \mathbf{C}dP, \tag{8}$$

$$\begin{aligned} &\left(1-p\left(1+st\right)-\lambda\left(1-t\right)\right)v'\left(k\right)dk - v\left(k\right)\left(1+st\right)dp + \left(\lambda-ps\right)v\left(k\right)dt = \\ &= c'\left(D\right)d\gamma + \gamma c''\left(D\right)dD, \end{aligned} \tag{9}$$

$$\begin{aligned} &\left(1-\lambda+D\left(p-1+\lambda\right)\right)\left(1-t\right)v''\left(k\right)dk - \left(1-\lambda+D\left(p-1+\lambda\right)\right)v'\left(k\right)dt \\ &+D\left(1-t\right)v'\left(k\right)dp + \left(p-1+\lambda\right)\left(1-t\right)v'\left(k\right)dD = 0. \end{aligned} \tag{10}$$

Thus, we have

$$\begin{aligned} \mathbf{D} &= \begin{pmatrix} \gamma c''\left(D\right) & -\left(1-p\left(1+st\right)-\lambda\left(1-t\right)\right)v'\left(k\right) \\ \left(p-1+\lambda\right)\left(1-t\right)v'\left(k\right) & \left(1-\lambda+D\left(p-1+\lambda\right)\right)\left(1-t\right)v''\left(k\right) \end{pmatrix}, \\ \mathbf{C} &= \begin{pmatrix} -c'\left(D\right) & \left(\lambda-ps\right)v\left(k\right) & -\left(1+st\right)v\left(k\right) \\ 0 & \left(1-\lambda+D\left(p-1+\lambda\right)\right)v'\left(k\right) & -D\left(1-t\right)v'\left(k\right) \end{pmatrix}. \end{aligned}$$

Solving the system (8), we get

$$dV = \mathbf{D}^{-1}\mathbf{C}dP. \tag{11}$$

Trivially,

$$\begin{aligned} \left|\mathbf{D}\right| &= \gamma\left(1-t\right)v''\left(k\right)c''\left(D\right)\left(1-\lambda+D\left(p-1+\lambda\right)\right) \\ &+\left(1-p\left(1+st\right)-\lambda\left(1-t\right)\right)\left(p-1+\lambda\right)\left(1-t\right)\left(v'\left(k\right)\right)^2. \end{aligned}$$

Since $1-p>\lambda$ and $v''\left(k\right)<0$ by assumption, $\left|\mathbf{D}\right|<0$.

Then,

$$\mathbf{D}^{-1}=\frac{1}{|\mathbf{D}|}\begin{pmatrix}\left(1-\lambda+D\left(p-1+\lambda\right)\right)\left(1-t\right)v''\left(k\right) & \left(1-p\left(1+st\right)-\lambda\left(1-t\right)\right)v'\left(k\right)\\ -\left(p-1+\lambda\right)\left(1-t\right)v'\left(k\right) & \gamma c''\left(D\right)\end{pmatrix};$$

$$\mathbf{D}^{-1}\mathbf{C}=\frac{1}{|\mathbf{D}|}\times$$
$$\times\begin{pmatrix}-c'\left(D\right)H\left(1-t\right) & \left(\lambda-ps\right)v\left(k\right)H\left(1-t\right)+GHE & -v(k)H\left(1-t\right)\left(1+st\right)-GDI\\ c'\left(D\right)IJ & -JI\left(\lambda-ps\right)v\left(k\right)+\gamma c''\left(D\right)HE & \left(1+st\right)v(k)IJ-\gamma c''\left(D\right)DI\end{pmatrix},$$

where

$$\begin{aligned}E &: = \frac{v'\left(k\right)}{v''\left(k\right)}<0,\\ G &: = \left(1-p\left(1+st\right)-\lambda\left(1-t\right)\right)v'(k)>0,\\ H &: = \left(1-\lambda+D\left(p-1+\lambda\right)\right)v''\left(k\right)<0,\\ I &: = \left(1-t\right)v'\left(k\right)>0,\\ J &: = p-1+\lambda<0.\end{aligned}$$

As we can see from the matrix, the effects of our parameters on investment are

$$\frac{dk^*}{d\gamma} = \frac{c'\left(D\right)IJ}{|\mathbf{D}|}>0, \tag{12a}$$

$$\frac{dk^*}{dt} = \frac{\gamma c''\left(D\right)HE-JI\left(\lambda-ps\right)v\left(k\right)}{|\mathbf{D}|}<0, \tag{12b}$$

$$\frac{dk^*}{dp} = \frac{v(k)IJ-\gamma c''\left(D\right)DI}{|\mathbf{D}|}>0. \tag{12c}$$

The new twist is introduced by endogenous fine on the effect of tax rate:

$$\lambda-ps>\frac{\lambda+p-1}{t}<0$$

If the surcharge rate is small, there is no changed compared to the benchkmark model and $\frac{dk^*}{dt}<0$. If the fine is large however, the effect may become ambiguous. We can also expect that higher surcharge rate weakens the negative effect of the tax, though this cannot be concluded from the expression above.

6.2 The cross-effects

6.2.1 Diversion ease

Differentiating (12b) with respect to γ, we get

$$\frac{d^2k^*}{dtd\gamma} = c''(D) HE |\mathbf{D}|^{-1} + \gamma \left(\begin{array}{c} c'''(D) HE |\mathbf{D}|^{-1} \frac{dD}{d\gamma} + c''(D) E |\mathbf{D}|^{-1} \frac{dH}{d\gamma} \\ +c''(D) H |\mathbf{D}|^{-1} \frac{dE}{d\gamma} - c''(D) HE |\mathbf{D}|^{-2} \frac{d|\mathbf{D}|}{d\gamma} \end{array} \right)$$
$$- (\lambda - ps) \left(Jv(k) |\mathbf{D}|^{-1} (1-t) v''(k) \frac{dk}{d\gamma} + JI |\mathbf{D}|^{-1} v'(k) \frac{dk}{d\gamma} - JIv(k) |\mathbf{D}|^{-2} \frac{d|\mathbf{D}|}{d\gamma} \right),$$

which can further be simplified to

$$\begin{aligned} \frac{d^2k^*}{dtd\gamma} |\mathbf{D}| &= \frac{1}{1-t} \left(c''(D) + \gamma c'''(D) \frac{dD}{d\gamma} - \gamma c''(D) |\mathbf{D}|^{-1} \frac{d|\mathbf{D}|}{d\gamma} \right) \\ &\quad - (\lambda - ps) J \left(v(k)(1-t) v''(k) \frac{dk}{d\gamma} + Iv'(k) \frac{dk}{d\gamma} - Iv(k) |\mathbf{D}|^{-1} \frac{d|\mathbf{D}|}{d\gamma} \right), \end{aligned}$$

because $HE = (1 - \lambda + D(p - 1 + \lambda)) v'(k)$ is the marginal benefit from investment (before tax) and in equilibrium is equal to $\frac{1}{1-t}$ (see FOC (4)). This does not depend on γ, so in optimum it must be that $\frac{d(HE)}{d\gamma} = 0$.

Here,

$$\begin{aligned} \frac{dD}{d\gamma} &= \frac{-c'(D) H (1-t)}{|\mathbf{D}|} < 0, \\ \frac{dk^*}{d\gamma} &= \frac{c'(D) IJ}{|\mathbf{D}|}, \end{aligned}$$

and

$$\begin{aligned} |\mathbf{D}| &= \gamma (1-t) c''(D) H + GJI, \\ \frac{d|\mathbf{D}|}{d\gamma} &= (1-t) c''(D) H + \gamma (1-t) c'''(D) H \frac{dD}{d\gamma} + \gamma (1-t) c''(D) \frac{dH}{d\gamma} + JI \frac{dG}{d\gamma} + GJ \frac{dI}{d\gamma}, \\ \frac{dH}{d\gamma} &= Jv''(k) \frac{dD}{d\gamma} + H \frac{v'''(k)}{v''(k)} \frac{dk}{d\gamma}, \\ \frac{dI}{d\gamma} &= (1-t) v''(k) \frac{dk}{d\gamma}, \\ \frac{dG}{d\gamma} &= G \frac{v''(k)}{v'(k)} \frac{dk}{d\gamma}. \end{aligned}$$

Thus, our cross-derivative can be written as

$$\begin{aligned}\frac{d^2k^*}{dtd\gamma}|\mathbf{D}| &= \frac{1}{1-t}\left(c''(D)+\gamma c'''(D)\frac{dD}{d\gamma}\right)\\ &-(\lambda-ps)J\left(v(k)(1-t)v''(k)+Iv'(k)\right)\frac{dk}{d\gamma}\\ &+\left((\lambda-ps)JIv(k)-\gamma c''(D)\frac{1}{1-t}\right)|\mathbf{D}|^{-1}\times\\ \times&\left(\begin{array}{c}(1-t)c''(D)H+\gamma(1-t)c'''(D)H\frac{dD}{d\gamma}+\\ +\gamma(1-t)c''(D)\frac{dH}{d\gamma}+JI\frac{dG}{d\gamma}+GJ\frac{dI}{d\gamma}\end{array}\right).\end{aligned}$$

It is convenient to denote

$$\begin{aligned}L &:= \left((\lambda-ps)JIv(k)-\gamma c''(D)\frac{1}{1-t}\right)|\mathbf{D}|^{-1}>0,\\ M &:= (1-t)c''(D)>0\end{aligned}$$

and ignore third-order derivatives of cost and value functions. Then after some manipulations we get

$$\begin{aligned}\frac{d^2k^*}{dtd\gamma}|\mathbf{D}| &= LMH+\frac{1}{1-t}c''(D)\\ &+\gamma LMJv''(k)\frac{dD}{d\gamma}\\ -(\lambda-ps)(1-t)J&\left(v(k)v''(k)+I\left(v'(k)\right)^2\right)\frac{dk}{d\gamma}.\end{aligned}$$

As can be seen, this formulation disentangles three effects of the diversion difficulty on the tax effectiveness. The first line embodies the direct effect, which is ambiguous. The second line is the effect via diversion amount; it is positive. The third line reflects the effect via shareholder capital itself, the scale effect. A sufficient condition for this effect to be negative is that the fine is small $\lambda > ps$ and $v(k)v''(k)+\left(v'(k)\right)^2>0$.

Thus, if we assume that the direct effect is nonpositive and that the scale effect dominates the effect through diversion, we have Hypothesis 4.

6.2.2 Auditing

Differentiating (12b) with respect to p and applying immediately the result that $\frac{d(HE)}{dp} = 0$, we get

$$\begin{aligned}\frac{d^2k^*}{dtdp}|\mathbf{D}| &= \gamma\frac{1}{1-t}c''(D)\frac{dD}{dp} - \gamma\frac{1}{1-t}c''(D)|\mathbf{D}|^{-1}\frac{d|\mathbf{D}|}{dp} \\ &\quad -I(\lambda - ps)v(k) - J(\lambda - ps)v(k)\frac{dI}{dp} \\ &\quad +sJI(\lambda - ps)v(k) - JI(\lambda - ps)v'(k)\frac{dk}{dp} \\ &\quad +JI(\lambda - ps)v(k)|\mathbf{D}|^{-1}\frac{d|\mathbf{D}|}{dp}\end{aligned}$$

where

$$\begin{aligned}\frac{dD}{dp} &= \frac{-v(k)H(1-t)(1+st) - GDI}{|\mathbf{D}|}, \\ \frac{dk}{dp} &= \frac{v(k)IJ - \gamma c''(D)DI}{|\mathbf{D}|} > 0, \\ \frac{dI}{dp} &= (1-t)v''(k)\frac{dk}{dp}\end{aligned}$$

and

$$\begin{aligned}|\mathbf{D}| &= \gamma(1-t)c''(D)H + GJI, \\ \frac{d|\mathbf{D}|}{dp} &= \gamma(1-t)c'''(D)H\frac{dD}{dp} + \gamma(1-t)c''(D)\frac{dH}{dp} + JI\frac{dG}{dp} + GI + GJ\frac{dI}{dp}, \\ \frac{dH}{dp} &= (p - 1 + \lambda)v''(k)\frac{dD}{dp} + Dv''(k) + H\frac{v'''(k)}{v''(k)}\frac{dk}{dp}, \\ \frac{dG}{dp} &= -(1+st)v'(k) + G\frac{v''(k)}{v'(k)}\frac{dk}{dp}.\end{aligned}$$

Ignoring the third-order derivatives, we can write our cross-derivative as

$$\begin{aligned}\frac{d^2k^*}{dtdp}|\mathbf{D}| &= \left[\gamma\frac{1}{1-t}c''(D)+\gamma LMJv''(k)\right]\frac{dD}{dp}\\ &+(sJ-1)I(\lambda-ps)v(k)+\gamma LMDv''(k)\\ &+LGI-LJI(1+st)v'(k)\\ &-\left(v(k)v''(k)+(v'(k))^2\right)(1-t)(\lambda-ps)J\frac{dk}{dp}\\ &+2(1-t)v''(k)GJL\frac{dk}{dp}\end{aligned}$$

As can be seen, this formulation disentangles three effects of the auditing probability on the tax effectiveness. The second line embodies the direct effect, which is ambiguous. The first line is the effect via diversion amount; it is positive, if $\frac{dD}{dp}<0$. The third and fourth lines reflect the effects via shareholder capital itself, the scale effect. A sufficient condition for this effect to be negative is that the fine is small $\lambda>ps$ and $v(k)v''(k)+(v'(k))^2>0$, just as in the case of difficulty in diversion.

Thus, if we assume that the direct effect is nonnegative and that the scale effect is dominated by the effect through diversion, we have Hypothesis 5.