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

Ted Azarmi[1,2] and Carolin Schmidt[1]

[1]University of Tuebingen and Heilbronn University
[2]ted.azarmi@uni-tuebingen.de, +4917661640021

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Abstract

Using an Arrow-Debreu framework we derive optimal investment for a firm that takes on NPV-positive projects. Both theoretically and empirically, analyzing all S&P 500 firms for the years 1950-2015, we confirm two fundamental pillars of finance literature: (1) that the stock market serves a valuation function that matters to current investment and (2) that firms invest to capture economic rents.

Surprisingly, we also find that both sales revenue and market value added have a negative impact on corporate investment. This may be explained by agency theory due to turnaround policies or management's attempt to safeguard their own labor capital. In particular, efforts to mitigate lower sales tend to decrease production output. Furthermore, additional borrowing is associated with higher short-term investment which can be explained by pecking order theory of finance.

Our results in the following table indicate that a 1 percentage point increase in the effective corporate tax rate approximately decreases working capital by \$10.30 million, input of raw material to production by \$1.18 million and corporate output by \$7.41 million. An additional percentage point in personal taxes reduces capital input by \$252.81 million, input of raw material to production by \$8.64 million and corporate output by \$389.78 million. This supports an underinvestment tax distortion hypothesis as postulated in our theoretical model.

Keywords: Corporate taxes, underinvestment, tax uncertainty, tax distortion, operating capital, agency problems

1 Introduction

The academic field of finance is closely related to economics. However, finance is based on two fundamental pillars which critically differ from economics:

1. The focus on monopoly, i.e. in capital budgeting, firms invest to capture economic rents, and

2. The stock market serves a valuation function, i.e. it is not a casino.

In addition, the academic field of finance relies on information provided by accounting statements. In finance, firms take the highest net present value (NPV) positive projects. However, the field is somewhat mute about where NPV-positive projects come from. Perhaps, these could arise from measures of efficiency and excellence in undertaking business activity. Similarly, a central issue in finance is that the stock market provides a valuation function, which means that it matters. This of course fundamentally differs from the Keynesian view of economics. To investigate what factors affect corporate investment we consider the above two areas and a number of other factors including taxation.

Let us focus on three classes of determinants of corporate investment: (1) the economic rent that a project generates, (2) behavioral or agency theory factors, 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 that reduced after-tax income affects corporate production. After all, in absence of capital rationing, both capital and labor input should be available for a net present value (NPV) positive project.

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, if we have economic rents, Stiglitz's tax neutrality theory does not hold. Therefore, we argue that corporate taxes could have an adverse effect on corporate investment. An extension of our work may be used to demonstrate an adverse affect of taxes on employment.

Then the relevant question is the magnitude of the reduction in corporate investment 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 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 production cost and yield an NPV positive project as in our paper. Nevertheless, we argue that the reduction in output of an underinvestment of a dollar would be significantly higher than a dollar. As an example, consider that in 2005 NorthStar consultants report that a dollar of taxpayer contribution to the University of Wisconsin generated 24 dollars for the state economy. However, that same dollar of taxation can reduce corporate output by more than 24 dollars such that the net effect on the economy would be negative.

The investment effect of corporate taxes may not be analyzed in isolation. Therefore, we conduct a rigorous panel regression that analyzes time-series data on yearly tax payments of all S&P 500 corporations over 65 years.

Our paper in spirit is close to a paper written by Djankov, Ganser, McLiesh, Ramalho and Shleifer (2010). They 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 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. In fact, 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. Therefore, it is crucial to investigate the effect of these tax changes on corporate investment.

Dobbins and Jacob (2016) 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 domestically owned firms.

Grunfeld (1958) provides a pioneering study of determinants of corporate investment. He finds that the market value of the firm is a principal variable that determines corporate investment. In this paper, we also find that firms' market value measured by the market capitalization is a significant determinant of corporate investment.

There is another corporate tax effect to consider. If corporate taxes are lower than personal taxes, a well-known tax-avoidance trick in the USA, for instance, would be that a wealthy individual registers as 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 also consider an overinvestment hypothesis, which is investment in turnaround operations. To test this hypothesis, we consider a relationship between sales, market value added, and long-term debt as factors that adversely affect output and production input. We believe that a negative relationship between sales and production output 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, and explores its policy implications. Section 4 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.

[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).

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

(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:

[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.

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

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

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

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.

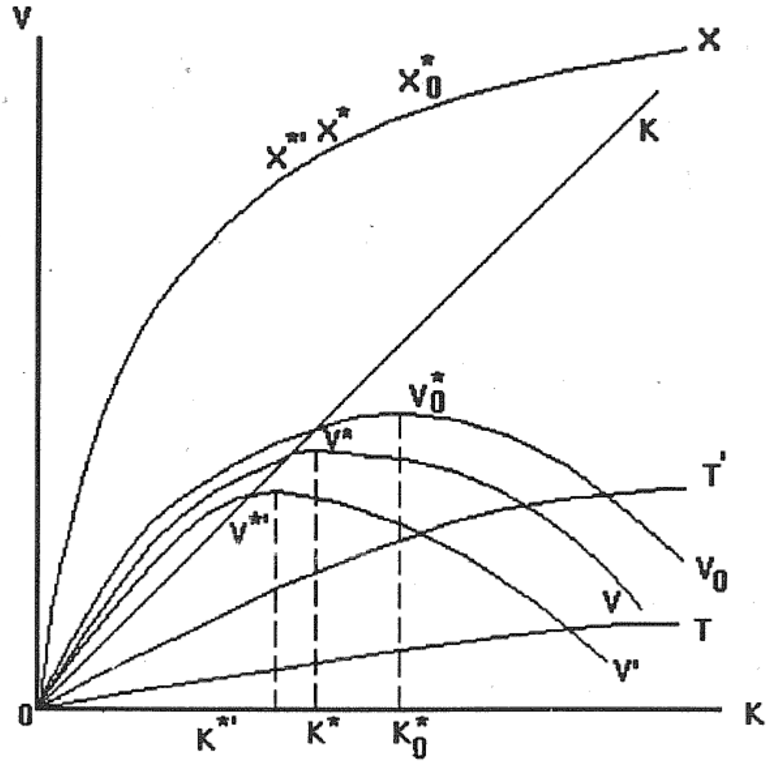


Figure 1 depicts a firm's investment decision and value maximization problem. In this figure, the investment scale K is measured on the horizontal axis and the firm value V on the vertical axis. This figure is drawn for a production function X with a diminishing marginal rate of return. Curve V_0 of 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 common 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 a proxy for tax subsidies tied to investment level. 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 are 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 5 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 5, 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 $\$100 - \$50 = \$50$.

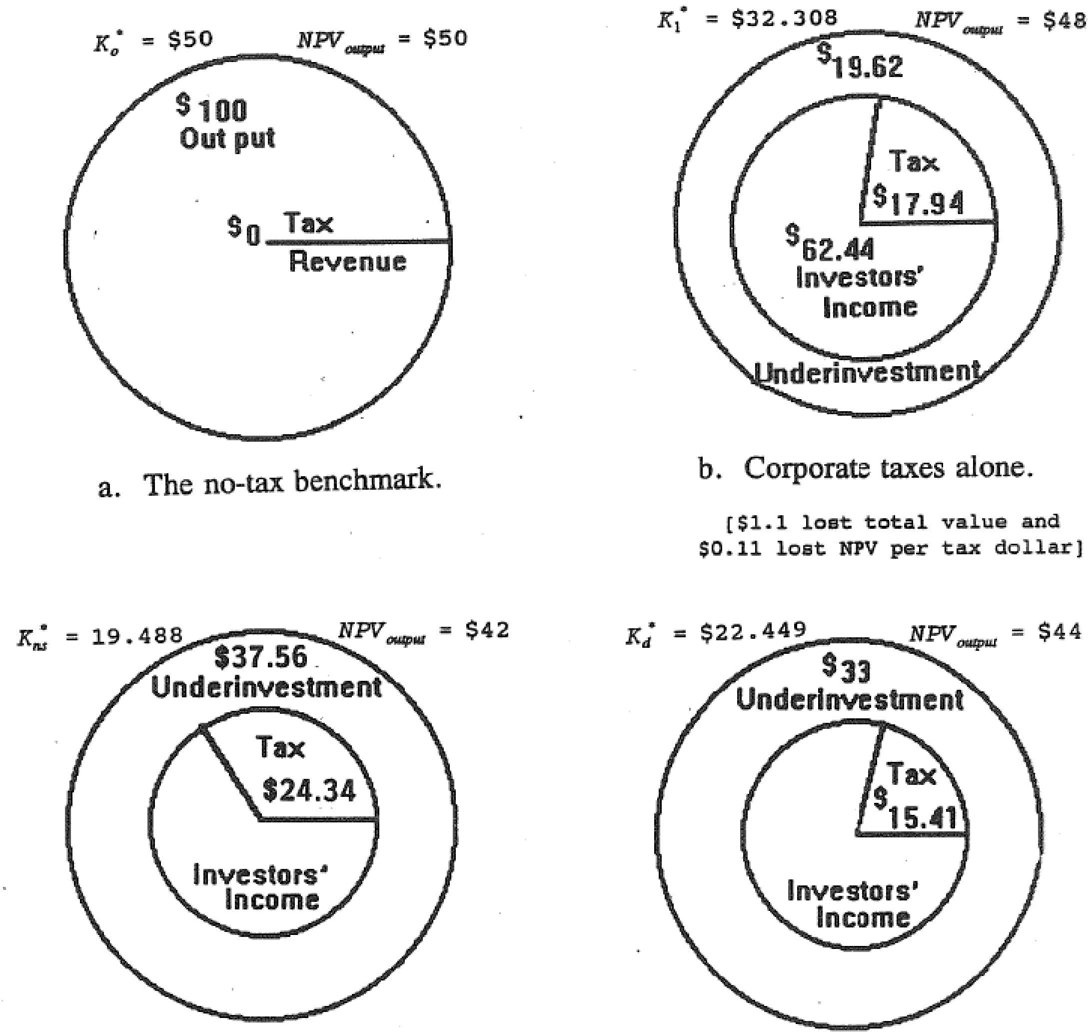
Figure 2(b) is a pie chart corresponding to an example economy with corporate taxes. The optimal investment scale in this case is \$32.308. Under this tax regime, the government receives \$17.94 of tax revenue. The owners of the firm receive a second-period cash inflow of \$62.44. The total output of 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 3.

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

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] 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 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 table shows the investment levels, K_1^*.
The expected tax liabilities, T_1 are in parentheses.
Benchmark: $K_0^* = \$50$ at $T_0 = 0$.

Table 1 considers different values for 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 $\theta \in [\theta, \theta_L]$ 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:*

$$
\begin{aligned}
\int_{\theta_L}^{\bar{\theta}} P(\theta)X(\theta, K^*_{ns.LL})d\theta <& [t^c \int_{\theta_2}^{\bar{\theta}} P(\theta)X(\theta, K^*_{ns.LL})d\theta \\
&+ (1 - t^c) \int_{\theta_2}^{\bar{\theta}} P(\theta)X(\theta, K^*_{ns.ll})t^p_b(\theta)d\theta \\
&+ \int_{\underline{\theta}}^{\theta_2} P(\theta)X(\theta, K^*_{ns.ll})t^p_b(\theta)d\theta] \\
&/[(1 - (\gamma t^c \int_{\theta_2}^{\bar{\theta}} P(\theta)(1 - t^p_b(\theta))d\theta)]
\end{aligned} \tag{6}
$$

Proof: See Appendix I.

When the inequality in Theorem 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 Theorem 1 means that as long as the expected value of the social loss, due to the limited liability provision, ($\int_{\underline{\theta}_L}^{\bar{\theta}} P(\theta)X(\theta, K^*_{ns.LL})d\theta$) is lower than the expected value of the firm's future tax obligations (the right-hand-side of the inequality in Theorem 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 optimal taxation policy under the efficiency (or the equity) criteria of the 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 underinvestment problem exists.

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 Analysis

3.1 Data

Our sample consists of the entire S&P 500 Compustat dataset beginning in 1950 and ending 2015. We test how the tax payment, after the resolution of DeAngelo and Masulis (1980) tax-uncertainty affects these firms' working capital. We narrowly focus on working capital[3], which isolates the most recent effective tax payment expectations of the firm on the most recent investment decision of that firm. This approach also highlights our belief that analyzing accounting information is central to the academic field of finance.

We use working capital, defined as current assets less non-interest-bearing liabilities. The fact that working capital uses current assets allows us to capture the year-to-year (short-term) variability of investment of a firm, which would be lost when one uses total assets, non-tangible assets, or other proxies of long-term investment. Non-interest-bearing liabilities are mainly accruals and accounts payable (trade payables). These assets are not the firm's invested capital as they are cash belonging to other stakeholders temporarily held inside the firm.

There are other proxies that could be used for short-term investment. E.g., as a firm invests more and expands, its accounts receivable, inventory and cash account should increase. Increases in accounts payable, notes payable and long-term debt are also proxies for additional investment. If retained earnings do not increase at the same rate as total assets and stock price increase, then this is likely a firm that borrows and invests in NPV positive projects. Interest expense, long-term debt and notes payable should then increase with higher borrowing. However, the above proxies are less direct and more problematic than working capital, e.g., inventory may decrease due to just-in-time production or a better inventory control system rather than due to a reduction of investment.

A direct proxy for how much a firm invests in a given year would be its cash outflows going toward plant, property and other intangible assets (CAPEX). Our analysis of this proxy shows that it does not capture the variability of year-to-year short-term investment data adequately for our research purpose[4]. That is, a firm may move its factory to a low-tax jurisdiction and that can be captured by a multi-country study such as Djankov et al. (2010). They conduct a rigorous cross-sectional empirical study of corporate tax effects on investment for 85 countries. Their study

[3]We use working capital instead of capital expenditure (CAPEX) because we are primarily interested in capital as an input to production. Similarly, labor as an input to production may be used. CAPEX only captures additional investment made for the next operating period. In other words, it is possible for a firm to have more capital input into production and more working capital but not increase its CAPEX, e.g., consider a firm in the service industry that does not buy additional fixed assets but increases its working capital

[4]We carried out a regression using this proxy without significant results.

captures the competition among tax authorities to attract more profitable projects by multinational firms in their jurisdiction.

3.2 Tax Hypothesis

We argue that taxation leads to decreased investment and that higher tax liabilities at the firm-level decrease investments even further. E.g., Devereux et al. (2002) document that major industrialized nations of the world are rather tax-competitive in attracting large profitable corporate investments. Therefore, taxes are an empirically and theoretically important determinant of investment. 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 ones divides 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 taxes reduce a firm's cash flow from $2 million to $1 million, under capital rationing (Stiglitz and Weiss, 1981), some NPV positive projects may be forgone. 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.

3.3 Results

3.3.1 Testing the model

In this subsection we empirically test our mathematical model of the optimal investment level as stated in Equation 5 and the resulting optimal firm value. In that equation, investment is a function of corporate and personal tax rates; an operator $P(\theta)$, which provides valuation under each state of nature, which can best be proxies by the stock price; and a scale parameter which may be viewed as the economic wealth generated by the project. Mathematically we showed that, in our model economy, both corporate and personal tax rates have an adverse effect on corporate output and investment levels, while the stock valuation and the economic return from the project have a positive impact on investment. To test this theoretical relationship, we specify a regression equation for the company j at time t of the following form:

$$Y_{j,t} = \beta_0 + \beta_1 t^c_{j,t-1} + \beta_2 t^p_{j,t-1} + \beta_3 P_{j,t-1} + \beta_4 NPV_{j,t-1} + \varepsilon_{j,t} \tag{11}$$

where $t^c_{j,t-1}$ is the effective corporate tax rate, defined as taxes that were actually paid by the firm divided by net income before taxes. This data is directly available from the income statement of each firm for each year. However, in a few cases, firms had losses or tax refunds due to loss carry-forward (resulting in negative tax rates). In addition, in a few other cases, firms had tax penalties or large tax obligations which exceeded their net income for that year (resulting in tax rates higher than 100 %). All these cases were eliminated from our dataset since they are not relevant to our theory which is primarily focused on firms that base their future investment and production decisions on their current taxes.

$t^p_{j,t-1}$ is the state-dependent personal tax rate, i.e., personal taxes are progressive, so in better states of nature, individuals have more income from wages, bonds and equity and pay a higher tax rate. In the finance literature, only individual taxes paid on bond income are relevant to investment decisions. That is, the standard finance literature assumption is that the effective individual tax rate on equity income is zero (Scholes et al., 2014). This is justified on the ground that equity is taxed only when it is sold, and most equity holdings are transferred inter-generationally free from tax payment. To test our model, we use data on average yearly personal tax rates which vary per year. This is more appropriate for our model as an increase in average individual tax rates causes an increase both in tax payments on wages and tax payments on individual savings. Therefore, by using average individual taxes, we can capture their effect on both labor cost and after-tax cost of capital.

To proxy the valuation operator, we include the last period's stock price. Given unbiased and rational expectations, a good proxy for what firms forecast their stock price to be at the time of making their investment and output decision is the actual realized value of that variable.

When a firm adds an NPV-positive project, it adds market value. Therefore, our proxy for the Cobb-Douglas scale parameter α is its market value added, defined as stock price less book value of equity.

To safeguard against spurious regression results, we use standard control variables. In particular, we include EBIT (e.g., Dobbins and Jacob, 2016; Fazzari et al., 1988; Lamont, 1987; Faulkender and Petersen, 2012) and the number of employees, which we both scale by total assets, a loss dummy variable, and the logarithm of total assets. This is in line with empirical studies such as the work by Dobbins and Jacob (2016).

In addition, we focus on variables that affect out dependent variable due to managerial agency costs. That is, the management of a firm may decide to overinvest in order to save their jobs even when NPV-positive projects are not available. Some of these investments may be turn-around strategies, e.g., when sales or profits are low, management may spend additional funds on advertising even though the NPV of the project is negative. To empirically study this phenomenon, we use working capital instead of OC as one of our dependent variables because (short-sighted) turn-around activity involves expenditures on consulting, advertising, but not building a factory. Another agency-related determinant of corporate investment and output to consider is related to debt financing. The burden of debt may increase the risk on managers' labor capital. Therefore, management may reduce input into production to mitigate that risk. We include debt in out regression to investigate this effect.

We analyze Equation 11 with three different proxies for the dependent variable Y: (1) Working capital as a proxy for short-term investment, (2) Raw material input and (3) Production output proxied by EBITDA.

Table 2: Determinants of production output and input of capital and raw material

	Working capital	Raw material input	Production output	NPV positive projects
Corporate tax rate	-10.30***	-1.18***	-7.1***	-0.0000
Personal tax rate	-252.81***	-8.64***	-389.78***	-3.10***
Stock price	11.24***	-0.001	0.14***	—
Profit	333.05	-202.18	215.56	12.22***
Market value added	-12.93***	0.01	-0.32***	—
Debt	611.79***	-95.76***	-871.87***	-8.30***
Sales	-299.52***	-38.52***	-549.78***	—
Production output	—	—	—	32.29***
Working capital	—	—	—	0.00006***
cons	3335.95***	253.64***	5654.94***	71.61***
R^2 (within) / N	0.1244 / 8946	0.2120 / 5260	0.5393 / 10067	0.0444 / 9806

Control variables: EBIT, number of employees, a loss dummy, total assets. Profit, debt, sales and the control variables are scaled by total assets. Explanatory variables are lagged.

Our results in Table 2 indicate that a 1 percentage point increase in the effective corporate tax rate approximately decreases working capital by $10.30 million, input of raw material to production by $1.18 million and corporate output by $7.41 million. Moreover, an additional percentage point in personal taxes reduces capital input by $252.81 million, input of raw material to production by $8.64 million and corporate output by $389.78 million. This supports an underinvestment tax distortion hypothesis as postulated in our theoretical model.

Additionally, we find a set of determinants of which may be explained by agency theory as follows: (1) Sales revenues and market value added are both significantly and negatively correlated with working capital and production output. This can be attributed to investment in turnaround strategies in order to safeguard management's interest in preserving their own labor capital. This may also be explained based on psychological effects such as loss aversion. (2) The amount of debt is significantly and positively correlated with corporate investment. However, debt has a negative impact on production output and use of raw materials. That is firms borrow to invest. Yet, debt financing comes with more conservative sales and production strategies to safeguard managerial ability to service debt.

We add an additional regression in the last column of Table 2 in order to test the pillar of finance that firms invest to capture economic rents. In particular, a current increase in working capital, profit, and production output adds future value to the firm proxied by the stock price.

3.4 Controlling for investment opportunities

Each year a firm has to pay for maintenance and replacement of its existing machineries. However, this does not represent an additional investment in long-term assets. Therefore, firms which have a CAPEX which exceeds their depreciation have in fact increased investment in machineries.

We are worried about firms that have no opportunity to invest as they respond to an increased tax rate. Therefore we focus on firms that have invested in machinery and equipment to observe reductions in capital input as their tax rates increase.

To implement this method we consider only those cases for which CAPEX exceeds depreciation and run a regression on this subset of data. The results are reported in Figure 3. This table shows that the results are robust enough that do not change significantly.

4 Conclusion

We built an Arrow-Debreu mathematical model economy and derived optimal investment for a publicly traded firm that takes on NPV-positive projects. Using

Figure 3: Results for a regression that controls for investment opportunities

```
. xtreg wcap ctaxrate ptaxrate gdpgrowth stockprice if capex_dep >= 0 & capx!=. & dp!=.,
> fe

Fixed-effects (within) regression               Number of obs      =      7797
Group variable: gvkey                           Number of groups   =       496

R-sq:  within  = 0.0438                         Obs per group: min =         1
       between = 0.1115                                        avg =      15.7
       overall = 0.0453                                        max =        33

                                                F(4,7297)          =     83.48
corr(u_i, Xb)  = 0.0499                         Prob > F           =    0.0000

------------------------------------------------------------------------------
        wcap |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ctaxrate |  -4.424581   1.847385    -2.40   0.017    -8.045989   -.8031724
    ptaxrate |   -261.523   20.55421   -12.72   0.000    -301.8152   -221.2308
   gdpgrowth |  -11.83158   9.017765    -1.31   0.190    -29.50901    5.845849
  stockprice |   4.404275   .6960166     6.33   0.000     3.039882    5.768669
       _cons |   3254.538   193.6401    16.81   0.000     2874.947    3634.129
-------------+----------------------------------------------------------------
     sigma_u |  1414.2396
     sigma_e |  1609.9657
         rho |  .43555011   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(495, 7297) =    10.39            Prob > F = 0.0000
```

parameter values close to those of the US economy, we solved the model and calculated the output.

We attempted to establish cause and effect by using various methods such as lagging variables, adding a number of standard controls identified by the literature such as EBIT, the number of employees, a loss dummy variable and the total assets. In particular, we empirically tested a theory that postulates cause and effect.

We used panel regression methodology to test our model based on data on the S&P 500 firms provided by Compustat from the 1950's onward. To analyze the determinants of corporate investment, we focused on short-term capital input and proxied it using accounting data on working capital. Our rationale was that investments in large capital assets such as factories are not made based on small changes in factors such as taxes and net income in a given year. I.e., corporate investments tend to be "lumpy." We used data on raw material inventory as an input to production as a dependent variable. Finally we proxied corporate output by operating profit (EBITDA). Empirically, we also looked for other determinants of corporate investment such as sales revenues, market value added and the amount of debt.

We studied panel data on corporate investment to catch the effect of NPV positive projects that are forgone. That is, after taxes, the NPV of the project is negative ("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 statutory tax rate of, say, 39% does not capture this paper's underinvestment effect. A firm may deduct generous or stringent depreciation from year to year. It can also use various tax-loopholes to subtract additional expenses from income to show less after-tax income and pay less taxes. At times, taxes are subject to negotiations, mutual agreement or court cases by the tax office. To capture these effects we focused on how much taxes a firm actually pays each year as a percentage of its earnings before taxes. This way we captured the effective tax as it is reflected in the 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.

The stock price has a fundamental positive effect on investment levels and corporate production output of S&P 500 firms in the last 65 years. Therefore, the stock market has a valuation function that affects the real side of the economy and cannot be viewed as merely a casino.

Both personal and corporate taxes adversely affect investment levels, corporate output and the use of raw materials. In fact, taxation has a significant adverse effect on economic output both in our model and empirical study. The tax under-investment effect is not just an association as our regression analysis is backed by a predictive theory and hypothesis testing. In order for the independent variable to cause the dependent variable, logic dictates that the independent variable must occur first in time; in short, the cause must come before the effect. This we have by lagging variables. A spurious or false relationship exists when what appears to be an association between the two variables is actually caused by a third extraneous variable. We safeguard against this problem by including variables that are known to influence investment as control variables in our regression.

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.

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References

Bradford, W. D. (1987). The Issue Decision of Manager-Owners under Information Asymmetry. *Journal of Finance 42*(5), 1245–1260.

Brennan, M. and A. Kraus (1987). Efficient Financing under Asymmetric Information. *Journal of Finance 42*(5), 1225–1243.

Chang, C. (1988). Optimal Taxation of Business and Individual Incomes. *Journal of Public Economics 35*(2), 251–263.

Constantinides, G. M. and B. D. Grundy (1989). Optimal Investment with Stock Repurchase and Financing as Signals. *Review of Financial Studies 2*(4), 445–466.

Dammon, R. and L. Senbet (1988). The Effects of Taxes and Depreciation on Corporate Investment and Financial Leverage. *Journal of Finance 43*(2), 357–373.

DeAngelo, H. and R. Masulis (1980). Optimal Capital Structure Under Corporate and Personal Taxation. *Journal of Financial Economics 8*(1), 3–29.

Devereux, M. P., R. Griffith, and A. Klemm (2002). Corporate Income Tax Reforms and International Tax Competition. *Economic Policy 17*(35), 449–495.

Djankov, S., T. Ganser, C. McLiesh, R. Ramalho, and A. Shleifer (2010). The Effect of Corporate Taxes on Investment and Entrepreneurship. *American Economic Journal: Macroeconomics 2*(3), 31–64.

Dobbins, L. and M. Jacob (2016). Do Corporate Tax Cuts Increase Investments? *Accounting and Business Research 46*(7), 731–759.

Faulkender, M. and M. Petersen (2012). Investment and capital constraints: repatriations under the American Jobs Creation Act. *Review of Financial Studies 25*(11), 3351–3388.

Fazzari, S. M., R. G. Hubbard, B. C. Petersen, A. S. Blinder, and J. M. Poterba (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity 1*, 141–206.

Galai, D. and R. W. Masulis (1976). The Option Pricing Model and the Risk Factor of Stock. *Journal of Financial Economics 3*(1), 53–81.

Green, R. and E. Talmor (1985). The Structure and Incentive Effects of Corporate Tax Liabilities. *Journal of Finance 40*(4), 1095–1114.

Green, R. C. and E. Talmor (1986). *Effects of Asymmetric Taxation on the Scale of Corporate Investments* (Recent Adv ed.). Cambridge: Cambridge University Press.

Grunfeld, Y. (1958). The Determinants of Corporate Investment. Unpublished Ph.D. Dissertation, University of Chicago.

John, K. and L. W. Senbet (1990). Limited Liability, Corporate Leverage, and Public Policy. Working Paper.

Lamont, O. (1987). Financing constraints and corporate investment. *Journal of Finance 52*(1), 83–109.

Miller, M. H. (1977). Debt and Taxes. *Journal of Finance 32*(2), 261–275.

Modigliani, F. and M. H. Miller (1958). The Cost of Capital, Corporation Finance, and the Theory of Finance. *American Economic Review 48*(3), 162–197.

Myers, S. C. and N. S. Majluf (1984). Corporate Financing and Investment Decisions When Firms Have Information that Investors Do Not Have. *Journal of Financial Economics 13*(2), 187–221.

Noe, T. H. (1988). Capital Structure and Signaling Game Equilibria. *Review of Financial Studies 1*(4), 331–356.

Scholes, M. S., M. A. Wolfson, M. M. Erickson, M. L. Hanlon, E. L. Maydew, and T. J. Shevlin (2014). *Taxes & Business Strategy* (5 ed.). Prentice Hall.

Stiglitz, J. (1973). Taxation, Corporation, Financial Policy, and the Cost of Capital. *Journal of Public Economics 2*(1), 1–34.

Stiglitz, J. (1976). The Corporation Tax. *Journal of Public Economics 5*(3), 303–311.

Stiglitz, J. and A. Weiss (1981). Credit Rationing in Markets with Imperfect Information. *American Economic Review 71*(3), 393–410.