Determinants of Corporate Investment: Theory and Evidence on the Investment Effect of Corporate Taxes

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August 2015

Abstract

Using an Arrow-Debreu framework, we derive optimal investment for a firm that takes on Net Present Value (NPV) positive projects. We compare corporate investment level in an example economy without taxation to an economy that taxes corporate income and individual returns from corporate securities. In addition to mathematically optimizing and graphically depicting a model economy, we solve the model for parameter values close to those of the US economy. We show that taxing corporations and individual income from corporate securities has a significant adverse effect on investment; that is, investment decisions considering after-tax future cash flows turn some NPV positive projects unprofitable, causing an underinvestment problem.

We test our theory, accounting for changes in available tax-loopholes and deductions and tax uncertainty by using actual corporate tax bills and using net operating working capital (NOWC) as a proxy for investment to better measure current investment payouts. Our panel regression uses the effective tax rate and various proxies for investment for a sample of S&P 500 firms over a 10-year period. In particular, we show that in our sample a 1 percentage point increase in the effective tax rate approximately decreases operating capital by $271 million, accounting investment outflows by $165 million and NOWC by $157 million. When an additional percentage point in taxes is paid, then total assets are reduced by $310 million, which leads to an underinvestment tax distortion. We also show that corporate investment is inversely correlated with sales due to turnaround corporate strategies.

Keywords: Corporate taxes, underinvestment, tax uncertainty, tax distortion, net operating working capital

1 Introduction

Let us focus on three categories of determinants of corporate investment. (1) A rate of return of a particular project tied to the economic rent or economic value that it generates for the firm, (2) the state of the economy (state of nature) and (3) taxes. From these three, corporate taxes have received prominent attention in the literature. Obviously, higher corporate taxes reduce after-tax corporate income. It is not obvious, however, how a reduced after-tax income affects corporate expenditures for capital equipment and employment of labor. That is, in an efficient capital market, there are alternative sources for investment in net present value (NPV) positive projects.

A fundamental theoretical treatment of the tax underinvestment question is due to Stiglitz (1976) who proposes a corporate tax irrelevancy result. His seminal work in spirit and form belongs to a class of irrelevancy theorems that include Modigliani and Miller's 1958 capital structure and dividend irrelevancy results in a perfect world without frictions (such as asymmetric information, transaction costs and taxes). In this paper we show that the key friction that theoretically derives corporate tax-neutrality in Stiglitz's world is that there are no economic rents. In other words, once competition does not drive NPV positive projects to zero rents (or profits), corporate tax neutrality does not hold. Therefore, we argue that corporate taxes could have an adverse effect on corporate investment and employment.

Then, the relevant question is the magnitude of the reduction in corporate investments due to corporate taxes. One may consider two hypotheses: first, that there is a wealth effect. That is corporate taxes reduce corporate wealth and thereby reduce resources available for corporate investments (assuming capital rationing). In turn, the government may (perhaps) spend the wealth that it extracts from the corporations causing an offsetting or mitigating increase in income and investment. However, a second dramatic hypothesis is that corporate taxes cause a greater adverse effect on investment than is commensurate with the reduction in resources. We label this hypothesis as the underinvestment effect. This means that one dollar of taxes raised from corporations reduces corporate investments by more than one dollar. The intuition for this effect is that the after tax corporate cash flows have a negative NPV, while before taxes the NPV was positive.

Consequently, the question is how many dollars of output are lost when an S&P 500 firm reduces its investment by 1 dollar. Let us use the analogy of a farmer who has two bags of seed to plant. If the government takes a bag of seed away, then it is fair to argue that half the harvest is lost. Of course, this analogy is too simple to capture the fact that after-tax future cash flows become too small to cover the cost and yield an NPV positive project as in our paper. Nevertheless, we argue that the reduction in output (the economic impact) of an underinvestment of a dollar (a bag of seed) would be significantly higher than a dollar. In fact, S&P 500 firms in our sample have a large positive return on investment. That applies to certain other business entities or organizations, e.g., in 2005 NorthStar consultants report that a dollar of taxpayer contribution to the University of Wisconsin generated 24 dollars for the state economy. In fact, from our data we observe approximately the same magnitude of impact for an investment dollar in large S&P 500 firms.

However, corporate taxes may not be taken in isolation. The investment effect of these taxes is difficult to calculate. To do so empirically we conduct a rigorous panel regression that accounts for the time-series data on yearly tax payments of a large number of S&P 500 corporations. We test how the last period's tax payment, after the resolution of DeAngelo and Masulis (1980) tax-uncertainty has on these firms' next period's working capital. We narrowly focus on working capital. This focus isolates the most recent effective tax payment expectations of the firm on the most recent investment decision of that firm. After accounting for all other possible distortions, we show that a corporate tax expectation of $ 12 million reduces investment by more than $ 300 million, for the average S&P 500 firm. This is a surprisingly large effect which can only be explained in light of our theory. It shows that additional expected corporate taxes make after-tax future corporate cash flows too small, so that a potentially wealth increasing NPV positive project turns to a no-economic-rent or NPV non-positive project. The evaporation of future projects and potential loss of unprofitable entire lines of future businesses accounts for a reduction of 25 dollars in value for each dollar of increase in marginal corporate taxes in our empirical study.

Our paper in spirit is close to a seminal paper published in the American Economic Review. In that article, Djankov, Ganser, McLiesh, Ramalho and Shleifer rigorously show that corporate taxes have a considerably negative effect on business activity, FDI and aggregate investment. In particular, Djankov et al. (2010) show that a 10% increase in the effective corporate tax rate raising the first-year effective tax rate by 10 percentage points reduces the investment rate by 2.2 percentage points and FDI rate by 2.3 percentage points. In their study, an increase in corporate taxes also reduces economic growth.

Devereux et al. (2002) show that in Europe the effective tax rates on marginal investment have remained stable. However, tax rates for highly profitable projects have decreased through various tax reforms.

Brandstetter and Jacob (2013) study the investment effect of corporate taxes. They conduct an empirical study based on the German tax reform of 2008. They show that after the tax decrease of 11 percentage points, both domestically owned and foreign-owned firms increased investments. However, this increase was higher for domestic-owned firms.

There is another corporate tax effect to consider. Lower corporate taxes could encourage tax evasion. For example, a well-known tax-avoidance trick in the USA for a wealthy individual is to incorporate their assets into a company to evade the higher individual income taxes. However, some argue that lower corporate taxes would make an economy more attractive for investments by multinational companies. For instance, the German tax reform of 2008 to cut taxes from 39% to 28% had the specific objective of encouraging investments in Germany by multinational firms.

Taxes may be viewed as a market friction that distorts a firm's investment decisions and general business activity in an economy. In general, this idea is not new in the finance literature. However, the market friction that is studied within the literature has been asymmetric information instead of effective taxation studied in this paper. In particular, Myers and Majluf (1984) show that when the new investors cannot access the same information that the current owners (old shareholders) possess, new shares are underpriced. In their model economy, asymmetric information distorts a firm's market value, allowing the new investors to exploit the underpricing of the new shares and expropriate wealth from the current shareholders. Consequently, in the model proposed by Myers and Majluf, the firm may prefer to underinvest, rather than issue underpriced new shares.

Bradford (1987) shows that this underinvestment problem is resolved as long as managers are allowed to purchase new shares. In addition, Brennan and Kraus (1987), Noe (1988), and Constantinides and Grundy (1989) show that by using a richer set of financing choices firms may signal their project type, thereby avoiding Myers' and Majluf's underinvestment problem.

Galai and Masulis (1976) and John and Senbet (1990) show that asymmetric information causes an overinvestment problem. In Galai's and Masulis' model, shareholders' claim resembles a call option and therefore increases in value when the volatility of the firm's underlying assets increases. Therefore, under asymmetric information, the stockholders may benefit from overinvesting by taking on negative-NPV high-risk projects.

In addition, John and Senbet present a model where, due to the corporate limited liability provision, the (ex ante unobservable) ruinously large negative payoffs (for instance, the cost of a nuclear meltdown at an atomic power plant) are largely borne by the society. Asymmetric information and limited liability allow a firm to ignore the social costs in figuring a project's NPV. A firm may overinvest by undertaking a project that would not have a positive NPV after accounting for its social costs. They show that corporate debt helps align the private and social sector interests. Consequently, in their model economy, debt financing helps mitigate the overinvestment problem.

In this paper we consider another overinvestment hypothesis; that is investment in turnaround operations. To test this hypothesis, we consider a relationship between sales and investment. We believe that a negative relationship between sales and investment indicates that firms that face difficult markets invest more in advertising and turnaround of their operations in order to overcome that economic crisis. Obviously, this is not in line with taking investments in NPV positive projects as reduction in sales does not necessarily indicate a positive NPV.

This paper is organized as follows: Section 2 describes the basic economic environment, derives the main result, and explores its financial implications. In this section the implications of this model are compared and contrasted with the predictions of the strand of the tax based capital structure literature. Section 3 tests this model empirically, discusses its possible extensions, explores its policy implications, and provides a conclusion.

2 The Model

A state-preference model similar to that used by DeAngelo and Masulis (1980) is employed in this paper. This model allows for the evaluation of the tax revenues and the tax distortion effects within a market valuation framework. In addition, this approach accommodates an environment wherein the tax revenues are uncertain[1]. Their model also does not parameterize use of labor implicitly, thereby relying on capital invested in providing employment.

2.1 Assumptions

(1) There are n firms (or industries), each with a different technology $X_j(\theta, K_j)$ within a two date (single period) economy. Each firm (the j^{th} firm) chooses its investment scale K_j at time zero and realizes a return of $X_j(\theta, K_j)$ dollars at time one. In addition, $X_j(\theta, K_j) = K^{\alpha_j} g_j(\theta)$ where $g_j(\theta)$ is a production function depending on the state of nature $\theta \in [\underline{\theta}, \overline{\theta}]$, and independent of the investment scale K. $\alpha \in (0, 1)$ is a constant scale parameter.

(2) There are m individuals with differential state dependent tax brackets. There is also a tax exempt agent (a mutual fund, insurance plan, etc.). These agents collectively hold the entire security claims against each firm's payoff. The individual saving and consumption decision and labor contribution (which is not within the scope of this study) has not been modeled.

(3) There is a government which imposes a tax regime with progressive individual income tax rates $t_j^p(\theta)$ and a constant corporate tax rate t^c.

(4) There is a valuation operator independent of both the tax regime and the aggregate investment decisions by the firms.

[1]Except for extreme tax rates, such as 85%, it can easily be shown that the mitigating effect of tax deduction and tax subsidies on disincentive for investment cannot undo the underinvestment tax distortion reported in this paper (see Theorem 3).

(5) Despite the limited number of securities and infinite number of states, it is assumed that the market can value debt and equity claims.

Assumptions 4 and 5 are standard in state-preference models similar to that of DeAngelo and Masulis (1980). They provide analytical tractability.

The production function in Assumption 1 had also been employed in Green and Talmor (1985, 1986) and Dammon and Senbet (1988). The analysis of this study may easily be carried out using a production function with somewhat of a more general form than that of Assumption 1, such as $X = F(k)g(\theta)$ (as long as F is concave and twice differentiable with respect to K and $F'(0) \neq \infty$). To insure that the results of this study are not an artifact of the production function of Assumption 1, we also graphically derive this result in Figure 1.

2.2 Corporate Investment in an Economy without Taxation

To establish a benchmark, let us derive the optimal investment scale K^* for a single firm within an economy without taxes. In this example, the current value of the firm V_0 may be written as follows:

$$V_0 = \int_{\underline{\theta}}^{\overline{\theta}} P(\theta) X(\theta, K) d\theta - K_0 \tag{1}$$

Here, K_0 is the investment level in a no-tax economy[2] and $P(\theta)$ is a market valuation operator. Intuitively, the above equation means that the value of a firm equals the current market value of its expected future cash flows minus its initial investment capital. In this simple case, the individuals receive the whole payoff, whereas the government's share T_0 is equal to zero.

Making the usual existence and uniqueness assumptions and using Assumption 1 one may compute the optimal investment scale in this economy from the following first order condition:

$$\begin{aligned} \frac{\partial V_0}{\partial K} &= \alpha K^{\alpha-1} \int_{\underline{\theta}}^{\overline{\theta}} P(\theta) g(\theta) d\theta - 1 \\ &= \alpha K^{-1} \int_{\underline{\theta}}^{\overline{\theta}} P(\theta) K^{\alpha} g(\theta) d\theta - 1 \\ &= \alpha K^{-1} \int_{\underline{\theta}}^{\overline{\theta}} P(\theta) X(\theta, K) d\theta - 1 = 0 \end{aligned} \tag{2}$$

Thus, the optimal investment scale with no taxes, K_0^*, may be written as follows:

[2] In general, to safeguard against notational clotter, we drop indices that are well understood from the text, e.g. $K_{0,j}$ becomes K_0.

$$K_0^* = \alpha \int_{\underline{\theta}}^{\overline{\theta}} P(\theta) X(\theta, K_0^*) d\theta \qquad (3)$$

The optimal investment level in Equation 3 is an increasing function of the investment scale parameter α. In addition, the optimal investment level increases at a rate proportional to α as $\int_{\underline{\theta}}^{\overline{\theta}} P(\theta)X(\theta, K_0^*)d\theta$, i.e. the expected value of the future cash flows of the firm, increases.

Figure 1: A firm's investment scale changes with taxation.

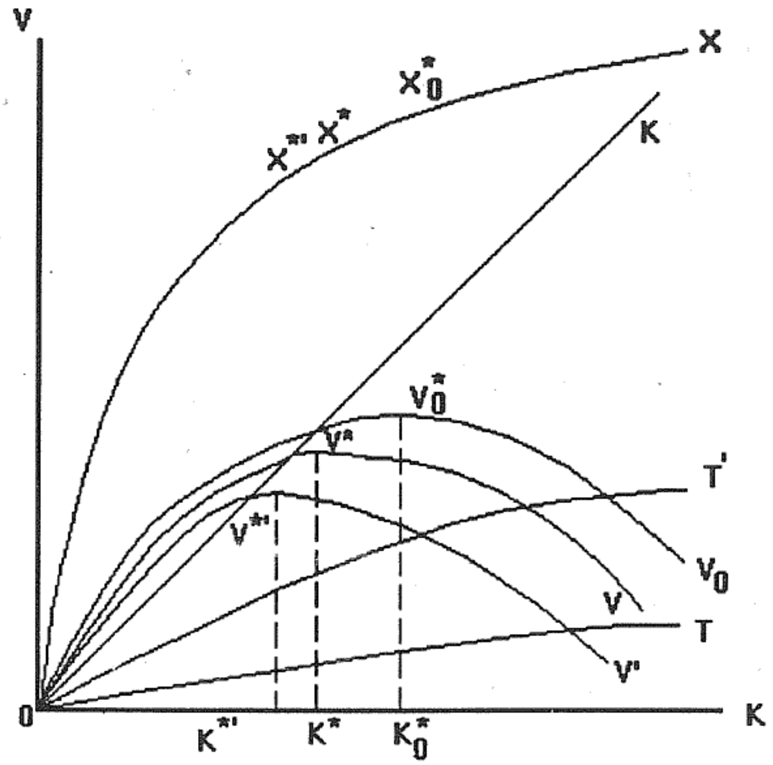


Figure 1 depicts a firm's investment decision and value maximization problem. In this figure, the investment scale K is measured on the horizontal axis and the firm value V on the vertical axis. This figure is drawn for a production function X with a diminishing marginal rate of return. Curve V_0 of Figure 1 shows the value of a firm in an economy without taxation. This curve has been plotted by subtracting the value of a firm's investment capital K (drawn on a 45 degree line) from the expected value of its future cash flows X. The firm value V_0 increases with the investment level K_0 until the firm attains a maximum value that corresponds to an optimal investment level K_0^*.

Due to the diminishing marginal rate of return feature of the production function, additional investment beyond the optimal amount K_0^* generates marginal cash flows whose present value is lower than the marginal cost of the investment capital.

2.3 Tax Disincentive for Investment

When the economy of Figure 1 is taxed, then the after-tax firm value curve can be plotted by subtracting both the government's share of the payoff, T, and the value of a firm's investment capital K from the value of its expected future cash flows X. The expected tax-revenue function T in Figure 1 is drawn for a tax-regime imposing a constant tax rate (of 10% for example) at the firm level. In this case, the slope of the tax revenue curve T at any given investment level is proportional to the slope of the payoff function X at a point corresponding to the same investment level, with a proportionality constant equal to the tax rate t (i.e., $\partial T/\partial K = t(\partial X/\partial K)$).

Since a constant tax rate raises more revenue from high cash flow levels than from lower ones, curve T is positively sloped. That is, a firm investing more incurs a higher expected future tax liability. Consequently, the vertical distance between the after-tax firm value V and the no-tax firm value V_0 increases at higher investment levels. This vertical distance equals the abscissa of the tax liability function T. Therefore, the after-tax firm value curve V is drawn to the left and under the no-tax firm value V_0. Consequently, in Figure 1 the optimal firm value within a no-tax economy is always higher (and corresponds to a larger investment level than that of an economy with a constant-rate regime (i.e., $V^* < V_0^*$ and $K^* < K_0^*$).

Increasing the corporate tax rate (to 25%, for example), leads to a revenue curve T' with a higher slope than T. This higher revenue curve T' moves the maximum of the after-tax firm value curve further down and to the left of V_0. Therefore, a relatively lower investment level $K^{*'}$ and a smaller after-tax firm value $V^{*'}$ will prevail within this example economy where relatively higher taxes are imposed.

Let us now consider two sources of capital; debt and equity, and model the effect of an individual tax rate $t_b^p(\theta)$ on a corporate debt payment to investors of magnitude F (taxes on bond returns). We assume that equity returns escape taxation at the individual level. This assumption is usual in tax literature and is justified on the basis that most stock holdings are taxed upon sale and are transfered intergenerationally for several periods (Scholes et al., 2014).

The value of the firm that is financed by debt and equity, $V_{F,E}$ may be written as follows:

$$
\begin{aligned}
V_{F,E} = & \int_{\underline{\theta}}^{\theta_2} P(\theta)X(\theta)(1 - t_b^p(\theta))d\theta \\
& + \int_{\theta_2}^{\overline{\theta}} P(\theta)[X(\theta)(1 - t^c) + \gamma K t^c](1 - t_b^p(\theta))d\theta - K
\end{aligned} \tag{4}
$$

where γ is the depreciation deduction. Intuitively, Equation 4 demonstrates that a firm's value is a combination of five factors: (1) the market value of its future cash flows after subtracting individual taxes in states $[\underline{\theta}, \theta]$, where there a no corporate taxes ($\int_{\underline{\theta}}^{\theta_2} P(\theta)X(\theta)(1-t_b^p(\theta))d\theta$); (2) plus the market value of future after-corporate-tax cash flows ($\int_{\theta_2}^{\overline{\theta}} P(\theta)[X(\theta)(1 - t^c)]d\theta$); (3) plus the tax subsidy value of the expected depreciation deduction ($\gamma K t^c \int_{\theta_2}^{\overline{\theta}} P(\theta)d\theta$); (4) minus the expected individual tax liability in those states $[\underline{\theta}, \theta_2]$ that are subject to corporate taxation ($-\int_{\theta_2}^{\overline{\theta}} P(\theta)[X(\theta)(1 - t^c) + \gamma K t^c]t_b^p(\theta))d\theta$), and (5) minus the value of its current investment K.

Taking the derivative of the firm value with respect to investment scale, using Leibnitz's rule (because θ_2, the state where the firm pays corporate taxes, depends on the investment scale), and simplifying the first order condition leads to the following optimal investment level:

$$
\begin{aligned}
K^* = & \Big[\alpha \int_{\underline{\theta}}^{\overline{\theta}} P(\theta)X(\theta, K^*)d\theta - \alpha t^c \int_{\theta_2}^{\overline{\theta}} P(\theta)X(\theta, K^*)d\theta \\
& - \alpha(1 - t^c) \int_{\theta_2}^{\overline{\theta}} P(\theta)X(\theta, K^*)t_b^p(\theta)d\theta - \alpha \int_{\underline{\theta}}^{\theta_2} P(\theta)X(\theta, K^*)t_b^p(\theta)d\theta\Big] \\
& \Big/ \Big[(1 - (\gamma t^c \int_{\theta_2}^{\overline{\theta}} P(\theta)(1 - t_b^p(\theta))d\theta\Big]
\end{aligned} \tag{5}
$$

Comparing Equation 3 with the no-tax (benchmark) investment level of Equation 3, one may identify the following tax disincentives for investment: (1) the investment level is reduced by the market value of the expected corporate tax liability of the firm ($\alpha t^c \int_{\theta_2}^{\overline{\theta}} P(\theta)X(\theta)d\theta$); (2) the investment level is further reduced by the sum of the two terms, $\alpha(1-t^c) \int_{\theta_2}^{\overline{\theta}} P(\theta)X(\theta)t_b^p(\theta)d\theta$ and $\alpha \int_{\underline{\theta}}^{\theta_2} P(\theta)X(\theta)t_b^p(\theta)d\theta$, representing the expected market value of the individual tax liability of the firm's owners (the security holders). The denominator of Equation 5 represents the effect of the depreciation deductions on the investment level. Since for any positive depreciation ($\gamma > 0$) this denominator term is smaller than unity, the depreciation deduction provides an investment incentive which helps to partially mitigate the underinvestment tax distortion.

Using Equation 3, let us consider a numerical example presented in Figure 2 in order to get some idea of the relative magnitude of the tax disincentive for investment in comparison with the benchmark no-tax economy. Figure 2(a) depicts a pie chart representing a no-tax economy with \$100 of output (positive cash flow of \$100 at $t = 1$). The optimal investment scale in this case is \$50 (negative cash flow of -\$50 at $t = 0$). In this no-tax regime, the government's tax revenue is zero. Therefore, the entire \$100 of output is paid out to the owners of the firms. The NPV of this project is $\$100 - \$50 = \$50$.

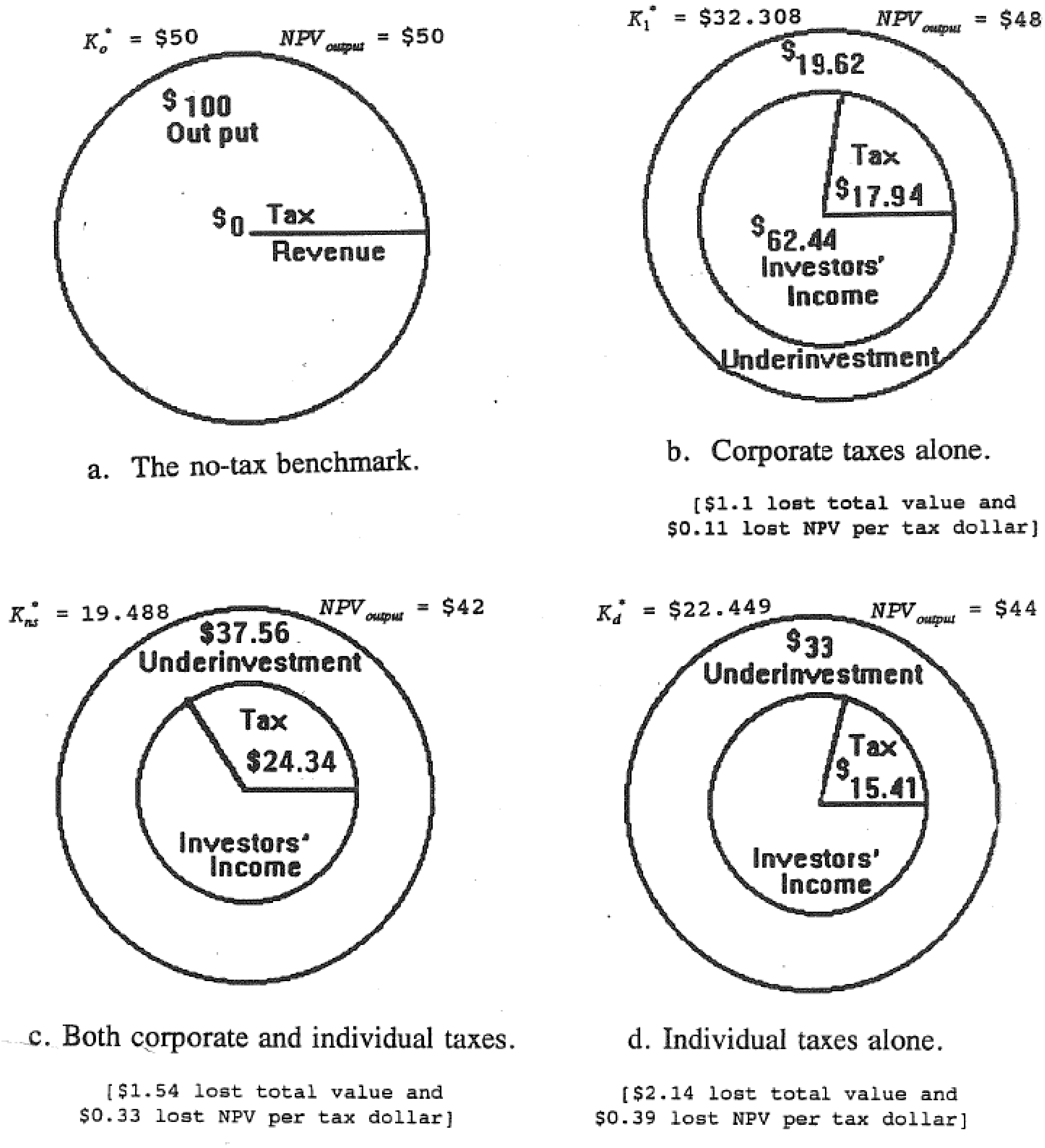
Figure 2(b) is a pie chart corresponding to an example economy with corporate taxes. The optimal investment scale in this case is \$32.308. Under this tax regime, the government receives \$17.94 of tax revenue. The owners of the firm receive a second period cash inflow of \$62.44. The total output of this firm is $\$62.44+\$17.94 = \$80.38$. That is, the \$100 potential output which was achievable in a world without taxation is reduced by \$19.62 of underinvestment.

The optimal investment scale in Figure 2(c) in a world of both corporate and individual taxes is reduced to \$19.488. This results to an underinvestment of \$37.56 corresponding to a tax revenue of \$24.34. In Figure 2(d) we consider only individual taxes. In this case, corporate taxes are abolished, but bond and equity revenues are taxed at the individual level. Then for our \$100 example economy, the firm's optimal investment level is \$22.449. This will produce an underinvestment level of \$33 and raise \$15.41 of tax revenues for the government. The NPV of this project is \$44. See Appendix II for computational details for this example.

The pie charts of Figure 2 show the relative size of the slice of the economic pie claimed by the government. These pie charts also show that, due to taxation, a smaller (output) pie will be produced. In Figures 2(b), (c), and (d), allocating respectively \$17.94, \$24.34 and \$15.41 of revenue to the government causes the \$100 benchmark economy to shrink by \$19.62, \$37.56, and \$33.00. When this loss in output value is normalized by the corresponding value of the tax revenue of each example economy, then the examples of Figures 2(b), (c), and (d) respectively cause \$1.10, \$1.54, and \$2.14 of reduction in output per dollar of tax revenue, respectively \$0.11, \$0.33, and \$0.39 of the firm's NPV is also lost per dollar of tax revenue. Therefore, our model implies a tax underinvestment effect exceeding the tax wealth effect of a dollar of wealth for a dollar of taxes paid. Empirically, we measure these underinvestment levels and report them in Section III.

Even though there are no corporate taxes in Figure 2(d), 33% of the output is lost to a tax disincentive for investment caused by individual taxes alone. This tax distortion may be explained by noting that here, as in Miller (1977), taxes on personal income are reflected in the asset prices, causing an increase in required returns. That is, in Miller's terminology, bond prices are "grossed up". Since investors only care about after-tax revenues from security income, individual taxes on these revenues also cause a disincentive for investment by affecting a firm's value

Figure 2: The tax disincentive for investment: an example.



a. The no-tax benchmark.

b. Corporate taxes alone.

[$1.1 lost total value and
$0.11 lost NPV per tax dollar]

c. Both corporate and individual taxes.

[$1.54 lost total value and
$0.33 lost NPV per tax dollar]

d. Individual taxes alone.

[$2.14 lost total value and
$0.39 lost NPV per tax dollar]

and its investment decision.

Figure 2 also documents a difference between individual and corporate tax distortions. It shows that the tax disincentive for investment causes relatively more underinvestment within an economy with no corporate taxes (2(d)) than in one with corporate taxes (2(b)). This difference may be traced to the investment incentive provided by depreciation allowance for corporations that pay taxes. Note that Figure 2(c) shows an interaction effect between corporate and individual taxes. Thus, depreciation allowances act as an investment tax subsidy, providing an incentive for additional investment.

In summary, Figure 2 illustrates that simply abolishing corporate taxes will not help this economy mitigate the underinvestment caused by the tax distortion. On the contrary, when there are no corporate taxes but the individual income from corporate securities is taxed (2(d)), this policy alternative causes more underinvestment than retaining corporate taxes and eliminating individual taxes (2(b)).

In order to demonstrate that the underinvestment levels of Figure 2 are robust enough that they hold for alternative tax parameters, let us refer to Table 1. This table shows the investment level within the example economy of Figure 2(b) for alternative values for the corporate tax rate t^c.

Table 1: The tax disincentive for investment varies with tax design.

		γ			
		0.2	0.4	0.6	0.8
t^c	0.1	45.779	46.321	46.991	47.665
		(4.479)	(4.195)	(3.907)	(3.611)
	0.3	37.614	39.197	40.883	42.68
		(12.258)	(11.714)	(11.111)	(10.445)
	0.5	30.096	32.308	34.716	37.418
		(18.393)	(17.942)	(17.359)	(16.638)
	0.7	23.786	25.675	28.558	31.956
		(22.786)	(22.684)	(22.453)	(22.016)

The investment levels, K_1^* are in bold-face typeset.
The expected tax liabilities, T_1 are in parentheses.
Benchmark: $K_0^* = \$50$ at $T_0 = 0$.

Table 1 also introduces a factor γ. This factor models the ability of a firm to take advantage of various tax-loopholes, more generous depreciation deductions and deducting non-production costs from income to optimize taxes. Let us call γ "tax deduction subsidy". In fact, Figure 2(b) depicts the third row ($t^c = 0.5$) and the second column ($\gamma = 0.4$) of Table 1. The expected tax liability for each example economy, T_1, has been shown in parentheses for each cell of Table 1. The investment values in this table show that, for any choice of tax parameters, there is an underinvestment tax distortion within this example economy (in comparison with the \$50 no-tax benchmark investment level). In addition, note that when the expected tax liability takes on its smallest value ($T_1 = \$3.611$), the investment level is at its maximum ($K = 47.665$) as shown in row one and column four. In this table, the investment level decreases with increased taxation, and it reaches a minimum of \$23.786, corresponding to the largest tax revenue displayed within Table 1 ($T_1 = \$22.786$). These investment and tax revenue values correspond to the largest displayed corporate tax rate ($t^c = 0.7$) and the smallest tax deduction subsidy ($\gamma = 0.2$).

To analyze whether the underinvestment tax distortion of this section is robust enough that it holds after considering the theoretical specification proposed by John and Senbet (1990), let us define θ_L as follows: at θ_L, $P(\theta_L)X(\theta_L, K) = -V_A$. That is, θ_L is a state of nature where the firm generates a negative second-period cash flow, $X(\theta_L, K)$. In addition, the value of the liability created by this cash flow, $P(\theta_L)X(\theta_L, K)$, equals the value of all other available second period assets of the firm, V_A. For a single project firm with no other fixed assets, at θ_L the second-period cash flow is worth zero dollars (John and Senbet (1990) implicitly assume that $V_A = 0$, so that negative project cash flows are never borne by the firm).

At any state of nature $\theta \in [\underline{\theta}, \theta_L]$ a value maximizing firm exploits its limited liability "put option" by forgoing all its other assets, together with its ruinously large negative second period cash flow. The society, by offering the firm the limited liability provision, in effect holds a short position in this put option. For instance, in a nuclear meltdown accident, after the firm uses up all its resources (available assets) for the clean up effort, then the society absorbs the remaining costs.

The following proposition identifies a condition which insures that the underinvestment tax distortion of this section is robust enough that it holds after considering the overinvestment limited liability distortion mentioned in John and Senbet (1990) .

Theorem 1 *Within an economy which imposes non-lump-sum taxes, despite the limited liability overinvestment problem, a firm underinvests as long as the following condition holds:*

$$\int_{\underline{\theta}}^{\overline{\theta}} P(\theta)X(\theta, K^*_{ns.LL})d\theta < t^c \int_{\underline{\theta}}^{\overline{\theta}} P(\theta)X(\theta, K^*_{ns.LL})d\theta \quad (6)$$

Proof: See Appendix I.

When the inequality in Proposition 1 holds, then under the tax regime of this section, a firm with limited liability chooses to invest $K^*_{ns.LL}$ dollars. This investment level is smaller than the investment level in the benchmark case of no taxes and no limited liability (i.e., $K^*_{ns.LL} < K^*_0$). Intuitively, the inequality of Proposition 1 means that as long as the expected value of the social loss, due to the limited liability provision, ($\int_{\underline{\theta}}^{\overline{\theta}} P(\theta)X(\theta, K^*_{ns.LL})d\theta$) is lower than the expected value of the firm's future tax obligations (the right-hand-side of the inequality in Proposition 1), the limited liability overinvestment problem is resolved.

2.4 Can the Tax Disincentive for Investment be Mitigated by Tax Subsidies?

In this paper, the social gain from leverage and the justification for differential taxation depend on the observation that, except for lump sum taxes, taxation causes a disincentive for investment. Within this economy (in addition to differentially taxed debt) one may consider two other alternative methods of mitigating this tax disincentive for investment: (A) abolish corporate taxation, (B) provide a more generous investment tax incentive. This subsection investigates whether this paper's results are robust enough that they hold for an economy implementing either of the above two tax policies.

Theorem 2 addresses policy (A). It shows that abolishing corporate taxation does not help mitigate the tax disincentive for investment. Theorem 3 focuses on direct tax incentives for investment (policy (B)) and shows that, except for extreme corporate tax rates, a direct tax incentive for investment does not resolve the tax-induced underinvestment problem.

Theorem 2 *Within this model's economy, abolishing corporate taxation does not help mitigate the tax disincentive for investment.*

Proof: See Appendix I.

The proof of Theorem 2 shows that the government may reduce the underinvestment tax distortion by moving from an economy that generates tax revenues solely from individual taxation to an economy which relies on revenue from corporate taxation, thereby allowing for an investment tax-subsidy at the corporate level. Consequently, abolishing corporate taxes and replacing them with individual taxes aggravates the tax disincentive for investment by creating a tax environment wherein the government can no longer use depreciation deductions (or any other corporate deduction which is tied to increased investment) to provide an investment incentive at the corporate level.

This result is consistent with Chang (1988) which establishes that abolishing corporate taxes does not constitute an optimum taxation policy under the efficiency (or the equity) criteria of public economics literature. In Chang's analysis, a firm's investment is financed completely by borrowing (except for a rerun of the same analysis when the funds for investment are raised completely through equity capital).

In addition, in Chang's model, the firm's objective is to maximize a single agent's utility. Under these assumptions, a tax disincentive for investment (which is the central issue in this paper's analysis) is ruled out.

In the absence of a tax disincentive for investment, Chang's analysis relies on the results established by Stiglitz (1973, 1976) that the corporate tax "with appropriate depreciation and interest deductibility is, at the margin, a lump sum tax". Then, using a restatement of the Fisherian Separation Theorem, Chang shows that the individual's consumption, investment and saving plan are not distorted by his model's lump sum corporate tax.

The fundamental difference between this paper's economy and that of Stiglitz (1973, 1976) is that here depreciation deductions may exceed the true economic depreciation of assets. Consequently, in this paper's economy, corporate taxes may no longer be approximated by a lump sum tax as in Stiglitz's model.

Tax policy (B) considers whether an investment tax subsidy alone can resolve the underinvestment problem and render the "investment incentive of leverage" redundant. Theorem 3 studies a condition under which, despite the mitigating effect of the depreciation deduction on the tax disincentive for investment, there remains an underinvestment problem which may be reduced by raising taxes from bonds within a differentially taxed economy.

Theorem 3 *When Inequality 7 holds, $\forall \gamma < 1$, both corporate and individual taxes cause a disincentive for investment.*

$$t^c < \frac{t_l + t_m + t_h}{2(1 - t_h)} \tag{7}$$

Proof: See Appendix I.

Inequality 7 establishes an upper bound for corporate taxes in an economy that imposes a progressive individual tax rate, consisting of three brackets: t_l for low income individuals, t_m for moderate incomes, and t_h for high income levels. The analysis is valid for any $t_l < t_m < t_h$. If corporate taxes are raised beyond the limit set by Inequality 7, then corporate taxation at the margin generates more value for the firm (since depreciation tax deductions loom larger) than the value that the government extracts. To further illustrate this result, let us consider an example economy with a three bracket tax regime: $t_l = 0.15; t_m = 0.2; t_h = 0.5$. In this case, Theorem 3 implies that, as long as the corporate tax rate is under 85%, the social gain from leverage is not redundant.

In addition, using example economies with a γ which exceeds 1 and reasonable tax rates, it can be easily shown that in these specific cases the "investment incentive of leverage" is not redundant. However, a general proof for $\gamma \geq 1$ has not yet been established. Therefore, Theorem 3 shows that (except for extreme tax regimes, such as a corporate tax rate of greater than 85% and a tax deduction subsidy of much larger than 100%), there is a tax disincentive for investment. This paper's results concerning corporate tax integration and the social gain from leverage depend on the existence of a tax disincentive for investment.

Furthermore, to show that after accounting for investors' tax basis, abolishing corporate taxation does not help mitigate the tax disincentive for investment, let us rework the proof of Theorem 2 under this new assumption. After accounting for investors' tax basis, their income within an economy that does not have corporate taxes, may be written as follows:

$$Y_{bd} = X(\theta) \sum_{i=1}^{m+1} \beta_i (1 - t_i^p(\theta)) + B_b t_i^p(\theta) \tag{8}$$

Consequently, within this economy, Equation (A.8) may be written as follows:

$$K_{db}^* = \alpha \int_{\underline{\theta}}^{\overline{\theta}} P(\theta) X(\theta, K_{db}^*) d\theta - \alpha \int_{\underline{\theta}}^{\overline{\theta}} P(\theta) X(\theta, K_{bd}^*) - B_b) t_b^p(\theta) d\theta \tag{9}$$

Since there is a

$$t'(\theta) \ni \int_{\underline{\theta}}^{\overline{\theta}} P(\theta)(X(\theta, K_{db}^*) - B_b) t^p(\theta) d\theta = \int_{\underline{\theta}}^{\overline{\theta}} P(\theta) X(\theta, K_d^*) t'(\theta) d\theta \tag{10}$$

it follows that $Dis(t') > Dis(t^c)$. Therefore, the proof of Theorem 2 is robust enough that it holds after accounting for investors' tax basis.

3 Empirical Test

Djankov et al. (2010) conduct a rigorous cross-sectional empirical study of corporate tax effects on investment for 85 countries. Their study captures the competition among tax authorities to attract more profitable projects by multinational firms into their jurisdiction. In fact, Devereux et al. (2002) document that major industrialized nations of the world are rather competitive in attracting large profitable corporate investments.

We study a panel data set for the same firm with historical data on investment to catch the effect of small NPV projects that are forgone because taxes eat up the after-tax NPV of the project and make the project unprofitable ("underinvestment effect"). Within the same country, a given firm faces tax uncertainty and variability of its tax burden in a given year. For a rigorous articulation of corporate tax uncertainty, please refer to DeAngelo and Masulis (1980).

Tax uncertainty and variability means that using a fixed statuary tax rate of say 39% does not capture the underinvestment effect. A firm may deduct generous or stringent depreciation from year to year. It can also use various tax-loop holes to subtract additional expenses from income to show less after tax income and pay less tax. To capture this effect we focus on how much taxes a firm actually pays each year as a percentage of various measures of its economic activity (net income, sales, gross revenue, etc.). This way we capture the marginal tax as it is reflected in the last year's income statement so that tax uncertainty is to a large degree resolved. This is the best proxy for tax rate that the firm expects to pay next year.

3.1 Data

Our sample is a random selection of firms from the S&P 500. For the construction of the data set we made the following adjustments to the index: first, we only included companies that were listed in the index during the whole observation period, i.e. from 2005 to 2013. Second, we dropped all REITs since they are exempt from taxation at the trust level when they pay out at least 90% of their income to their unitholders. The investment behavior of REITs is thus probably driven by other reasons than taxation. Furthermore, we dropped all financial firms since they usually have significantly less intangible assets than other companies. By applying these rules, we eliminated 46 of the 500 companies. From the remaining 454 companies we took a random sample of 50 firms and collected data from their income statements, balance sheets and cash flow statements.

Independent variables: From the accounting information, we created a data set of the following proxies for investments[3]

Our primary proxy for how much a firm invests in a given year are its reported accounting cash outflows going toward plant, property and other intangible assets (INV_t)[4].

Another good way to measure short-term investment level of a firm is to look at its net operating working capital account $(NOWC_t)$, which is current assets less non-interest bearing current liabilities. Non-interest bearing liabilities are mainly accruals and accounts payable (trade payables).

A firm that invests more in its operations expands. Therefore, we argue that an increase in net sales $(NETSALES_t)$, in the total assets of a firm $(TOTASSETS_t)$

[3]There are other proxies which we did not use. Net income and sales of future years should increase with higher investment; therefore it could be used as a forwarded variable. Accounts receivable, inventory and cash account should also increase as the firm expands. Increases in accounts payable, notes payable and long-term debt are also proxies for additional investment. If retained earning do not increase at the same rate as total assets and stock price increases, then this is likely a firm that borrows and invests in NPV positive projects. Both interest expense and long term debt and notes payable should then increase with higher borrowing.

[4]Since some companies did not report investments in these assets separately but included them in other positions, we dropped cases where investments in plant, property and intangibles were not reported.

and in its operating capital (OC_t) should proxy increasing investments. We calculated the operating capital as total liabilities and equity less non-interest bearing liabilities.

To proxy the expected state of nature, we include the growth in GDP of that year ($GDPGROWTH_t$). Our rationale for doing so is that, assuming that firms have unbiased and rational expectations, a good proxy for what firms forecast the GDP to be at the time of their investment is the actual realized value of that variable in the future.

Dependent variable: To calculate the effective tax rate, taxes paid are divided by net income before taxes. In a few cases, firms had losses or tax refunds due to loss carried forward (resulting in negative tax rates). These cases were eliminated from our data set since they are not part of our theory which is primarily focused on firms that pay taxes and base their investment decisions on their future cash flows.

3.2 Method

We argue that taxation leads to decreased investment and that higher tax liabilities at the firm-level decrease investments even further. Formally, we differentiate between the following three hypotheses:

Hypothesis 1: Corporate Tax Neutrality

According to this hypothesis, when a firm is taxed $1 million, it will still build its new NPV-positive factory because the investment is profitable, even though the government takes a share of that profit as taxes. Under this hypothesis, how you divide the output pie does not shrink it. That is, taxes do not affect investment. For a rigorous articulation of this theory, see Stiglitz (1973, 1976).

Hypothesis 2: Wealth Effect

Under this hypothesis, when a firm has $2 million to invest from which half of it is taxed, it will have $1 million less capital to invest. To the extent that the firm faces capital rationing, some NPV positive projects may not be undertaken (**?**). As all the firms in the economy face the tax burden, on aggregate there will be some reduction in investment at the same rate or a lower rate than the tax rate.

Hypothesis 3: Underinvestment (this paper's theory)

Some marginal projects are NPV positive without taxation. However, future tax obligation reduces after-tax future cash flows of these marginal projects to the extent that they become NPV negative. Taxation reduces the output pie by turning some NPV positive projects to NPV negative ones. That is, corporate taxes reduce the economic output. To implement this theory in a formal relationship, we specify a regression equation of the following form:

$$investment_{j,t} = \alpha + \beta_1 t^c_{j,t-1} + \beta_2 E(\theta_t) + \varepsilon_{j,t} \quad (11)$$

We run additional random effects panel regressions for each of our proxies for investment.

3.3 Results

Table 2 reports the regression results for a proxy of investment ($NOWC_t$) against the previous year's effective tax rate ($PREVTAXRATE_{t-1}$) and a proxy for the expected state of nature in that year ($GDPGROWTH_t$).

Table 2: Empirical results of panel regression 11

$NOWC_t$	Coef.	Std. error	z	p-value	95% Confidence interval	
prevtaxrate	-156.9125	42.96829	-3.65	0.000	-241.1288	-72.69622
gdpgrowth	201.5519	130.5946	1.54	0.123	-54.40885	457.5126
cons	8662.909	1732.392	5.00	0.000	5267.483	12058.33

Table 3: Empirical results of a simplified regression model

$NOWC_t$	Coef.	Std. error	z	p-value	95% Confidence interval	
prevtaxrate	-156.9265	43.08376	-3.64	0.000	-241.3691	-72.48391
cons	9308.377	1681.938	5.53	0.000	6011.838	12604.92

Table 3 reports the regression results of a simplified version. Taxes paid in the prior year reduce the average net operating working capital ($NOWC_t$) of a firm by $156.9 million. This reduction is highly significant; the p-value is 0.000. $NOWC_t$ captures short-term capital changes of a firm and is therefore the best proxy for the coming year's change in investment level. An increase in taxes of 1 percentage point raises approximately $12 million from our average firm. This tax revenue contributes to an investment distortion which reduces net operating working capital by $144.9 million in excess of the tax bill.

We divided our sample into two groups: one group with marginally NPV-positive projects (rate of return lower than 10%) and another group with highly profitable projects (rate of return higher than 10%) in order to test whether tax-induced underinvestment affects these two groups differently. We then estimated a panel regression for the two groups.

Table 4: Evidence in support of underinvestment hypothesis: firms with marginally positive projects

$NOWC_t$	Coef.	Std. error	z	p-value	95% Confidence interval	
prevtaxrate	-114.2279	48.61081	-2.35	0.019	-209.5033	-18.95244
cons	8011.177	1977.437	4.05	0.000	4135.472	11886.88

Table 4 presents evidence in support of the underinvestment theory for firms that have marginally positive projects. We define marginally positive NPV projects as those projects that generate a return of 10% or less. That is, after accounting for the average cost of capital, their economic value added is marginal. For firms with marginal NPV-projects, taxes paid in the previous year decrese the average NOWC of a firm by $114.2 million.

Table 5: Evidence in support of the underinvestment hypothesis: firms with large economic rents

$NOWC_t$	Coef.	Std. error	z	p-value	95% Confidence interval	
prevtaxrate	-235.7041	76.09691	-3.10	0.002	-384.8513	-86.55691
cons	11631.04	2530.58	4.60	0.000	6671.199	16590.89

Table 5 reports the results for the group with highly profitable projects. Taxes paid last year reduce the average NOWC by $235.7 million. It is surprising that highly profitable firms are willing to forgo economic gains in order not to their them with the government.

Table 6: Multiple regression model

$NOWC_t$	Coef.	Std. error	z	p-value	95% Confidence interval	
prevtaxrate	-59.05	30.25	-1.95	0.051	-118.34	0.235
nibt	-0.09	0.09	-0.97	0.330	-0.26	0.09
totassets	0.35	0.02	14.45	0.000	0.30	0.40
netsales	-0.14	0.01	-9.51	0.000	-0.17	-0.11
cons	1077.56	1254.16	0.86	0.390	-1380.54	3535.66

In Table 6 we address the central question of our empirical study. This table shows that, when lack of availability of tax deductions leads to a payment of a 1 percentage point additional taxes over the previous year for a given firm, then that year's investment, measured by NOWC, is reduced by $ 59 millions.

A one dollar increase in NIBT results to 9 cents reduction in this year's investment (NOWC). This result is, however, insignificant according to the p-value. If it was significant, it would have the following interpretation: there are two ways of interpreting this result; 1) The standard finance literature argues that the objective of a firm is to maximize its stock price; not profits. That is, short-term profit maximization can be achieved by not paying for a costly investment this year, at the expense of sacrificing long-term growth. 2) Short-term investments may be undertaken as a turnaround measure. That is, a firm that is underperforming now may invest more this year in order to turn around the situation.

A one dollar increase in total assets leads to 35 cents increase in NOWC; that is, firms with greater resources obviously invest more.

Net sales have a negative significant effect on NOWC. That is, for a one dollar reduction in net sales, the firm has a 14 cents increase in NOWC. This is due to a turnaround strategy; that is, firms that face difficulty in achieving their sales target tend to invest more in advertising and other turnaround measures and vice versa. These turnaround expenditures are not needed when sales increase.

4 Conclusion

When the condition in Proposition 1 does not hold, the firm overinvests. However, according to the analysis by John and Senbet (1990), leverage still contributes to resolving this overinvestment problem. Therefore, taking John and Senbet's theory together with this paper's analysis, one may conclude that leverage (regardless of the applicable analysis) helps to mitigate an investment distortion effect. When the inequality in Proposition 1 is satisfied, there is an underinvestment problem, otherwise (ignoring the case of strict equality) there is an overinvestment distortion.

There is a fundamental difference in this paper's underlying assumptions and that of John and Senbet. Differential taxation is the only market friction within this paper's economy. That is, in contrast with John and Senbet's analysis, this paper does not rely on asymmetric information.

Even with full information, the government may only resolve the underinvestment problem within a centrally managed economy where only public investments are allowed. Therefore, this paper's results apply, as long as centrally managed economies are prohibitively costly. In contrast, when a project's ruinously large social cost is observable, regulation fully resolves the limited liability over-investment problem. For example, when the society is informed regarding the social costs of a "nuclear meltdown", it can prevent the firm from ignoring these social costs by regulating that activity. In other words, with full information, standard Agency Theory implies that a "Forcing Contract" leads to the resolution of the agency costs.

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