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Jenny Simon

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Abstract

I present a rationale for a government to discriminate between debt and equity financing when taxing corporate income. For risk-averse entrepreneurs, equity generates more surplus than debt, because it provides financing and insurance. A government seeking to extract surplus from entrepreneurs would naturally tax equity-generated income more than debt-generated income. I also establish a less obvious reason why the government might want to extract surplus from entrepreneurs. It is well understood that when the quality of projects is unobservable to investors, risk-averse entrepreneurs with higher-return projects might retain a larger share of equity to signal their type (Leland and Pyle (1977)). I show that in such an adverse selection setting, while competitive investors are constrained to offer actuarially fair terms, the government can use taxes to discriminate between types. This degree of freedom allows manipulation of the relevant incentive constraints so that a lower level of debt suffices for separation, and an increase in overall efficiency can be obtained. Since entrepreneurs separate along their debt-to-equity ratios, the optimal non-linear tax schedule to achieve the desired discrimination is isomorphic to one that taxes debt-generated income at a lower rate than equity-generated income.

JEL-Code: G180, G110, H250, D820.

Keywords: corporate taxation, debt bias, investment decision under asymmetric information.

Jenny Simon
Stockholm Institute of Transition Economics
Stockholm School of Economics
Sveavägen 65, P.O.Box 6501
Sweden - 11383 Stockholm
jenny.simon@hhs.se

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1 Introduction

Many tax codes do not treat debt and equity financing equally. While interest payments for loans can often be deducted from the corporate income tax base, dividends to equity holders are taxed as profits on the firm side (and then often again as capital income on the investor's side). This constitutes discrimination in favor of debt financing, which is widely believed to be suboptimal. In this paper, I present a reason why a government might optimally choose to discriminate between debt and equity financing. When provided by a competitive financial market, debt and equity financing generate different levels of surplus for the entrepreneur: While both help the entrepreneur to realize the *implementation gain* of his project, equity also provides *insurance*. A government aiming to extract the surplus from entrepreneurs thus has no reason to tax income generated by different means of financing at the same rate.

The rationale for a government to aim to extract surplus, though, is less obvious. Risk-averse entrepreneurs whose projects differ in expected returns, typically differ in their willingness to pay for insurance of the same risk. Yet, if financial markets are competitive and insurance can be obtained at actuarially fair terms, every such entrepreneur prefers equity to debt. Perfect insurance is obtained only when the complete ownership of the project is sold to an investor. However, if the characteristics of projects are unobservable to investors ex-ante, catering to different entrepreneurs becomes a problem of screening types. Leland and Pyle (1977) have shown that in this case entrepreneurs with higher-return projects will retain a larger share of their project to signal their type to investors.

How does tax discrimination between debt and equity influence the outcome of this signaling game? Much along the lines of Spence (1973), using more debt to finance a new investment is a costly and socially inefficient signal. It is wasteful, because the risk-averse party needs to take more risk than if information were symmetric. Then, subsidizing the wasteful signal might simply lead to an increased use of debt, but most likely not to a difference in the outcome of the signaling game². However, this logic only applies if debt receives an absolute subsidy. The typical corporate income tax schedule instead entails only a *relative* subsidy of debt over equity.

In this paper, I show that relative discrimination between debt and equity can instead lead to a more efficient outcome. Adverse selection necessitates the use of

²There are two caveats: First, if the entrepreneurs' preferences exhibit *increasing* absolute risk aversion, a linear subsidy to debt might draw in more lower types, thereby weakening the signal. At the shares of retained equity that the high types are able to afford when trading off their risk aversion against the combined incentives for using debt (the signaling value and the tax incentives), investors might not be able to infer their types anymore, as the same tax subsidy might have led to lower types retaining the same shares of their projects. A separating equilibrium might then fail to exist. Second, the tax schedule would have to include a no-arbitrage condition, so that types can take out at most enough debt to bridge the gap in financing that arises due to a lower equity issue. With a tax subsidy, the highest types, who would be willing to keep almost all the ownership of their project, will run into that constraint. They cannot increase the share of debt any further to separate themselves from lower types, so some pooling at the top might result.

debt as a signal. The level of debt necessary for separation is thus dictated by the incentive constraints of a screening problem. Competition between investors does not allow for any further price discrimination between types - everyone receives his equilibrium amount of insurance at actuarially fair terms. The government, however, is not restricted to the prices dictated by competition. Instead, it can use differential taxation to implement a form of price discrimination between types that resembles the pricing choice of a monopolist investor/insurer. This degree of freedom allows additional manipulation of the incentive constraints and can thus lead to a *lower* overall use of debt. Such an increase in efficiency requires extracting surplus from entrepreneurs. While the equilibrium with taxes can be more efficient than the competitive equilibrium, it overall distributes away from the entrepreneurs and toward other parts of the economy (not modeled here). Studies comparing monopolistic versus competitive insurance markets come to similar conclusions (e.g. Stiglitz (1977), Dahlby (1987), de Feo and Hindriks (2009)).

The optimal discrimination between types generally calls for a non-linear tax on corporate income. I show that since entrepreneurs separate along their debt-to-equity ratios, the optimal tax schedule is isomorphic to one that taxes the fraction of income generated with equity differently from that generated with debt financing. In such a schedule, each type faces a higher tax rate on equity-financed income than on debt-financed income, because the surplus generated by equity financing is larger (implementation *and* insurance gains). In some cases, even a linear schedule with separate tax rates on the fraction of income generated by debt versus equity with a debt bias approximates the optimal non-linear tax schedule that maximizes revenue.

Related Literature

The modern discussion about what determines the capital structure of corporations started with the seminal contribution by Modigliani and Miller (1958). They state that in an efficient market and in the absence of taxes, bankruptcy and agency costs, and asymmetric information, the value of the firm is invariant with respect to its capital structure. Relaxing any of these conditions in turn and analyzing the resulting optimal capital structure has since been a major focus of the corporate finance literature. Harris and Raviv (1991) provide a comprehensive overview.

Many tax codes favor debt financing over equity. For corporations, interest payments on loans are to a large extent deductible from the tax base, while dividend returns to equity holders are not. In the US, Graham (2000) estimates the tax benefits for debt to amount to 9.7% of firm value. de Mooij (2011) reports that the cost of equity-financed investment was higher than that of debt-financed investment in 2007 for firms in the US, Japan, and the EU-27. Bradley et al. (1984) survey the large literature that has investigated the effects of this discrimination between means of financing. The general argument is that firms choose the optimal level of debt by trading off tax incentives against the potential costs of financial distress resulting from debt financing.

Whether firms do indeed base their choice of capital structure on the tax incen-

tives for debt has long been questioned³. However, recent studies do find evidence for the hypothesis that “the desirability of debt finance at the margin increases with the firm’s effective marginal tax rate on deductible interest” (MacKie-Mason (1990), p.1482). The behavioral response of firms to the “debt bias” has been quantified most recently by Gordon and Lee (2001, 2007). They estimate that shifting from the average tax distortion to no tax distortion would reduce debt-to-capital ratios by 0.022, implying that an additional 2.2% of capital would be financed with equity rather than debt (Gordon and Lee (2007)).

These studies focus on the optimal financing decision from the firm’s point of view, taking the debt bias in corporate income tax schedules as given. None of them ask why it might be in the government’s interest to implement such discrimination. Despite the arguments against this discrimination, it has persisted over time, and might have even become larger (de Mooij (2011)). Yet, the general consensus is that discrimination between debt and equity should be eliminated (as for example Auerbach et al. (2010) argue in the Mirrlees Review).

In contrast to the static tax incentive versus bankruptcy costs trade-off view, a large stream of the corporate finance literature following Modigliani and Miller (1958) has considered asymmetric information between entrepreneurs and financiers and its effect on firms’ capital structure. A firm’s choice of the means of financing, so the main argument runs, might contain information about its underlying value. The signal conveyed to investors and the associated costs in terms of firm valuation are what determines the decision to issue new equity or debt.

In a seminal contribution, Myers and Majluf (1984) have argued that information asymmetries can explain why the stock price of a company typically declines after new equity is issued. If investors cannot observe the underlying value of a firm (e.g. the quality of a new project for which the firm seeks financing), they will factor in some probability that the entrepreneur or manager of the firm is behaving opportunistically, issuing shares when they are overvalued. Issuing debt does not affect the price of financing in the same way - the value of debt, especially safe or highly rated debt, is largely unaffected by a change in the stock price. A number of studies have tested the implications of this theory empirically, and have found evidence for stock price decreases related to new equity issues (see Dierkens (1991) for a summary). Myers (1984) therefore proposes a “pecking order” of corporate finance. According to this theory, firms finance new projects with internal funds first, and only after exhausting them seek outside capital, first in the form of safe debt and only when absolutely necessary through new equity. These papers consider firms as risk-neutral agents. One important difference between debt and equity, however, is the amount of risk the entrepreneur can shift to the investor.

On the investment side of the financing transaction, Gordon and Bradford (1980)

³MacKie-Mason (1990) briefly surveys Titman and Wessels (1988), Fischer et al. (1989), Ang and Peterson (1986), Long and Malitz (1985), Bradley et al. (1984), and Marsh (1982) as “studies that fail to find plausible or significant tax effects” (p.1471).

have considered a model with risk-averse investors. They conclude that an investor's portfolio mix of stocks and bonds will depend on the tax rates he faces as well as his risk-aversion. When tax rates are not linear and absolute risk aversion is not perfectly constant, the individually optimal mix will depend on the overall size of the portfolio.

Leland and Pyle (1977) instead consider a setup with risk-averse entrepreneurs that is most closely related to the one presented here. In this case, with everything else equal, debt is a less attractive means of raising capital, because the entrepreneur has to bear more risk compared to selling shares in his firm. The authors then show that entrepreneurs retaining a higher stake in their firm can serve as a signal of confidence to investors, so that those with higher quality projects would be willing to retain higher shares of equity (and instead issue debt to meet their financing needs) simply to separate themselves from lower type entrepreneurs. Entrepreneurs weigh the benefit from receiving more favorable terms of financing (due to a higher market valuation of their firm) against the cost of having to bear more risk. This finding parallels those of the classic insurance literature pioneered by Rothschild and Stiglitz (1976), as well as the literature on education as a signaling device initiated by Spence (1973). Accordingly, the results of the present paper relate to findings in the insurance literature that compares monopolistic and competitive provision, first introduced by Stiglitz (1977) and Dahlby (1987), and more recently generalized by Chade and Schlee (2011) and de Feo and Hindriks (2009).

Recently, other authors have considered the optimal taxation point of view on corporate income taxation in setups with asymmetric information. The main concern of this literature has been the inefficient entry of entrepreneurs in models of occupational choice. Gathak et al. (2007) show that if entrepreneurs differ along only one dimension, a lump-sum tax on entrepreneurs can correct against an excessive entry of low type entrepreneurs. Scheuer (2011) investigates a model where entrepreneurs differ along two dimensions. Then, credit market imperfections lead to the government optimally intervening with a nonlinear subsidy on entrepreneurial profits, due to the inefficient entry of entrepreneurial types at both ends of the ability distribution. None of these papers derives an optimal tax schedule that involves discrimination between debt and equity. However, unlike this paper, they all consider risk-neutral entrepreneurs, and therefore disregard the potential of tax discrimination along the dimension of risk aversion.

The rest of the paper is structured as follows. In section 2, I set up a model reminiscent of Leland and Pyle (1977), where risk-averse entrepreneurs with heterogeneous projects seek financing from competitive investors. Asymmetric information about the quality of projects results in an adverse selection problem. To illustrate my point, I employ a setup with two types of entrepreneurs. Section 3 describes the competitive equilibrium in this economy. Section 4 then analyzes a government's opportunities to intervene. It is first shown that the revenue-maximizing tax schedule implements price discrimination between types and generally leads to a different level of debt for the high-return type entrepreneur than in the competitive equilib-

rium. Section 4.1 then proceeds to show that a tax schedule with a debt bias can be designed to collect the same revenue as the optimal tax schedule. Finally, section 4.2 analyzes a specific example in which even a linear tax schedule with different rates on debt versus equity-generated income approximates the optimal non-linear schedule. Section 5 concludes.

2 Setup

Consider an economy populated by entrepreneurs who seek financing for their projects and investors who compete to provide the funds.

Entrepreneurs

There exists a continuum of entrepreneurs of size one. Each entrepreneur owns the idea for a project, but has no initial wealth to cover the required setup costs I to implement his project. Entrepreneurs are risk-averse, their utility function u is increasing, strictly concave, differentiable and exhibits non-increasing absolute risk aversion (NIARA).

Entrepreneurs are of two different types, indicated by index $i \in \{L, H\}$. β and $(1 - \beta)$ are their respective shares in the population. Types differ with respect to the return their project can generate. In particular, I assume that an implemented project produces a gross return of

$$Y(\theta_i, E) = I + \theta_i + E. \quad (1)$$

Here, θ_i is the *individual* mean return (net of the setup costs I) that differs with the type of the entrepreneur, and is known to him even before the implementation of the project. E represents an *aggregate* shock, its realization is unknown to everybody at the time of interaction between entrepreneurs and investors.

I assume that

(A1) $E \in \{\epsilon, -\epsilon\}$, with $\mathbb{E}[E] = 0$.

(A2) ϵ is small compared to θ_i : $0 < \epsilon \ll \theta_L < \theta_H$.

Assumption (A1) implies that a risk-neutral agent would disregard the aggregate shock in his optimization of ex-ante utility. However, since entrepreneurs are risk-averse, they do take the aggregate risk into account when deciding whether to implement their project. Assumption (A2) implies that the initial setup costs I are always recovered. Every project has a positive return.

Although they have no initial wealth, entrepreneurs do have outside options, denoted by ψ_i . For example, one might think of entrepreneurs being able to implement their project elsewhere in the world, or to simply remain in the labor force of the economy's productive sector. I assume that

(A3) $\psi_i < C_i$, where C_i is the certainty equivalent defined by $u(C_i) = \mathbb{E}[u(\theta_i + E)]$;

(A4) $C_H > \theta_L$.

Assumption (A3) ensures that entrepreneurs are willing to implement their projects if they are offered financing at sufficiently good terms. Assumption (A4) puts a joint restriction on $\theta_L - \theta_H$ (the spread of the mean returns), the aggregate risk E and the concavity of the entrepreneurs' utility function. It essentially places a lower bound on the spread of safe outside options. With this assumption, I am restricting attention to cases where an equilibrium always exists.

Investors

The financial market consists of a large number of risk-neutral investors, each with unlimited funds. They can either invest at the safe gross interest rate normalized to

(A5) $R = 1$

or finance projects.

Investors can offer financing contracts to entrepreneurs. A financial contract is a pair $(x, T) \in (0, 1) \times \mathbb{R}$. I denote by $x \in (0, 1)$ the share of the project that remains in the ownership of the entrepreneur. Thus, $x = 0$ corresponds to an equity contract where complete ownership of the project is transferred to the investor, while $x = 1$ denotes a pure debt contract where the entrepreneur remains the owner of his project. x is thus a measure of the degree of insurance the entrepreneur purchases (where a smaller x corresponds to more insurance).

In any case, the contract specifies a fixed payment T to the entrepreneur, which is net of the setup cost I . It is without loss of generality to consider only contracts where T is not a function of the realization of the aggregate shock E ⁴. It is useful to think of T as reflecting the price the entrepreneur pays for a financing service with a degree of insurance x . Since *realized* output Y_i perfectly reveals all private information, contracts must be restricted to not being contingent on it. Otherwise, a simple penalty for lying about the true type would easily circumvent the adverse selection problem that is at the heart of this study. The payoffs realized do depend on realized output for all players holding parts of the ownership rights.

Timing

The strategic interaction considered is the following:

1. Entrepreneurs learn their type.
2. Investors offer a set of contracts, denoted by $\mathbb{X} = \{(x, T) \in (0, 1) \times \mathbb{R}\}$. They are subsequently committed to honoring the terms of the offers.

⁴In principle, a debt contract could specify a T that depends on the realization of E . This would be the case if entrepreneurs were asked to pay an interest rate on their debt that is so high that they might not be able to afford it in the bad state. However, competition between investors will ensure that interest rates on debt contracts are at least equal to the safe rate $R = 1$. Assumption (A2) then ensures that limited liability is never a binding constraint.

3. Entrepreneurs choose whether to implement their projects (let $\xi_i \in \{0, 1\}$ represent that decision), and if so which contract to accept. They can accept only one contract⁵. Accordingly, payments T_i are made and the projects implemented.
4. Aggregate uncertainty is realized and returns are distributed according to the contracted ownership of shares.

The concept of competition between investors is similar to that introduced by Rothschild and Stiglitz (1976). As is well known, in this setup an equilibrium might not exist. Assumption (A4) does ensure, however, that an equilibrium always exists⁶.

3 Equilibrium without Taxes

In the last active stage, each entrepreneur makes an implementation decision $\xi_i \in \{0, 1\}$ and decides which contract to sign, taking the set of contracts offered as given. He solves:

$$\begin{aligned} \max_{\xi, (x, T)} \quad & \xi \mathbb{E}[u(x(\theta + E) + T)] + (1 - \xi) u(\psi) \\ \text{s.t.} \quad & \xi \in \{0, 1\} \quad \text{and} \quad (x, T) \in \mathbb{X}. \end{aligned} \tag{2}$$

The financial market in this economy is competitive. Thus, even though investors are maximizing their expected profits, in equilibrium they will make zero profits in expectation. Entrepreneurs on the other hand are risk-averse; how much of the aggregate risk they have to bear plays a decisive role in their implementation and financing decisions.

Definition 1

An equilibrium is a set of contracts $\mathbb{X} = \{(x_i, T_i) \in (0, 1) \times \mathbb{R}, i = L, H\}$ and an implementation decision ξ_i of each entrepreneur such that:

- (i) entrepreneurs maximize their expected utility;
- (ii) investors make zero expected profits.

3.1 Observable Types

In a first-best world, investors are able to observe an entrepreneur's type and can offer type-specific contracts. Since investors are competitive, the optimal contract for a type i entrepreneur maximizes his expected utility, subject to a zero expected profit constraint for the investor. The implementation decision is made taking into account the entrepreneur's outside option ψ_i :

⁵This is a short cut to assuming that trades are observable.

⁶Classic (e.g. Riley (1979)) as well as more recent studies (e.g. Dubey and Geanakoplos (2002)) have modified the Rothschild-Stiglitz concept of competitive equilibrium to deal with the non-existence of equilibrium problem. The general consensus is that there always exists a separating equilibrium.

$$\begin{aligned} \max_{\xi_i, (x_i, T_i)} \quad & \xi_i \mathbb{E}[u(x_i(\theta_i + E) + T_i)] + (1 - \xi_i) u(\psi_i) \\ \text{s.t.} \quad & (1 - x_i)\theta_i - T_i \geq 0. \end{aligned} \quad (3)$$

Lemma 1

If types are observable, in equilibrium all projects are implemented in the economy. All entrepreneurs obtain full insurance at actuarially fair terms: $\xi_i = 1$ and $(x_i^*, T_i^*) = (0, \theta_i) \quad \forall i$.

Proof: Suppose that $\xi_i = 1$. Then, the optimal contract solves

$$\begin{aligned} \max_{(x_i, T_i)} \quad & \frac{1}{2}[u(x_i(\theta_i + \epsilon) + T_i) + u(x_i(\theta_i - \epsilon) + T_i)] \\ \text{s.t.} \quad & \frac{1}{2}[u(x_i(\theta_i + \epsilon) + T_i) + u(x_i(\theta_i - \epsilon) + T_i)] \geq u(\psi_i) \end{aligned} \quad (4)$$

$$(1 - x_i)\theta_i - T_i \geq 0. \quad (5)$$

The first-order conditions for this optimization are:

$$[x_i] \quad \frac{1}{2}(1 + \mu) [u'(x_i(\theta_i + \epsilon) + T_i)(\theta_i + \epsilon) + u'(x_i(\theta_i - \epsilon) + T_i)(\theta_i - \epsilon)] = \lambda \theta_i \quad (6)$$

$$[T_i] \quad \frac{1}{2}(1 + \mu) [u'(x_i(\theta_i + \epsilon) + T_i) + u'(x_i(\theta_i - \epsilon) + T_i)] = \lambda, \quad (7)$$

where μ and λ are the Lagrange multipliers associated with the individual rationality constraint of the entrepreneur (4) and the zero expected profit condition for the investor (5) respectively. These necessary conditions for optimality require

$$\theta_i = \frac{u'(x_i(\theta_i + \epsilon) + T_i)(\theta_i + \epsilon) + u'(x_i(\theta_i - \epsilon) + T_i)(\theta_i - \epsilon)}{u'(x_i(\theta_i + \epsilon) + T_i) + u'(x_i(\theta_i - \epsilon) + T_i)}, \quad (8)$$

which implies $x_i^* = 0$. The zero expected profit constraint (5) determines $T_i^* = \theta_i$. A contract $(x_i = 0, T = \theta_i)$ satisfies the individual rationality constraint of entrepreneur i , and so he optimally chooses $\xi_i = 1$. \square

Borch's Rule⁷ of optimal risk sharing implies that the risk-neutral party (here the investor) should bear all the risk. Each entrepreneurial type receives full insurance. Competition between investors implies that in equilibrium entrepreneurs will be offered actuarially fair insurance. Being offered such favorable terms, all entrepreneurs optimally decide to implement their projects, and sell their firms to an investor in an equity contract.

Financial contracts serve two purposes: They provide financing to set up the project as well as insurance against the aggregate risk. In a first-best world, one could think of separate markets for these two tasks. Each entrepreneur would then issue safe debt to finance the setup costs I and sign a separate insurance contract. The first-best allocation in such a world would be equivalent to the setup presented.

⁷See Borch (1962).

3.2 Unobservable Types

Suppose now that investors in the economy cannot observe an entrepreneur's type, and so are uncertain about the mean expected return of their investment when offering to buy a share of equity. The first-best set of contracts cannot be an equilibrium anymore. Since $T_L^* < T_H^*$, every entrepreneur would claim to have a high-return idea to maximize the price he can fetch from selling the ownership rights to his project. The investor's zero expected profit condition would then be violated, he would make certain losses. Recall that while *realized* returns are perfectly informative about the entrepreneur's type, investors are by assumption precluded from offering contracts with payments T contingent on realized returns.

The equilibrium implementation decisions and set of contracts in this adverse selection problem are the solution to a standard screening problem. Since preferences exhibit NIARA, they satisfy the single-crossing property. By the Revelation Principle⁸ it suffices to design contracts that are incentive-compatible for each type of entrepreneur to choose the contract that is meant for him.

$$\begin{aligned} \max_{\xi_i, X} \quad & \beta \{ \xi_L \mathbb{E}[u(x_L(\theta_L + E) + T_L)] + (1 - \xi_L) u(\psi_L) \} + \\ & (1 - \beta) \{ \xi_H \mathbb{E}[u(x_H(\theta_H + E) + T_H)] + (1 - \xi_H) u(\psi_H) \} \\ \text{s.t.} \quad & \xi_L \mathbb{E}[u(x_L(\theta_L + E) + T_L)] \geq \xi_L \mathbb{E}[u(x_H(\theta_L + E) + T_H)] \end{aligned} \quad (9)$$

$$\xi_H \mathbb{E}[u(x_H(\theta_H + E) + T_H)] \geq \xi_H \mathbb{E}[u(x_L(\theta_H + E) + T_L)] \quad (10)$$

$$\xi_L \beta [(1 - x_L)\theta_L] + \xi_H (1 - \beta) [(1 - x_H)\theta_H] \geq \xi_L \beta T_L + \xi_H \beta T_H \quad (11)$$

The optimization is now further constrained by (9) and (10), the incentive compatibility constraints for entrepreneurial types L and H respectively. Investors breaking even in expectation is ensured by constraint (11). With the added complication of an information asymmetry between entrepreneurs and investors, not all entrepreneurs obtain full insurance in equilibrium:

Lemma 2

If types are unobservable, in the unique equilibrium all projects are implemented: $\xi_i = 1$ for $i = L, H$. In particular,

(i) *type L entrepreneurs obtain full insurance at actuarially fair terms:*
 $(x_L, T_L) = (0, \theta_L)$;

(ii) *type H entrepreneurs obtain partial insurance at actuarially fair terms:*
 $(x_H, T_H) = (0 < x_H \leq 1, (1 - x_H)\theta_H)$.

Proof: See appendix A.1.

Even though investors are risk-neutral, they cannot provide full insurance to all

⁸See for example Myerson (1979) and Harris and Townsend (1981).

entrepreneurs. Due to asymmetric information, full insurance for all types could only be granted in a pooling equilibrium, where type H entrepreneurs receive less than actuarially fair insurance and subsidize type L entrepreneurs. Just as in the canonical Rothschild-Stiglitz model, such a pooling contract is not an equilibrium: A contract that offers a little less insurance and attracts only high types, without subsidizing low types, is a profitable deviation. This type of cream-skimming by investors rules out a pooling equilibrium.

Just as in the insurance literature, in the separating equilibrium, higher types (i.e. lower risks) receive less insurance. This property of the equilibrium parallels the findings of Leland and Pyle (1977): Higher type entrepreneurs retain a higher share of their projects to signal their type to the market.

Competition between investors drives their expected profits to zero. All the surplus generated from implementing projects and providing (partial) insurance accrue to the entrepreneurs.

4 Equilibrium with Taxes

Suppose the government of the economy is aiming to extract the surplus entrepreneurs make. One might think of entrepreneurs as being foreign to the economy, and free to set up their projects anywhere in the world. A government might then want to ensure that some (or all) of the surplus generated through the use of the economy's financial market is recovered. More generally, one might also think of a government trying to redistribute away from entrepreneurs to other parts of the economy (not modeled in the presented setup).

I assume that the government announces a tax schedule τ at the beginning of time and is subsequently committed to it. Taxes can in principle depend on types, and on the specifics of the financing contract (x, T) , and are always collected from the entrepreneur. Investors and entrepreneurs take the taxes announced as given in their decisions. I denote the problem of a type i entrepreneur with \mathbb{U}_i :

$$\begin{aligned} \max_{\xi, (x, T)} \quad & \xi \mathbb{E}[u(x(\theta_i + E) + T - \tau(x, T, \theta_i))] + (1 - \xi)u(\psi) \\ \text{s.t.} \quad & \xi \in \{0, 1\} \quad \text{and} \quad (x, T) \in \mathbb{X}. \end{aligned}$$

As before, the optimal financing contracts are found as a solution to the screening problem (9)-(11), where investors take the effect of the tax schedule on the entrepreneurs' decision problem into account. I denote the investor's problem by \mathbb{P} . The government then solves:

$$\begin{aligned} \max_{\{\tau(x, T, \theta)\}} \quad & \beta \xi_L \tau(x_L, T_L, \theta_L) + (1 - \beta) \xi_H \tau(x_H, T_H, \theta_H) \\ \text{s.t.} \quad & \xi_i \in \operatorname{argmax} \mathbb{U}_i \quad \forall i \tag{12} \\ & \mathbb{X} \in \operatorname{argmax} \mathbb{P}. \tag{13} \end{aligned}$$

The government maximizes tax revenue and only cares about the entrepreneurs' utility insofar as it would like their participation constraints to be satisfied.

Definition 2

An equilibrium with taxes is a set of contracts $\mathbb{X} = \{(x_i, T_i) \in (0, 1) \times \mathbb{R}, i = L, H\}$, an implementation decision ξ_i by each entrepreneur, and a tax schedule $\{\tau(x_i, T_i, \theta_i)\}$ such that:

- (i) entrepreneurs maximize their expected utility, taking taxes as given;
- (ii) investors make zero expected profits;
- (iii) the government maximizes tax revenue.

The equilibrium is comparable in structure to the competitive equilibrium. However, the government will tax entrepreneurial surplus.

Lemma 3

When types are unobservable, in the equilibrium with taxes all projects are implemented: $\xi_i = 1$ for $i = L, H$. In particular,

- (i) type L entrepreneurs obtain full insurance and investors pay actuarially fair terms:
 $(x_L, T_L) = (0, \theta_L)$;
- (ii) type H entrepreneurs obtain partial insurance and investors pay actuarially fair terms:
 $(x_H, T_H) = (0 < x_H \leq 1, (1 - x_H)\theta_H)$;
- (iii) type H entrepreneurs will be taxed so that they are indifferent between implementing their projects or their outside option.

Proof: See appendix A.2.

This equilibrium structure is analogous to the one in Stiglitz (1977), who analyzes a monopoly insurance problem. Indeed, the government's objective to maximize tax revenue coincides with that of a monopolist investor. As in Stiglitz (1977), contracts in the equilibrium with taxes (denoted with superscript G) will generally differ from those in the competitive equilibrium without taxes (denoted with superscript C).

Proposition 1

Generically, $\mathbb{X}^G \neq \mathbb{X}^C$.

Proof: See appendix A.3.

In the equilibrium without taxes, it follows from competition between investors that debt earns no interest beyond $R = 1$ and all insurance is sold at actuarially fair terms. Insurance coverage for the high types is determined solely by the incentive constraints of the low types. Competition between investors leaves no room for price discrimination between types of entrepreneurs. The government, however, does not face competition. Using taxes, it can implement effective prices that differ from those consistent with competition. It essentially acts like a monopolist, who is able to charge differential mark-ups. This degree of freedom allows the government to manipulate the incentive constraints of the low types such that a different level of insurance for the high type emerges in equilibrium.

Corollary 1

When $\tau_H > \tau_L$, type H entrepreneurs receive more insurance than in the competitive equilibrium ($x_H^G < x_H^C$).

Proof: See appendix A.4.

The possibility of an increase in efficiency again parallels findings in the insurance literature. For insurance markets with adverse selection, it has been shown by Dahlby (1987) that coverage for the low risk types is higher when purchased from a monopolist insurer, rather than in a competitive market. More generally, de Feo and Hindriks (2009) show that monopolists are often more efficient at providing insurance under adverse selection than a competitive market.

It should be noted that while the equilibrium with taxation can be more efficient than the competitive equilibrium, the necessary discrimination has distributional consequences. The government's objective is to maximize the revenue extracted from the entrepreneurs. One might interpret this as a re-distributional objective away from entrepreneurs and toward other parts of the economy (not modeled in this paper).

4.1 Implementing the Optimal Non-linear Tax Schedule

Lemma 3 stated that the government is able to extract all the surplus from the entrepreneurs. Generally, a non-linear tax schedule will be optimal to achieve that objective. It will satisfy the individual rationality constraints for both types with equality, so that no surplus is left to the entrepreneurs:

$$u(\theta_L - \tau_L) = u(\psi_L) \quad (14)$$

$$\mathbb{E}[u(\theta_H - \tau_H + x_H^G E)] = u(\psi_H) \quad (15)$$

Proposition 2

The optimal tax schedule $\{\tau_L, \tau_H\}$ is isomorphic to one that taxes the fraction of income generated by equity at a higher rate than the fraction of income generated by debt.

Proof: Define R_i as the absolute risk premium type i would be willing to pay to avoid the risk he would be exposed to from holding all the shares in his project:

$$\mathbb{E}[u(\theta_i - \tau_i + E)] = u(\theta_i - \tau_i - R_i). \quad (16)$$

Since the aggregate risk is small (by assumption (A2)), the absolute risk premium can be approximated by

$$R_i \approx \frac{1}{2} r_i \text{Var}(E), \quad (17)$$

where $r_i = -\frac{u''}{u'}$ is the Arrow-Pratt measure of absolute risk aversion for type i evaluated at $\theta_i - \tau_i$. Using this definition, the optimal non-linear tax schedule satisfies

$$T_i = \theta_i - \psi_i - (x_i^G)^2 R_i \quad \text{for } i = L, H. \quad (18)$$

By assumption (A3), each entrepreneur's outside option is $\psi_i < C_i$. This can always be written as $\psi_i = \delta_i \theta_i - R_i$. Thus, the surplus to be taxed away is

$$T_i = (1 - \delta_i)\theta_i + (1 - (x_i^G)^2)R_i \quad \text{for } i = L, H. \quad (19)$$

The first summand, $(1 - \delta_i)\theta_i$, represents the *implementation gain*, i.e. the surplus generated only from obtaining financing for the setup costs and so being able to implement the project. The rest, $(1 - (x_i^G)^2)R_i$, represents the *insurance gain*, i.e. the additional surplus generated from receiving insurance. From this intuition, it is clear that the same tax revenue τ_i can be generated by taxing the fractions of income generated by debt or equity at different rates:

$$\begin{aligned} x_i^G \theta_i \tau_i^D + (1 - x_i^G)\theta_i \tau_i^E &= \tau_i \\ &= (1 - \delta_i)\theta_i + (1 - (x_i^G)^2)R_i \\ &= x_i^G(1 - \delta_i)\theta_i + (1 - x_i^G)(1 - \delta_i)\theta_i + (1 - (x_i^G)^2)R_i. \end{aligned}$$

Here, τ_i^D is the tax *rate* applied to the share of income retained by the entrepreneur. It taxes the surplus generated with debt, i.e. only a fraction of the implementation gain. τ_i^E is the tax *rate* applied to the fraction of income sold as equity to the investors. It taxes the surplus generated by equity, which consists of both a proportional fraction of the implementation gain as well as the insurance gain. Notice that

$$\tau_i^D = 1 - \delta_i \quad (20)$$

$$\tau_i^E = 1 - \delta_i + (1 - x_i^G) \frac{R_i}{\theta_i(1 - x_i^G)} \quad (21)$$

$$\rightarrow \tau_i^D < \tau_i^E. \quad (22)$$

Thus, the optimal tax schedule τ_i is isomorphic to one that taxes the fraction of income generated by equity at a higher rate than income generated by debt. \square

Proposition 2 states that a tax schedule with a debt bias might indeed be optimal, given the government's objective of extracting all surplus from the entrepreneurs. In reality, the debt bias in a typical corporate income tax schedule takes a particular form: It allows the costs of debt to be deducted from the tax base, whereas payments to equity holders are (to a large extent) considered taxable profits. In the model, such a debt bias would occur when a corporate income tax rate $\bar{\tau}_i$ were levied on $\theta_i + T_i$, i.e. on all of the entrepreneurs' generated income before paying out any equity holders. The entrepreneur thus earns $(\theta_i + T_i)(1 - \bar{\tau}_i) - (1 - x_i^G)\theta_i$, where competition determines $T_i = (1 - x_i^G)\theta_i(1 - \bar{\tau}_i)$. This results in a double taxation of the fraction of income generated by equity financing:

$$(\theta_i + T_i)(1 - \bar{\tau}_i) - (1 - x_i^G)\theta_i = x_i^G \theta_i (1 - \bar{\tau}_i) + (1 - x_i^G)\theta_i (1 - \bar{\tau}_i)^2 \quad (23)$$

$$= x_i^G \theta_i (1 - \tau_i^D) + (1 - x_i^G)\theta_i (1 - \tau_i^E) \quad (24)$$

with $\tau_i^D < \tau_i^E$ ⁹. Thus, this particular form of a debt bias is nothing other than taxing the fraction of income generated with equity at a higher rate than the fraction

⁹In reality, there are many rules for what exactly can or cannot be deducted from the tax base, so that τ^E will never be exactly $2\tau^D - (\tau^D)^2$ as suggested by this simple example.

generated with debt. The debt bias observed in many tax codes might be optimal, at least in structure, for maximizing revenue generated from corporate income taxation.

4.2 Continuum of Types with CARA Preferences

So far, I have shown that the optimal tax schedule to extract all the surplus generated for the entrepreneurs can be implemented using separate tax rates for the fractions of income corresponding to the share of ownership retained by the entrepreneur or sold to an investor. The marginal tax rates on these fractions of income differ, because with the means of financing, the surplus generated differs: While both debt and equity help the entrepreneur to realize the implementation gain, only equity provides insurance against the aggregate risk, and so generates additional surplus. Thus, the tax rate on debt-financed income will be lower than that on equity-financed income for each type. However, generally, these tax rates still depend on types. So the question arises of why the government would postulate a tax schedule with two separate tax rates per type when it could just announce one tax payment τ_i per type that incorporates all the surplus generated.

In what follows, I show that in some cases, a simple *linear* tax schedule for debt-financed and equity-financed income can approximate the optimal non-linear corporate tax. Since the fractions of income financed with equity vary with type, the effective tax entrepreneurs face is still non-linear:

$$x_i\theta_i(1 - \tau^D) + (1 - x_i)\theta_i(1 - \tau_E) = \theta_i(1 - \tau_i) \quad (25)$$

$$\text{where } \tau_i = \tau^E + x_i(\tau^D - \tau^E). \quad (26)$$

Suppose there exist a continuum of different types of entrepreneurs, indexed by $\theta \in [\underline{\theta}, \bar{\theta}]$, $0 < \underline{\theta} < \bar{\theta} < 1$, with a density function $f(\theta)$ that is strictly positive, continuous and differentiable everywhere, and satisfies a monotone likelihood ration property. Stiglitz (1977) shows that under these conditions, a fully separating equilibrium exists and is such that the lowest type $\underline{\theta}$ receives full insurance, whereas all other types receive only partial insurance coverage decreasing with type. Chade and Schlee (2011) have more recently extended the analysis to provide conditions for full separation under more general type distributions.

Moreover, suppose that entrepreneurial preferences exhibit constant absolute risk aversion, and that each entrepreneur's outside option is a constant fraction of the certainty equivalent his project generates, i.e. it can be expressed as $\psi_i = \delta\theta_i - R$. Again, R is the absolute risk premium, which is now constant for all agents. Under these assumptions, the implementation gain of an entrepreneur is proportional to his type, while the insurance gain depends only the degree of insurance coverage. Further, consider a population of entrepreneurs with $\bar{\theta} \leq 2\underline{\theta}$.

From equation (18), we know that the optimal tax schedule collects revenue

$$\tau(\theta) = (1 - \delta)\theta + (1 - x(\theta)^2)R \quad (27)$$

from a type θ entrepreneur. The revenue collected with linear tax rates on debt and equity-financed income is

$$x(\theta)\theta\tau^D + (1 - x(\theta))\theta\tau^E. \quad (28)$$

The tax rates τ^D and τ^E are pinned down by the implementation gain and the insurance gain from full insurance. A type that signs an equilibrium contract without any insurance ($x(\theta) = 1, T(\theta) = 0$), faces only the tax rate τ^D , which extracts the full implementation gain:

$$\theta\tau^D = (1 - \delta)\theta \quad \rightarrow \quad \tau^D = 1 - \delta. \quad (29)$$

The lowest type receives full insurance, so he realizes the implementation gain and the full insurance gain, and faces only tax rate τ^E , so that

$$\theta\tau^E = (1 - \delta)\theta + R \quad \rightarrow \quad \tau^E = 1 - \delta + \frac{R}{\theta} > \tau^D. \quad (30)$$

With these tax rates, the surplus extracted from any type θ with a contract ($0 < x(\theta) < 1, T(\theta)$) generates tax revenue that is approximately the same as the optimal tax revenue in equation (27):

$$\begin{aligned} x(\theta)\theta\tau^D + (1 - x(\theta))\theta\tau^E &\approx (1 - \delta)\theta + (1 - x(\theta)^2)R \\ \theta(\tau^E + x(\theta)(\tau^D - \tau^E)) &\approx (1 - \delta)\theta + (1 - x(\theta)^2)R \\ \theta(1 - \delta + (1 - x(\theta))R) &\approx (1 - \delta)\theta + (1 - x(\theta)^2)R \\ \frac{\theta}{\theta} &\approx (1 + x(\theta)). \end{aligned} \quad (31)$$

When the spread of mean returns is small, a linear schedule of tax rates $\{\tau^D, \tau^E\}$ applied to the fractions of income generated by debt and equity financing respectively approximates the optimal non-linear tax schedule.

5 Discussion

Many governments discriminate between debt and equity financing when taxing corporate income. Conventional wisdom, however, suggests that these means of financing should be treated equivalently. I present a rationale for why a government might choose to discriminate between debt and equity: Debt and equity financing generate different levels of surplus for the entrepreneur. While both help him to realize the *implementation gain* of his project, equity also provides *insurance*. A government aiming to extract surplus from entrepreneurs thus has no reason to tax income generated by different means of financing at the same rate.

A difference in surplus generated by equity versus debt only occurs when entrepreneurs are risk-averse. Yet, if insurance can be obtained at actuarially fair terms (as is the case in competitive financial markets), every entrepreneur prefers equity to debt. It is then due to an adverse selection problem that different types of entrepreneurs

choose different debt-to-equity ratios. The associated screening problem results in an equilibrium that separates entrepreneurs using the share of retained earnings as a screening device. The level of debt necessary for separation is solely determined by the incentive constraints. Competition between investors does not allow for any further price discrimination between types. The government, however, can introduce taxes such that different types effectively face different mark-ups over actuarially fair insurance terms. This additional opportunity for discrimination can relax incentive constraints and lead to a more efficient outcome, with a higher overall degree of insurance.

To implement the optimal discrimination scheme between types, the government can make use of the fact that separation occurs along the debt-to-equity ratio. A differential taxation of income generated with debt versus income generated with equity financing is one way to achieve optimal discrimination. This mechanism provides another less obvious justification for a debt bias in corporate income taxation.

It should be noted that while the equilibrium with taxation can be more efficient than the competitive equilibrium, the necessary discrimination has distributional consequences. I have analyzed a government whose objective is to maximize the revenue extracted from the entrepreneurs. One might interpret this as a re-distributional objective away from entrepreneurs and toward other parts of the economy (not modeled in this paper).

Alternatively, one might consider an economy that would like to attract foreign entrepreneurs to set up their firms in the country. In the search for an opportunity to finance their projects, entrepreneurs can decide where in the world to set up their firm. They make this decision solely based on expected utility maximization, taking into account any uncertainty they might face, and optimizing over the terms of financing they are offered by investors in different countries. If investors in the economy are competitive, they might well be able to attract foreign entrepreneurs. However, all the surplus generated accrues to the entrepreneur, i.e. outside the economy. The government might then try to regain some of that surplus to distribute it among members of the economy.

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A Appendix

A.1 Proof of Lemma 2

First, I show that all projects are always implemented: Assumption (A2) implies that every project has a positive return. Competition between investors and assumption (A5) then imply that every entrepreneur can always issue (safe) debt at the gross interest rate $R = 1$. Thus, assumption (A3) implies that every project generates at least a positive implementation gain for the entrepreneur, even if he cannot obtain any insurance.

Second, I establish that the only equilibrium is a separating equilibrium. Given

that all projects are implemented, the screening problem (9) through (11) can be rewritten as

$$\begin{aligned} \max_{\underline{x}} \quad & \beta \mathbb{E}[u(x_L(\theta_L + E) + T_L)] + (1 - \beta)\mathbb{E}[u(x_H(\theta_H + E) + T_H)] \\ \text{s.t.} \quad & \mathbb{E}[u(x_L(\theta_L + E) + T_L)] \geq u(\psi_L) \end{aligned} \quad (32)$$

$$\mathbb{E}[u(x_H(\theta_H + E) + T_H)] \geq u(\psi_H) \quad (33)$$

$$\mathbb{E}[u(x_L(\theta_L + E) + T_L)] \geq \mathbb{E}[u(x_H(\theta_L + E) + T_H)] \quad (34)$$

$$\mathbb{E}[u(x_H(\theta_H + E) + T_H)] \geq \mathbb{E}[u(x_L(\theta_H + E) + T_L)] \quad (35)$$

$$\beta[(1 - x_L)\theta_L] + (1 - \beta)[(1 - x_H)\theta_H] \geq \beta T_L + \beta T_H. \quad (36)$$

This is a standard screening problem where maximization of entrepreneurial surplus is subject to individual rationality and incentive-compatibility constraints, as well as a zero profit condition for investors. As in the classic Rothschild and Stiglitz (1976) setup, a pooling contract cannot be an equilibrium. Due to competition between investors, the only candidate pooling contract would offer full insurance at *average* actuarially fair terms:

$$(x, T) = (0, \beta\theta_L + (1 - \beta)\theta_H). \quad (37)$$

High types would obtain full insurance but subsidize low types. A profitable deviation is possible. There exists a contract (x', T') that offers less than full insurance and satisfies:

$$\mathbb{E}[u(x'\theta_H + T' + x'E)] > u(\beta\theta_L + (1 - \beta)\theta_H) \quad (38)$$

$$\mathbb{E}[u(x'\theta_L + T' + x'E)] < u(\beta\theta_L + (1 - \beta)\theta_H) \quad (39)$$

Only high types would take up this contract. The investor could offer T' so that the first condition binds, and make a profit. Low types would stick with the pooling contract, which then makes certain losses. Thus, the pooling contract cannot be an equilibrium.

Next, it is shown that the only separating equilibrium must be such that type L entrepreneurs obtain full insurance, and type H entrepreneurs only partial insurance. In a separating equilibrium, the zero profit condition must hold for each type separately, so that T_i is pinned down by

$$T_i = (1 - x_i)\theta_i. \quad (40)$$

Competition implies that one type will get full insurance. Otherwise, a profit could be made by offering full insurance to one type. However, contracts $(x_H = 0, T_H = \theta_H)$ (full insurance) and $(x_L > 0, T_L = (1 - x_L)\theta_L)$ (partial insurance) can never satisfy type L's incentive compatibility constraint (34):

$$\mathbb{E}[u(x_L\theta_L + T_L + x_LE)] = \mathbb{E}[u(\theta_L + x_LE)] < u(\theta_L) < u(\theta_H). \quad (41)$$

Thus, a separating equilibrium must be such that $(x_L, T_L) = (0, \theta_L)$, i.e. type L receives full insurance. Since type H entrepreneurs are also risk-averse, they strictly prefer higher levels of insurance if offered at actuarially fair terms. The terms are ensured by competition, so that the unique separating equilibrium is that with the highest possible level of insurance for type H. It is pinned down by the incentive constraint of type L (34):

$$u(\theta_L) = \mathbb{E}[u(x_H\theta_L + (1 - x_H)\theta_H) + x_H E]. \quad (42)$$

It remains to be shown that such a separating equilibrium always exists. In Rothschild and Stiglitz (1976), a separating equilibrium might fail to exist, if the terms offered to type H are so bad that they would prefer to pool with type L. Here, the worst terms that could possibly be offered to type H entrepreneurs would be no insurance, i.e. $(x_H, T_H) = (1, 0)$. By assumption (A4), a type H entrepreneur would still prefer that contract to the full insurance contract offered to type L $(x_L, T_L) = (0, \theta_L)$:

$$\mathbb{E}[u(\theta_H + E)] = u(C_H) > u(\theta_L). \quad (43)$$

This concludes the proof.

A.2 Proof of Lemma 3

The proof is analogous to that for Lemma (2). It remains true that most surplus is generated when one type gets full insurance and the other as much as possible, given incentive-compatibility constraints. One must simply note that the government cannot increase revenue by implementing a tax such that type H entrepreneurs get full insurance and type L entrepreneurs get only partial insurance. To make such contracts incentive-compatible, the government would have to pay a subsidy to type L entrepreneurs without generating more revenue. Point (iii) is straight forward to see: the government's objective is to maximize revenue, so that leaving any surplus to type H would be wasteful.

A.3 Proof of Lemma 1

In the competitive equilibrium, type H's contract $(x_H^C, T_H^C) = (x_H^C > 0, (1 - x_H^C)\theta_H)$ is such that type L's incentive constraint (9) binds:

$$\mathbb{E}[u(x_H^C\theta_L + (1 - x_H^C)\theta_H + x_H^C E)] = u(\theta_L). \quad (44)$$

Define $R_i^{\mathbb{X}}$ as the absolute risk premium type i would be willing to pay to avoid the risk he would be exposed to from holding all the shares in his project under contracts \mathbb{X} :

$$\mathbb{E}[u(\theta_i + E)] = u(\theta_i - R_i^{\mathbb{X}}). \quad (45)$$

Since the aggregate risk is small (by assumption (A2)), the absolute risk premium can be approximated as

$$R_i^{\mathbb{X}} \approx \frac{1}{2} r_i^{\mathbb{X}} \text{Var}(E), \quad (46)$$

where $r_i^{\mathbb{X}} = -\frac{u''}{u'}$ is the Arrow-Pratt measure of absolute risk aversion for type i evaluated under the contract \mathbb{X} . Using this definition, condition (44) can be rewritten as:

$$u(x_H^C \theta_L + (1 - x_H^C) \theta_H - (x_H^C)^2 R_L^C) = u(\theta_L)^{10} \quad (47)$$

Thus, x_H^C solves

$$(1 - x_H^C)(\theta_H - \theta_L) - (x_H^C)^2 R_L^C = 0. \quad (48)$$

In the equilibrium with taxes, the incentive constraint is:

$$\mathbb{E}[u(x_H^G \theta_L + (1 - x_H^G) \theta_H - \tau_H + x_H^G E)] = u(\theta_L - \tau_L) \quad (49)$$

and x_H^G analogously solves

$$(1 - x_H^G)(\theta_H - \theta_L) - (x_H^G)^2 R_L^G = \tau_H - \tau_L \quad (50)$$

$$(1 - x_H^G)(\theta_H - \theta_L) - (x_H^G)^2 R_L^C = \tau_H - \tau_L + (x_H^G)^2 (R_L^G - R_L^C). \quad (51)$$

Thus, generally $x_H^G \neq x_H^C$, i.e. the equilibrium sets of contracts differ.

However, there might exist one specific parameterization such that $x_H^G = x_H^C$. Suppose preferences are CARA, so that the absolute risk premium R is constant. If the surplus taxed from both types is exactly the same, then the set of contracts is unchanged. The surplus consists of both implementation and insurance gain. The insurance gain with CARA is proportional to the level of insurance obtained. The implementation gain would have to be such that it exactly offsets the difference in insurance. While this is possible, a tiny difference in outside options would already yield a different set of contracts.

A.4 Proof of Corollary 1

In the competitive equilibrium, x_H^C solves (48):

$$(1 - x_H^C)(\theta_H - \theta_L) - (x_H^C)^2 R_L^C = 0, \quad (52)$$

whereas in the equilibrium with taxes, x_H^G solves (51):

$$(1 - x_H^G)(\theta_H - \theta_L) - (x_H^G)^2 R_L^C = \tau_H - \tau_L + (x_H^G)^2 (R_L^G - R_L^C). \quad (53)$$

Since preferences are NIARA, $R_L^G \geq R_L^C$. Thus, when $\tau_H > \tau_L$, the right-hand side of (53) is positive, so that $x_H^G < x_H^C$.

¹⁰Using the fact that $Var(xE) = x^2 Var(E)$.