Taxes, Institutions and Innovation: Theory and International Evidence

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ABSTRACT

We develop an international model of the design of institutions for regulating innovative activities of private corporations. Informational limitations faced by the social planner preclude complete contracting with private firms. Corporate innovation creates positive and negative externalities. The social planner in each country takes into account the legal system in place, and designs an umbrella of institutions that include a menu of organizational forms, liability structures, corporate taxes, and subsidies. We show that limited liability may be accompanied by excessive innovation. However, when the nonmonetized benefits are very high, private firms may be too conservative in innovation policies. Firms choose their organizational form and level of innovation consistent with private optimality. With the optimal institutional design for each country, we demonstrate that private innovation choices are aligned with social optimality. In particular, we show that the optimally designed corporate tax rate in each country is a decreasing function of its legal effectiveness. Using data from 63 countries over 2003-2018, we document supporting evidence. MNCs can take advantage of differential liability and corporate tax structures across national boundaries to circumvent institutional design constraints. However, when MNCs generate positive externalities to host countries, their governments may provide subsidies and incentives.

Keywords: Innovation, Multinational corporations, Legal systems, Organizational forms, Externalities, International taxation, Institutions, Social optimality

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I. Introduction

Innovative activity is central to the growth of economies. Innovation in the private sector, both by manufacturing firms and by financial institutions, imposes positive and negative externalities; the social impact of these private firms depends on the sharing rule between their owners and the society at large. This sharing rule is governed by laws, regulations, and institutions in place. The European sovereign debt crises and the global financial crisis have generated extensive debate on the need for financial regulation around the world. At the center of the debate has been how tight financial regulation should be. In fact, a sweeping financial regulation was enacted in the US (the Dodd-Frank Act, 2010). The financial crisis has also drawn widespread public attention to the negative (and positive) externalities imposed on the society at large by the activities of private firms (banks and corporations). Industrial accidents, such as those by Fukushima Daiichi nuclear power plant and the British Petroleum oil spill, have highlighted the importance of these externalities in a much broader context. More recently, climate change has taken center stage in the debate on such externalities.

A recognition of the large impact of these firms on the society-at-large, including non-financial claimholders of these firms, have led to renewed calls for stricter regulation of their activities by policy-makers and the government. Examples of such non-financial claimholders include customers, employees, suppliers, warranty holders, insurance holders, legal claimants and others in the society-at-large who may hold existing or potential claims against the firms and financial institutions.[1] Passionate anti-corporation groups have painted a picture of corporations (and banks) as amoral profit maximizing institutions.[2] Meanwhile, in mainstream corporate finance, shareholder wealth maximization remains a central paradigm, and corporate governance mechanisms are

[1] Thus, nonfinancial claimholders are defined broadly to include potential awardees of legal settlements resulting from future industrial accidents as well as current holders of jury claims in product liability suits.

[2] See for example, *The Corporation: The Pathological Pursuit of Profit and Power* by Joel Bakan or *Gangs of America: The Rise of Corporate Power and the Disabling of Democracy* by Ted Nace.

typically geared toward this private objective. While some have argued that a failure of corporate governance mechanisms have been behind the incentive problems that led to the financial crisis, most analyses now blame the reality that the objectives of private firms (banks and corporations) differ significantly from that of society-at-large. Even if the corporate governance mechanisms are functioning well for the capital claimants (both equity holders and debt holders), the firms may have undertaken levels of innovation and risks well above what is optimal for society at large.[3]

In this paper we argue that the above-mentioned misalignment of objectives and the resulting deviation of private firms' risk-taking and innovation from the socially optimal level will depend on several factors; importantly, the legal structure in place, the extent of liability implied by the organizational form of business and the taxation of the enterprise. For example, a corporation's concern for non-financial claimholders that have been injured by a firm is likely to depend on the ability of these claimholders to access courts and sue the corporation. In the United States, where legal structure is well developed, examples of large potential claims held by non-financial claimholders are pervasive. Product liability suits, such as those against Manville Corporation - the asbestos manufacturer (see, Anderson (1982)); A.H. Robins; maker of the Dalkon Shield contraceptive device; and Dow Corning - maker of silicone breast implants, can potentially generate legal claims against the corporation exceeding the value of its assets and force corporations into bankruptcy.

More recently, as reported in the *New York Times* on July 12, 2018, Johnson & Johnson was ordered to pay $4.69 billion to 22 women and their families who had claimed that asbestos in the company's talcum powder products caused them to develop ovarian cancer. On climate change, as stated in the *Economist* on December 8, 2018, a key question is whether international oil companies can reduce greenhouse-gas emissions without gutting their businesses. In fact, on December 3, 2018, Royal Dutch Shell went further than any other oil major company in insisting it could. The firm announced that it would set specific targets for reducing carbon emissions every three to five years, with the goal of shrinking its net carbon footprint by about half by 2050. On the other hand, innovation by private firms can also produce large positive externalities. For example, a pharmaceutical company that

[3] In our paper, "innovation" captures the spirit of deviating from the old and tried method which generates normal profits (normalized to zero) with probability 1 and instead invest in a risky project that generates a random cash flow. When the innovation succeeds, which happens with a probability p, the resulting cash flow is high. When the innovation fails, which happens with a probability (1 – p), the cash flow is low. The level of investment is fixed in our framework and innovation is different from overinvestment (i.e., where a firm invests more than the optimal level) in a risky technology.

innovates a cure for cancer or a vaccination for coronavirus (COVID-19) does produce enormous benefits to society, but only a small part of it may be captured in the profits of the innovating firm. We will denote these nonmonetized benefits to society as an important positive externality arising from successful innovation.

From this foregoing discussion, it is clear that the presence of positive and negative externalities will affect the non-financial stakeholders in the society differently from the capital suppliers (debt holders and equity holders) in the firm. In other words, the private firm may optimally choose a level of innovation that is different from the socially optimal level of innovation. In fact, limited liability might be accompanied by excessive innovation by the firm. On the other hand, when the nonmonetized benefits to society are very high, private firms may be too conservative in their innovation policies. In our model, firms choose their organizational form and level of innovation consistent with private optimality. Lack of sufficient information on the part of the social planner would preclude complete contracting and invasive regulation as a way of aligning the privately optimal level of innovation with the socially optimal level of innovation.

Our approach is consistent with the institutional theory proposed by North (1990), Jackson and Deeg (2008), Henisz and Swaminathan (2008), and we ask the following question: Can the social planner in country i take into account the existing legal system in that country, and design supplementing institutions optimally to curtail the distorted incentives of corporations that are harmful to society? The fundamental idea behind institutional theory is that well-designed institutions do matter. In other words, they create the "rules of the game" within which the private firms will choose their organizational form, and consequently an innovation policy that will maximize their private objective (assumed to be the value of the firm). If the social planner for country i has designed the institutions optimally, the innovation policy chosen by the firms in country i will be aligned with the socially optimal innovation policy for country i.

As mentioned above, the social planner starts with the existing legal system of her country. The social planner then designs a menu of organizational forms from which the firms can choose the one that is privately optimal for it. If a firm has chosen a limited liability organizational form, there are two consequences. The firm is entitled to a well-defined limitation of liability that will be described later. In return, the limited liability firm will be obligated to pay a corporate tax at a rate that is optimally determined by the social planner. On the other hand, the institutional design may involve a subsidy from the social planner in cases in which the innovation involves large positive

externality. Within this institutional structure, the firms in country i will select (1) an organizational form, (2) an innovation policy given its organizational form, both to maximize its private objective of firm value maximization. We will show that when the institutional structure is optimally designed by the social planner in country i, the innovation policy in (2) will coincide with the socially optimal innovation policy for country i.

In this paper, we focus on the limited liability organization. Limited liability specifies a sharing rule between the non-financial claimholders and the set of all financial claimholders. This in turn affects the private incentives to innovate. In the absence of limited liability, many socially beneficial innovations might be passed up due to the threat of lawsuits while, in the presence of limited liability, the corporation may undertake innovation beyond what is socially desirable. In other words, limited liability may induce innovation level which deviates from social optimality.[4]

We then proceed to examine the role of corporate taxation and subsidies in altering the sharing rule between financial owners and non-financial claimants. In particular, corporate taxation affects a corporation's incentive to innovate through a reduction of its cash flows from a successful innovation. A lower after-tax profit in the successful state reduces the incentives of owners to innovate. Therefore, corporate taxation can be viewed as the price that corporations have to pay for limited liability, and it plays an important role in aligning the interests of non-financial claimholders and the owners of a corporation.[5]

In the framework analyzed here, corporate taxation prevents excessive corporate innovative activity that is socially undesirable. We note that the benefits to corporations from limited liability arise from not being liable to the legal costs that are greater than the corporation value. As the legal structure gets weaker, the benefits of limited liability reduce because the corporation is only held

[4] The existing corporate finance literature has focused on the conflict of interest among various classes of capital contributors to the corporation. The incentive effects of outstanding risky debt and the distortions in investment choices have been studied extensively. Modeling the scale or the riskiness of investment as "private" choices made by corporate insiders, it has been shown that risky debt induces underinvestment (compared to value-maximizing levels) and risk-shifting (shifting into high-risk projects even at the expense of corporation-value). See Jensen and Meckling (1976) and Myers (1977). However, even in the absence of any conflicts among holders of external financial claims, say in the case of an all-equity corporation, corporate limited liability induces conflict of interest between equity holders and non financial claimholders (and more generally society-at-large).

[5] The view that taxation can be used to control a corporation's power to abuse stakeholders was, in fact, a primary motive to introduce taxation (see, for example, Kornhauser (1990)). Actually in President Taft's message justifying the introduction of the corporate tax, the principal reason was that it enabled the federal government to exercise some degree of supervision, primarily by obtaining information about the business affairs of corporations, and more broadly by serving a regulatory function. *"While the faculty of assuming a corporate form has been of the utmost utility in the business world, it is also true that substantially all of the abuses and all of the evils which have aroused the public to the necessity of reform were made possible by the use of this very faculty"*. See also Avi-Yonah (2004), Pechman (1987) and Desai, Dyck and Zingales (2007) for providing monitoring role for corporate taxation. In contrast, we focus on the incentive effect of corporate taxation on innovation policy of a limited liability firm.

accountable for a smaller fraction of the social cost. Consequently, corporations will not be willing to pay a high tax rate in poor legal structures.

In our framework, we are able to characterize some properties of our optimal institutional design for different countries as a function of the strength of the embedding legal system. In particular, our result is that the optimal corporate tax rates are a declining function of the effectiveness of the legal system. Using archival data from 63 countries over 2003-2018, we find empirical support for this prediction of our model. We conduct several additional tests using different proxies for the strength of the legal system, and show that our main result is robust to the legal proxies that we use. We also document an inverse relationship between corporate taxes around the world and an aggregate legal strength metric. Our relationship is also robust to inclusion of country and year fixed effects.

Moreover, as shown in Section II, when the nonmonetized benefits to society are very high, private firms may be too conservative in their innovation policies. In this case, other forms of instruments, rather than, taxes are called for. In this regard, our framework helps us understand the dark and the bright side of activities of multinational corporations (MNCs). On the one hand, the framework provides an explanation for MNC strategies that arbitrage differences in legal liability structures and corporate taxes across national boundaries. On the other hand, MNCs can provide positive externalities to innovating in the host countries when the required technology or capacity is not available there. Host countries will provide subsidies and incentives to make it attractive for MNCs to locate in the host country. Such innovation incentives are part of our institutional design.

This paper makes several contributions. *First,* the paper characterizes certain benefits and costs of corporate limited liability and shows how corporate taxation can be used to mitigate, or even eliminate, the excessive innovation incentives of the limited liability corporation. As a corollary, the paper provides a justification for the double-taxation of corporations.[6] In this context, corporate taxation can be viewed as the price of corporate limited liability.

Second, the paper generates implications on how optimal corporate taxation is related to the strength of legal regimes and hence the value of limited liability across legal structures. We derive a cross-country equilibrium relationship between corporate taxes and the effectiveness of legal

[6] This refers to the tax levied on the corporate profits in addition to personal taxes levied on its shareholders. Double-taxation has troubled economists. Indeed, as Stiglitz (1988, p.586) notes, "most economists cannot see any strong argument for the differential tax treatment." In our paper, corporate taxation is designed to align the innovation incentives of the limited liability corporations with social optimality. In other words, corporate tax is the price for the benefit of corporate limited liability.

system. We document supporting evidence.

Third, our paper contributes to a better understanding of how institutions matter. Jackson and Deeg (2008) examine the construct of institutions from the comparative capitalism (CC) and international business (IB) perspectives. While there is general agreement that institutions do matter, what is emerging is lack of consensus, both at the conceptual and empirical levels, on how institutions matter (e.g., Jackson and Deeg (2008); Eden (2010); Verbeke (2019)). In our framework, we subdivide the institutional structure to be made up of two components: (1) the legal system of the country under reference, (2) the organizational form menu and the corporate tax rate associated with the limited liability organizational form. Even though the components of the institutional structure are designed to align private innovation with social optimality, we do not endogenize the form of these institutions. However, we do endogenize the liability structure and optimal corporate tax rate for country i as a function of the strength of legal system in that country. In particular, we show that the optimally designed corporate tax rates are a declining function of the strength of the legal systems.

The rest of the paper is organized as follows. In section II we present the innovation policy choice of a private firm in the basic model. In section III, we analyze the innovation policy in the simple case of an ideally strong legal system. In section IV, we investigate the institutional design features, such as corporate taxation, and legal regimes for the alignment of private innovative choices with social optimality. Section V provides empirical evidence on the relationship between strength of the legal system and corporate tax rates using archival cross-country data from 63 countries. Section VI discusses some extensions, and Section VII concludes.

II. The Model and Framework

In our framework, the legal system that exists in each country is assumed to be exogenously given. Even though the specific heterogeneity that we model pertains to the legal system in place, we could generalize the existing initial configuration of each economy to pertain to other features of the economy including its political system, the degree of development of its markets, the degree of development of its financial institutions etc. For a given initial state of its institutional development, we ask how supplementary institutions should be optimally designed such that corporate innovation policies are aligned with social goals. In this sense, our analysis goes beyond the fundamental idea that institutions matter. Our social planners design a constellation of interdependent structures and systems within their respective countries that is a function of their

existing institutional characteristics.

Consistent with most of the early papers in the Law and Finance literature (La Porta et al. (1997, 1998)), we assume that different countries have legal systems of varying strengths. The strength of the legal system in a country is exogenously given and cannot be changed within a short period of time.[7] However, the supplementary institutional structure is carefully designed by the social planner to align the privately-optimal innovation decisions with social optimality. Here, optimal firm responses to a given institutional construct in the respective country environment is taken into account in the institutional design.[8]

We believe that our framework captures one of the important points of institutional theory highlighted by Henisz and Swaminathan (2008) (see, also Eden (2010)). Moreover, the supplementing institutions are cleverly designed such that the firms in country i respond to that institutional construct in their choice of organizational form and subsequently their innovation policy in a privately optimal manner. However, the innovation policy so chosen would turn out to be aligned with the socially optimal innovation policy for country i. Although our approach of interacting institutions is similar to that in institutional theory (Hall and Soskice (2001), North (1990), Jackson and Deeg (2008), Aguilera and Grogaard (2019)), the focal effect of institutions in our framework is through their effect on the investment, and innovation decisions of firms even though informational constraints preclude complete contracting and invasive regulation, the social planner is able to implement her goals through a well-designed set of interacting institutions. Our approach can be characterized as a "thick" approach in the framework of Jackson & Deeg (2008) in which institutions are designed taking into account country-level heterogeneity and such institutions may influence firm-level innovation policies.

As mentioned above, the social planner starts with the existing legal system of her country. The social planner then designs a menu of organizational forms from which the firms can choose the one that is privately optimal for it. If a firm has chosen a limited liability organizational form, there

[7] Our rationale is built on the foundation provided by La Porta et al. (1997, 1998) who had argued that legal traditions were typically introduced into various countries through conquest and colonization and, as such, were largely exogenous. In other words, while it is conceivable that countries may be able to make changes to their legal systems, we view that such a change in the strength of the legal system would be relatively slow, and hence the legal strength is likely to be largely exogenous in the short-run.

[8] We believe our approach does integrate the third of the three focal points highlighted by Henisz and Swaminathan (2008: 539) as being important for future researchers on institutions and IB. Relevant to our paper, though, are the "rules of the game" highlighted by Eden (2010: 175) as importantly influencing the private incentives of firms engaging in the economic activity of production, distribution, innovation and exchange (see also, North (1990)).

are two consequences.[9] The firm is entitled to a well-defined limitation of liability that will be described later. In return, the firm will be obligated to pay a corporate tax at a rate that is optimally determined by the social planner in that country. Within this institutional structure, the firms in country i will select (1) an organizational form, (2) an innovation policy given its organizational form, both to maximize its private objective of firm value maximization. We will show that when the institutional structure is optimally designed by the social planner in country i, the innovation policy in (2) will coincide with the socially optimal innovation policy for country i.

Thus, in in our model, countries are characterized by differences in their respective legal systems. The social planner of country i takes into account the strength of its legal system λ_i, $0 < \lambda_i < 1$. For each country i, the social planner designs an optimal institutional configuration. The details of the legal system will be given in Section II.C and the design problem will be described in Section III.

The essential aspects of how the choice of organizational form and corporate taxation interact can be captured in the following simple model.

A. To Innovate or Not to Innovate

We use a two-date, single period model with t=0 denoting the initial date and t=1 the final date. The representative private firm in our economy invests I at date t=0 in its project. At this point the firm can choose two alternative methods of implementing the project. It can use the old and tried method or the innovative method. The old and tried method involves an investment of I dollars and it generates cash flows whose discounted present value is I dollars.[10] On the other hand, the innovative project generates a random cash flow at t=1. When the innovation succeeds,

[9] In fact, offering limited liability rights to corporations is often cited as a landmark ruling that empowered the corporation to its "pathological pursuit of profits". See for example the op-ed piece "Reward but no risk" in New York Times, May 10, 2003. Quite early, it had been well recognized that limited liability was a mixed blessing and the implications of limited liability - the feature that the owners are not liable for any claims greater than the value of the corporation - were widely debated. In this debate, the concern for society is evident from the following observation in Hunt (1937): "There was a corporation and widespread conviction that unlimited liability was not only some safeguard against speculation, but also that general limitation, by allowing men to indulge in their spirit of adventure without endangering their fortunes would produce a sudden convulsion, a rush into all sorts of schemes [and society will be exposed to] the evils of inconsiderate enterprise and reckless speculation".

[10] Using the old and tried method involves an investment of I dollars that generates a cash flow whose discounted present value is I dollars. In other words, the project earns positive profits commensurate with the normal required rate of return. These profits, when discounted at the required rate of return, generate a present value of I dollars, and hence the project has an NPV equal to zero. In our benchmark model, this traditional technology is assumed not to produce any externalities, positive or negative, as discussed in detail in Section II.B. The cash flows from this traditional technology will not be subject to corporate taxation in view of the fact that the project does not produce any externalities (see, Section III.C). By the same token, the corporation is also exempted from any legal liabilities associated with doing business as discussed in Section II.B. As we can see later, taxation and subsidies will be introduced as mechanisms that will align private innovation incentives with social optimality. See Section III.E and Section III.F for details.

which happens with a probability p, the resulting cash flow is high and is equal to H. When the innovation fails, which happens with a probability (1 – p), the cash flow is low, and is equal to L. The probability of the success of innovation, p, is uniformly distributed on [0, 1] and is common knowledge at t=0. However, the realized value of p is privately observed by the firm's insider/manager at t=1 before she decides whether to innovate or not.[11] The value of p is assumed to be not verifiable.[12] It is assumed that risk neutral valuation is appropriate for our economy.[13]

B. Non-Financial Claimants

While the total payoffs to the financial claimants (capital suppliers) when the innovation succeeds and fails are respectively H and L, the society at large bears externalities from the innovation. Let us assume that the costs that the society bears in the failure state are C_L and in the success state is C_H. In other words, in the bad state the non-financial claimholders bear cost C_L while in the good state, the non-financial claimholders bear a cost C_H. The innovation also has positive externalities. For simplicity, we assume that these positive externalities take the form of benefits to society-at-large, say to non-financial claimants, equal to B_H in the success state and B_L (standardized to zero) in the failure state.[14] Examples of positive externalities could be employment, infrastructure development etc. Importantly, B_H cannot be monetized by the private firm (the part of the benefits that can be monetized is already included in H, the cash flows in the success state). The decision makers in the firm would ignore these nonmonetized benefits B_H in their decision on whether or not to innovate since these are not part of the profits of the firm.

C. Legal System

The non-financial claimants can resort to the legal systems in their respective countries to claim compensation for the social costs C_H and C_L imposed on society by the firms. To capture this in a simple manner, we denote the strength of the legal system by λ, $0 < \lambda < 1$. This is the fraction of the

[11] We abstract from any agency issues between managers and the shareholders of the corporation, and the role of incentive features of managerial compensation in addressing the public-private conflict (see, for instance, John, Saunders, Senbet, 2000).

[12] This rules out the possibility that contracts on innovation policy stating their probability of success are not possible. Incomplete contracting is a crucial feature of our model that captures the fact that writing and enforcing contracts that specify probability of success of innovations are not feasible. This feature would also preclude invasive regulation of innovation decisions made by the firm.

[13] See Section VI.A for a discussion of relaxing this assumption of risk-neutrality. Without any loss of generality, the riskfree rate is normalized to 0.

[14] More generally, let the social costs and the nonmonetized benefits in each state be C_I and B_I, where I denotes the state.

social costs (C_L or C_H) that the corporation is held accountable for such that it is a liability of the corporation. Thus, λC_i (i = L, H) is the maximum compensation that the non-financial claimants are able to recover from the corporate owners through the legal channel. In an "ideal" legal regime, $\lambda = 1$, and the firm is held responsible for the total costs, C_H and C_L, imposed on society. However, in an extremely poor legal regime ($\lambda = 0$), the corporation is not held liable for any of the social costs, and the non-financial claimants bear the entire cost of the corporation's activities. In a given legal system λ that is in place, the extent to which the firm is actually made to pay up its liability λC_i (i = L, H), may further depend on its organizational form and the availability of assets and cash in the firm. A firm that is organized as a limited liability will have its legal liability limited to the extent of cash flows available in the firm. In the success state, the firm is liable for the entire liability, λC_H , since $H > \lambda C_H$. However, in the failure state its legal liability is limited to L, the available cash flows (i.e., assuming $L < \lambda C_L$).

III. Corporate Limited Liability and Corporate Taxation

We now consider how in each country i, the firm's organizational form affects the innovation policy it chooses to pursue. In this section, we assume that the legal systems are "ideally strong", that is $\lambda_i = 1$ in all the countries. In section IV, when we analyze the impact of law in the design of taxation, we consider the general case of legal systems of varying strengths. The case of an "ideal" legal system ensures that the non-financial claimants have recourse to the legal system to hold the firm liable for all the social costs, C_L or C_H. To focus our analysis to the interesting scenario described here, we will make the following assumptions.

Assumption 1: (a) $C_L > L$, and (b) $C_H < H$.

The assumption **1**(a), central to our paper, states that the cash flows L in the low state are insufficient to meet the social costs C_L that the non-financial claimants have to bear. This assumption captures scenarios in which the social costs of particular products and the legal liability resulting from them exceed the value of corporate assets in the states of the world in which the innovation fails. Examples include product liability suits mentioned earlier in the introduction where the legal claims exceeded corporation value. The assumption also subsumes scenarios of industrial accidents where both the corporation and the society bear large losses. Examples include large oil spills (e.g., the British Petroleum) and large chemical accidents (e.g., the Union Carbide Bhopal accident).

The assumption **1**(b) states that social cost C_H imposed in the high state is lower than corporation value, H. In other words, the corporation has sufficient assets in place to pay out liability claims in the high state. This ensures that the corporate owners have an incentive to undertake projects with a high probability of success. For simplicity, we set L = 0 in the remaining analysis. This would imply that when the innovation fails, a limited liability corporation would not be required to pay any of its legal liability C_L since its available cash flows L happen to be zero. We now characterize the socially optimal innovation policy and compare it that of a limited liability firm.

Our framework is within the existing agency paradigm arising from lack of complete contracting due to informational asymmetries between the private firm and the social planner regarding the success probability of the innovative projects available to the firm. Since the firm has superior information about the technology of innovation, incomplete contracting arises naturally. This precludes reaching socially efficient outcomes through complete contracting or efficient bargaining as envisioned in the Coase theorem (see, Coase (1960)). Later, in his retrospective speech while accepting the Nobel Prize (1991), Coase presaged the role that regulation and institutions can play in the presence of positive transaction costs.

A. Social Optimality

The social planner seeks to maximize the welfare of all claimants, including the nonfinancial ones, in determining whether an innovation should be implemented.

Proposition 1

Independent of the strength of the legal system (λ) in the embedding economy, the socially optimal innovation level is: $p_s = \dfrac{\left(I + C_L\right)}{\left(H - C_H + B_H + C_L\right)}$.

Proof: See below.

If an innovation has been implemented, and in the state it succeeds, the social planner adds up the following: the cash flows from the project (the benefits that can be monetized) equal to H, social costs C_H, and nonmonetized benefits B_H.[15] If an innovation has been implemented, and in the state it fails, the social planner considers the following: the cash flow from the project equal 0

[15] In this state, the firm absorbs all the costs it imposes.

and the social costs equal C_L. Therefore, the social planner, who considers all social costs and benefits, as well as all cash flows to the firm, would choose the innovation if and only if its probability of success, $p > p_s$. The cut-off point probability p_s is given by the following equality:

$$p_s(H - C_H + B_H) - (1 - p_s)C_L - I = 0$$

$$p_s = \frac{(I + C_L)}{(H - C_H + B_H + C_L)} \qquad \textbf{(1)}$$

Equation (1) characterizes the cut-off probability p_s such that the innovation should be implemented whenever $p > p_s$, where p is the probability that the innovation succeeds. From now on we will denote the cut-off probability p_s as the socially optimal innovation policy.

Private firms may deviate from the above innovation policy if they are focused on the cash flow claims of the financial claimants and do not place adequate weight on the social costs C_H or C_L or the nonmonetized benefits B_H. It should be recognized that the social optimality condition is independent of the institutional structures in place: legal structure, tax structure, and organization structure. However, the relative weights that a firm may place on its after-tax cash flows, and the social costs will depend on the tax and legal regimes in place, as well as its liability structure. In the next subsections, we examine the innovation policy that would be implemented by the private firm as a function of its limited liability.

B. Unlimited Liability

The owners of an unlimited liability corporation receive the cash flow H if the innovation succeeds (and have to compensate the social costs of C_H) which happens with probability p but also face the prospect of losing C_L, the value of legal claims in the low state. This assumes that the corporation owner is personally responsible for the full extent of the legal claims.[16] Since the owners are liable, they choose to invest if $p(H - C_H) - (1 - p)C_L > I$. Therefore, the unlimited liability corporation will innovate only when its success probability $p > p_N$, where

[16] Thus, here we assume that the aggregate personal wealth of the owners of the firm is sufficient to meet these legal claims. See section VI.B for a discussion of the case where this assumption is relaxed.

$$p_N = \frac{(I + C_L)}{(H - C_H + C_L)} \quad \textbf{(2)}$$

Comparing p_N, the cut-off probability for the unlimited liability firm in equation (2) with p_S, the socially optimal cut-off probability in equation (1) we find that $p_N > p_s$, since the denominator in equation (2) is smaller. Consequently, relative to the socially optimal innovation policy an unlimited liability firm innovates too little. The reason that the unlimited liability corporation is cautious is because it accounts for the potential liability claims via the legal system but does not account for (or internalize) the nonmonetized benefits B_H to society that its innovation generates.

C. Limited Liability

We now consider the innovation policy of a corporation with limited liability. The owners of a limited liability corporation receive the cash flow H in case of a successful innovation (and have to compensate the social costs of C_H) with probability p. However, the owners of a limited liability corporation can walk away from the legal claims C_L by non-financial claimants in case of a failure of an implemented innovation. Therefore, the limited liability firm chooses to innovate if $p(H - C_H) > I$. Equivalently, the limited liability corporation innovates whenever the success probability of its innovation p is such that $p > p_L$, where

$$p_L = \frac{I}{(H - C_H)} \quad \textbf{(3)}$$

The innovation policy of the limited liability corporation differs from the socially optimal policy for two reasons: (1) the limited liability corporation takes advantage of the limitation of its liability in the failure state and ignores the social cost C_L, and (2) it ignores the positive externalities (B_H, the nonmonetized benefits to society). Examine the following wedge term Φ:

$$\Phi = \frac{(H - C_H - I)}{I} - \frac{B_H}{C_L} \quad \textbf{(4)}$$

The first term in Φ summarizes the value relevance of the innovation to the limited liability firm. It captures the cash flow to the firm in the successful state net of the social costs and the investment outlay required per dollar of investment. This term represents the attractiveness of the innovation to the firm value of the limited liability firm when the project is successful, i.e., it takes into account

H, the high profits to the firm minus C_H, the legal liability transfers required, and I, the required investment. Intuitively, the higher this first term is, the more aggressive is the innovation policy implemented by the limited liability firm for a given value of B_H/C_L.

The second term in Φ summarizes a benefit-to-cost measure of the innovation to society at large. It captures the gains to society from the nonmonetized social benefit of the innovation, and the cost to society in the form of social cost in the failure state arising from limitation of liability. Specifically, the measure is the nonmonetized benefits to society B_H per dollar of social cost C_L in the failure state arising from the innovation. When the nonmonetized social benefits are high, for a given level of social costs in the failure state, the socially optimal innovation level is more aggressive. On the other hand, for larger values of C_L, the social planner pursues a more conservative innovation policy, the limited liability firm escapes the social cost C_L, with the full brunt of this cost being borne by the social planner. Hence, for a given level of firm-value characteristics (represented by the firm term in Φ, such as, H, C_H, and I), the socially optimal level of innovation will be more aggressive the higher is the value of B_H/C_L. In this case, $\Phi < 0$, and the private firm innovates more conservatively than the socially optimal innovation level.

We formalize the intuition of the foregoing discussion in Proposition 2.

Proposition 2

$p_L \leq p_s$ *if and only if* $\Phi \geq 0$. *When* $\Phi > 0$, *the limited liability corporation innovates more aggressively relative to the socially optimal level, i.e.,* $p_L < p_s$.

Proof: See Appendix.

Proposition 2 implies that when $\Phi = 0$, the limited liability firm would innovate exactly at the socially optimal level, and hence no additional institutional mechanisms are required to achieve social optimality. However, when $\Phi > 0$ ($\Phi < 0$), the limited liability corporation will implement an innovation policy that is more (less) aggressive than the socially optimal innovation policy. In both cases (i.e., when $\Phi > 0$ and $\Phi < 0$), the social planner will need to design complementary institutions to align the privately optimal innovation policies with the socially optimal policy.

One particular institutional mechanism that we consider for the case when $\Phi > 0$ is corporate taxation. In the case when $\Phi > 0$, we have $\frac{(H - C_H - I)}{I} > \frac{B_H}{C_L}$. Here innovation is privately very

attractive, and the limited liability firm innovates too aggressively relative to the socially optimal level. If the social planner levies corporate taxes on (H - C_H), the after-tax profits to the firm decreases, reducing the attractiveness of the innovation to the private firm. Now, if the corporate tax rate is chosen such that $\frac{(H-C_H)(1-T)-I}{I}$ equals $\frac{B_H}{C_L}$, the privately optimal innovation policy will be equal to the socially optimal innovation policy. The details of this institutional design and the corresponding corporate tax design are given in Section III.E for $\lambda = 1$ case, and in Section IV.C for the case of a general λ.

When $\Phi < 0$, $p_L > p_s$, and the limited liability firm would innovate more conservatively than the socially optimal level. In this case, we have $\frac{(H-C_H-I)}{I} < \frac{B_H}{C_L}$. In other words, given the profits H, the required liability transfer C_H, and the required investment I, the innovation is not sufficiently attractive to the private firm compared to its attractiveness to the social planner given its high value of B_H. In this case when $\Phi < 0$, the social planner will have to design an appropriate set of institutions that will make the innovation attractive to the private firm. Based on the measure of attractiveness of the innovation $\frac{(H-C_H-I)}{I}$, the social planner may implement a set of institutions to increase the value of $\frac{(H-C_H-I)}{I}$ to the private firm. This can be done through an increase in H, a decrease in C_H, or a decrease in I such that $\frac{(H-C_H)-I}{I}$ equals $\frac{B_H}{C_L}$ so as to align the privately optimal innovation policy with the socially optimal innovation policy.

We will consider three types of institutional mechanisms: (1) direct subsidy to augment the profitability H in the success state of the innovation, (2) a partial or full limitation of legal liability imposed on the private firm in the success state and/or the failure state of the innovation, and (3) an investment subsidy such that at the point of investing the private firm has to invest only a fraction $(1-\alpha^*)$ of the required investment, and the social planner provides an investment subsidy of the amount $\alpha^* I$ in the innovation. We will show that the cost to the social planner in the implementation of institutions (1), (2), and (3) will be different, and that in all three cases, the subsidy amounts will be smaller than B_H, the nonmonetized benefits to society. The details of the implementation of these different institutional mechanisms are discussed in Section III.F.

D. Numerical calibration

A simple numerical calibration will be useful to understand the interaction of the relative magnitudes

of H, B_H and C_L and their impact on Φ. For a given set of values of I and C_H, we vary H and B_H separately. We compute the corresponding values of Term 1 and Term 2, where Term 1= $\frac{(H-C_H-I)}{I}$ and Term 2=$\frac{B_H}{C_L}$. The highlighted cells in Table 1 denote $\Phi > 0$, i.e., Term 1 > Term 2.

When the nonmonetized social benefits (B_H) are low relative to the social costs (C_L), conditional on a failed innovation, Term 2 is small and the corresponding socially optimal policy will be less aggressive (i.e., a high value for p_s). On the other hand, when Term 1 is high, the limited liability firm finds the innovation attractive due to the high value of H (net of C_H and I), and pursues an aggressive innovation policy using a low value for p_L. As can be seen by comparing the corresponding numbers in Tables 1 and 2, whenever $\Phi > 0$, $p_L < p_s$, the limited liability firm pursues an aggressive innovation policy relative to the socially optimal one.

<Tables 1 and 2 here>

The foregoing analysis has implications for the innovation policy and regulatory rules that we might find in different industries with high and low expected values for B_H, C_H and C_L. For example, consider innovations in the nuclear industry. Based on historically well-known nuclear accidents, an argument could be made that the values of C_H and C_L are likely to be high. The Chernobyl nuclear accident is estimated to have exposed 10 million people to nuclear radiation in the surrounding countries with a social cost of roughly $700 billion over the past 30 years. See Samet and Seo (2016).[17] Of course, nuclear energy also bestows enormous benefits to society as a clean source of energy with relatively low emissions of green-house gases. Taking into account the resulting high expected value B_H several governments have used various policies to encourage innovation in this industry. For example, in the U.S., in addition to being able to operate as a limited liability corporation, the Price-Anderson Act (Public Law 85-256) limits liability from nuclear accidents for a private company to an amount of $12.6 billion (as of 2011).[18] This represents a substantial limitation of liability for the firm, compared to the potential social costs of a nuclear accident. In some other countries (e.g., China, Russia, India, South Africa), the social planner runs the nuclear industry and decides on the innovation policy.

[17] We note that there is a high degree of uncertainty regarding the social costs C_H and C_L. For the purposes of our model, we assume that the social planner will come up with estimates of expected values of these costs based on historical experience. For example, Samet and Seo (2016) contain an insightful discussion of how the indirect costs related to medical care of affected victims of the nuclear accident were estimated.

[18] For details, see https://en.wikipedia.org/wiki/Price%E2%80%93Anderson_Nuclear_Industries_Indemnity_Act.

Now we provide an example of an industry with potentially large values of B_H, nonmonetized expected benefits to the society. In the pharmaceutical industry, firms that innovate procedures and medicines that cure devastating diseases are able to realize profits equal to fraction of the social benefits that derive from the innovation. As an example, consider the case of a cure for river blindness by the pharmaceutical giant, Merck.[19] Merck, initially provided Mectizan® at a low price to patients in affected countries. Later, Merck started a program of providing the medication free of charge in all the developing countries, thereby protecting about a billion people in the world who are at risk. It is estimated that the foregone revenues from this program during 2005–2011 is US$3.8 billion (see, for details, Hernando, Colwell and Wright (2016)). In the pharmaceutical industry, the nonmonetized part of the social benefits (B_H) is often high, and it is a function of the legal infrastructure in that economy that protects property rights.

So far our analysis has focused on the effects of the organizational structure on the innovation policy choices by private firms. We now consider the role of corporate taxes and subsidies in aligning private innovative choices with socially optimality, and how they interact with the legal structures across countries.

E. The Role of Corporate Taxation

We examine the role of corporate taxation in mitigating the conflict between the private objectives of the limited liability corporation and that of the society at large. We show that corporate taxation affects a corporations' incentive to innovate by reducing its cash flows from a successful innovation. Therefore, corporate taxation can be viewed as the price that corporations have to be pay for limited liability.

Corporate taxation introduces an additional claimholder (the government) to the corporations' cash flows and hence alters the sharing rule between the corporate owners and the non-financial claimholders. Let the corporate tax rate be T. When the innovation succeeds, the corporate owners now only receive $\left(H - C_H\right)\left(1 - T\right)$.[20,21] In the failure state, the owners of the limited liability

[19] Scientists William C Campbell and Satoshi Omura have been awarded the Nobel prize for medicine for their discovery of a way to treat river blindness. They together discovered a group of compounds known as avermectins, the derivatives of which are used to treat and prevent river blindness. Their research led to the creation of ivermectin (brand name Mectizan®) which is used to treat the disease in developing countries.

[20] As discussed in footnote 10, the traditional technology will not be subject to corporate taxation in view of the fact that the project does not produce any externalities.

[21] In assuming that the taxable income equals ($H - C_H$), we abstract from the details of many realistic features of the tax code, particularly deductions allowed for investment and R&D, and sector-specific investment tax credits. There

corporation can walk away from any claims exceeding cash flows by non-financial claimants and do not pay any taxes.

Therefore, in the presence of taxation, the limited liability corporation chooses to invest if

$$p(H - C_H)(1 - T) - I \geq 0$$

With corporate taxation, the limited liability corporation implements innovations whenever its success probability $p > p_T$, where the project has a non-negative NPV.

$$p_T = \frac{I}{(H - C_H)(1 - T)} \quad \textbf{(5)}$$

Comparing equation (3) with equation (5), it can be seen that p_T is greater than p_L for any positive corporate tax rate T, since the denominator in equation (5) is smaller than that in equation (3). In other words, for any $T > 0$, the firm innovates less aggressively relative to the taxless scenario.[22] This incentive to reduce innovation now can now counterbalance the incentive to increase innovation due to corporate limited liability. The tax rate, T, can then be chosen such that p_T is equal to p_S, the socially optimal innovation level. Proposition 3 (see below) characterizes such an optimal tax rate T*. When $\Phi > 0$, there is a wedge between the private benefit-cost ratio of the financial claimholders and the social benefit-cost ratio of the non-financial claimholders.

When $\Phi > 0$, based on Proposition 1, we know that the innovation rate of the limited liability firm

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is large heterogeneity in the depreciation tax shields allowed among the 63 countries used in our sample. In a recent study, Asen (2020) documents evidence consistent with this. The cumulative recovery over the life of the asset ranges from 41.7% in Chile to 100% in Estonia among the OECD countries. Similarly, in the EU countries, the depreciation allowances vary across type and life of assets. For example, according to the Common Corporate Tax Base (CCTB) proposal for European Union (EU) countries, for long-lived assets, such as buildings, depreciation schedule allows an annual rate of 4 percent. Even though we abstract from the heterogeneity with respect to the features of the tax code in our main theoretical model, in Section IV.D, we consider MNC tax strategies that take advantage of this heterogeneity.

[22] This effect of corporate taxation on innovation policy will be attenuated in the presence of deductions related to investment, such as depreciation tax shields. In our main model we do not consider depreciation tax shields. Had we modelled a tax code that allows for a 100% depreciation tax shield, and rederived the cut-off innovation policy, equation (5) would be replaced by the following expression:

$$p_T = \frac{I}{(H - C_H - I)(1 - T) + I}$$

This innovation policy would continue to be a function of the corporate tax rate, T.

is more aggressive than the socially optimal level. Hence, a socially optimal tax rate T^* would equate the innovation level of a firm which has to pay the corporate tax rate to the socially optimal level, i.e., p_T in equation (5) would equal p_S in equation (1). Such a tax rate T^* has a simple characterization.

Proposition 3

For $\Phi > 0$ *and a corporate tax rate of* $T^* = \left[1 - \frac{p_L}{p_s}\right] = \frac{\phi p_L}{\left[1+\frac{I}{C_L}\right]}$ *the innovation policy of the corporation is identical to the socially optimal innovation policy. This tax rate* T^* *is increasing in* Φ *and* C_L*. This tax rate* T^* *is decreasing in* p_L *and* B_H*.*

Proof: See Appendix.

Policy Remarks: Based on Proposition 2, we know that in the absence of taxes, the limited liability firm innovates more relative to the socially optimal level, i.e., $p_L < p_S$. Furthermore, since $p_L > 0$ and $p_S > 0$, we can see that, based on Proposition 3, that $T^* > 0$ and $T^* < 1$. The optimal rate of taxation T*, which is applied to the profits in the successful state, alters the *ex ante* innovation incentives of limited liability corporations to be in line with social optimality. The role of corporate taxation can be viewed in the same manner as the government taking claims in the private firms in the global financial crisis. The government, in exchange for bailing out failing financial institutions, is known to have taken equity-like claims, such as preferred stock and warrants, as a mechanism for repaying the tax payer. In this respect, we wish to make two observations. First, taxation of profitable states works in a fashion similar to holding equity or warrants in the private firms in a setting of *ex post* resolution of crisis. Second, corporate taxation has *ex ante* incentive effects, since as we show, it can play a role in realigning the incentives of private firms with the goals of the government. Interestingly, taxation plays such a role even in good times, and unlike equity claims in the bailout schemes, it does not entail voting rights for the government. Thus, incentives are realigned in the right way without mandating specific innovation levels through invasive regulation.

Proposition 3 also implies that the optimal corporate tax rate is a declining function of B_H, the nonmonetized social benefits of a successful innovation. The social planner may choose to encourage innovation on the part of private firms in certain sectors by providing sector-specific tax incentives. This can be done in several ways. Examples include sector-specific depreciation

tax shields, research and development tax credits, and energy investment tax credits. These features in the tax code essentially lower the corporate tax rate for firms in certain sectors from the baseline economy wide tax rate.

F. Institutional Design when B_H is high and $\Phi < 0$

When B_H, the nonmonetized benefits to society is very high, the private firm innovation policy is less aggressive than the socially optimal innovation policy, i.e., $p_N > p_s$. The reason for the deviation of p_N from p_s is clear from a comparison of p_N in equation (2) with p_s in equation (1).[23] While the social planner takes into account B_H, the nonmonetized social benefits for computing p_s, the private firm does not. Therefore, $p_N > p_s$. One possible institutional mechanism that can be used by the social planner is to augment the profits H from a successful innovation by providing a subsidy (S) to the firm. That is, the firm receives (H + S) when the innovation succeeds. If the social planner wishes to fully align the innovation policy of the private firm (with unlimited liability) with the socially optimal policy, the subsidy has to be set equal to B_H.

A direct subsidy equal to B_H is not the only mechanism to align the incentives of the private firm with social optimality. In our framework, we will design alternative institutional mechanisms for limiting liability for the private firm to change its innovation incentive. When combined with these mechanisms, the social planner can reduce the direct subsidy required for incentivize alignment. The appealing feature of these alternative mechanisms is to reduce the resource requirement associated with direct subsidies.

In many countries, the social planner has competing demands for the limited resources of the economy and may not be able to subsidize private firms to the tune of B_H, especially in the case of innovations in which the nonmonetized benefits are very high. In the remainder of the section, we will consider design of institutions by the social planner such that the subsidy to the private firms is combined with different types of limitation of legal liabilities and/or investment subsidy by the social planner in the innovation.

Now we consider the case of a limited liability firm when $\Phi < 0$. From the discussion in Section

[23] Here, it is useful to consider the private firm to be an unlimited liability firm discussed in Section III.B. The unlimited liability firm is responsible for the social costs, C_H in the successful state of the innovation and C_L in the failure state of the innovation. In other words, the only difference between the private objective of value-maximization of the unlimited liability firm and the social planner's objective is that the unlimited liability firm does not take into account the nonmonetized social benefits B_H. Therefore, a dollar-for-dollar subsidy of B_H given to the private firm fully aligns its innovation policy with the socially optimal one.

III.C, we know $p_L > p_s$, and the limited liability firm would innovate more conservatively than the socially optimal level. One possible solution is to supplement the profits H with a subsidy S^* in the successful state such that $\frac{(H+S^*-C_H)-I}{I}$ equals $\frac{B_H}{C_L}$. Such a subsidy S^* will make the innovation more attractive to the limited liability firm, and its innovation policy p_L will be more aggressive. With a subsidy S^*, p_L will be equal to p_s. We characterize the optimal amount of the subsidy S^* required to align the innovation policy of the limited liability firm with that of the socially optimal one.[24]

Proposition 4

For the case when $\Phi < 0$ the subsidy S^* required is given below:

$$S^* = \frac{\left[\frac{B_H}{C_L} - \frac{(H - C_H - I)}{I}\right]}{\left[\frac{1}{C_L} + \frac{1}{I}\right]} = \frac{-\phi}{\left[\frac{1}{C_L} + \frac{1}{I}\right]} > 0$$

With this subsidy S^*, the innovation policy of the limited liability corporation is identical to the socially optimal innovation policy.

S^* is strictly less than B_H, the subsidy required in the case of the unlimited liability firm.

Proof: See Appendix.

Policy Remarks: In the case of an unlimited liability firm, aligning innovation incentives requires a subsidy equal to the full extent of the nonmonetized benefits derived from the innovation. In the case of a high B_H innovation, the subsidy required may be higher than the resources available to the social planner. Through an appropriate combination of legal institutions and subsidies, the social planner is able to achieve the innovation alignment using a more modest subsidy.

Can the social planner do even better? It turns out that the social planner has the option of fully or partially limiting the liabilities of the private firm associated with C_H, the social cost in the successful state. In other words, over and above the limitation of liability in the failure state associated with the limited liability organization form, the social planner can exempt the private firm from some or all of the liability arising from a successful innovation. A well-known example

[24] Although our analysis deals with a dollar amount subsidy, S^*, a parallel analysis can formulate the subsidy as a fraction γ^* of H, where $S^* = \gamma^* H$.

is the Price-Anderson Act (Public Law 85-256) in the United States. This law limits liability from nuclear accidents for a private company to an amount of $12.6 billion (as of 2011), even when the assets of the company far exceed the social cost.

Proposition 5

For the case when $\Phi < 0$ and the limited liability firm is given additional limitation of liability in the successful state equal to be a fraction f (0<f<1) of the social cost C_H, the subsidy $\hat{S}$ required is given below:

$$\hat{S} = S^* - (1 - f)C_H.$$

With this subsidy $\hat{S}$, the innovation policy of the limited liability corporation is identical to the socially optimal innovation policy.

Moreover, we have $\hat{S} < S^* < B_H$.

Proof: See Appendix.

Policy Remarks: With an additional limitation of liability for the private firm, the social planner is able to achieve the alignment of innovation policy of the limited liability firm with a smaller subsidy $\hat{S}$ than that would be required for a limited liability firm without this additional limitation of liability. Propositions 4 and 5 highlight the complementary role of legal institutions in incentive alignment by combining them with taxes and subsidies.

Moreover, the social planner can use other legal institutions in the case of high B_H innovations to augment their attractiveness to the private firm, in addition to the limitation of liabilities that we discussed above. Making suitable changes in patent laws, trademark laws, and other property rights regulations can effectively increase H (perhaps at the expense of reducing B_H). This would increase Φ for that innovation and decrease p_L such that the private firm would pursue a more aggressive innovation policy. Examples in the area of pharmaceutical innovations include lengthening patent protection period and weaker pricing regulation of high B_H products.

When $\Phi < 0$, we know that $p_L > p_s$ and the institutions designed by the social planner has to provide additional incentives for the private firm to implement the innovation. When the expected profitability of the innovation is not sufficiently attractive to the private firm, the firm shies away from implementing the innovation. This results in a conservative innovation policy compared to the socially optimal policy. The social planner has another important institutional

mechanism to incentivize the private firm. It can effectively subsidize investments in a variety of ways, such as subsidizing infrastructure development and human capital development. This is a pervasive institutional feature of many emerging economies. It is also found in specific large innovations in infrastructure construction around the world.

In our model, when $\Phi < 0$, $p_L > p_S$. Recall $p_L = \frac{I}{(H - C_H)}$. The design of investment subsidy involves the social planner contributing a fraction α^* of the investment I required at the point of the implementation of the innovation. The fraction α^* is chosen optimally by the social planner such that $p_L(\alpha^*) = \frac{I(1-\alpha^*)}{(H-C_H)}$ is equal to p_s.

Proposition 6

For the case when $\Phi < 0$ we have $p_L > p_s$. A fraction α^* of the required investment I is provided by the social planner at the point of implementing the innovation. When $\alpha^* = \left[1 - \frac{p_S}{p_L}\right]$, the innovation policy of the limited liability corporation is identical to the socially optimal innovation policy.

Proof: See Appendix.

Policy Remarks: In our framework, investment subsidy by the social planner refers to the following institution. The total investment required for the innovation is I dollars. At the point of deciding whether or not to implement the innovation with $\Phi < 0$, the social planner can provide assistance of value α^*I to the private firm such that the remaining required investment is only $(1 - \alpha^*)$I. Here, the social planner is not seeking ownership in the innovation such that it is entitled to $\alpha^*(H - C_H)$ of the profits. In fact, the innovating firm gets to keep the entire profits of $(H - C_H)$. In this respect, the institutional arrangement of investment subsidy is different from the state owned enterprises that are prevalent in many countries, such as China, UAE, Russia, Saudi Arabia, and India. Here are several mechanisms by which the social planner can implement investment subsidy in socially beneficial innovations undertaken by private firms. An important example would be allowing the private firm to access free of charge the proprietary knowledge gained from costly R&D undertaken by government agencies.

A second common example is for the social planner to invest in costly infrastructure development and human capital development that private firms can access in order to reduce the required investment outlay. It should be noted that providing an investment incentive of α^*I

reduces the direct subsidy required to be a fraction of B_H. In cases in which $\Phi < 0$, we have $\alpha^* I < I < B_H$. As in the case of Propositions 5 and 6, the social planner is able to reduce the subsidy required by influencing the investment incentives of the private firm directly.

IV. Legal Systems, Institutional Design and Taxation

We have so far assumed an "idealized legal system" ($\lambda = 1$). In this section, we highlight the role of legal strength in altering the sharing rule between firm owners and other stakeholders. In particular, we analyze the general case of a legal system $\lambda, 0 \leq \lambda \leq 1$ in the embedding economy. Thus, we will characterize the corporate innovation policies and the optimal tax structure as a function of the legal system λ.

A. Social Optimality

Since the social planner seeks to maximize the welfare of all claimants, any payoffs that the non-financial claimants receive through the legal structure are simply transfers and do not affect the optimality of the social planners' problem. The legal structure impacts the social planner's problem only through the corporation's innovation choices which in turn may be influenced by the payoffs to nonfinancial claimholders. Thus, the socially optimal innovation policy is the same as that we derived in Section III.A, and all projects with probability of success, $p > p_S$, should be accepted where p_S is given by the following equality.

$$p_s\left(H - C_H + B_H\right) - \left(1 - p_s\right) C_L = I$$

$$p_s = \frac{C_L + I}{H - C_H + B_H + C_L} \qquad \textbf{(6)}$$

B. Limited Liability

We now consider the innovation policy of a corporation with limited liability. The owners of a limited liability corporation face the prospect of gaining $(H - C_H\lambda)$ in case of a successful innovation. However, the owners of a limited liability corporation can walk away from any claims by non-financial claimants in case of innovation failure. Therefore, the limited liability corporation chooses to innovate whenever the success probability $p\left(H - C_H\lambda\right) > I$. Therefore, the limited liability corporation implements all innovations with success probability $p > p_L\left(\lambda\right)$, where

$$p_L(\lambda) = \frac{I}{H - C_H\lambda} \quad \textbf{(7)}$$

The analysis of the innovation policy of the limited liability firm is parallel to that in Section III.C. The only generalization is that the legal liability of the private firm is λC_H in the success state and λC_L in the failure state of the innovation. The value of limited liability to a private firm in a weak legal regime would only be a fraction λ of its value in a strong legal regime. This consideration will affect the interaction of limited liability with corporate taxation in affecting the innovation incentives of the private firm.

C. Design of Corporate Taxation

We now proceed to examine the role of law in the design of corporate tax and the equilibrium social impact of corporations. Firm owners benefit from limited liability as it allows them to walk away from the social costs they impose in excess of the corporation cash flows (corresponding to the low state in the model considered). However, in the presence of corporate taxation, this benefit comes at a price. In a regime with legal strength λ and corporate tax T, the owners of a limited liability corporation receive $(H - \lambda C_H)(1 - T)$ when the innovation succeeds and 0 in the low state. Therefore, the limited liability corporation chooses to innovate whenever the success probability $p(H - \lambda C_H)(1 - T) > I$. Thus, the limited liability corporation implements all innovations with success probability $p > p_T(\lambda)$, where

$$p_T(\lambda) = \frac{I}{(H - \lambda C_H)(1 - T)} \quad \textbf{(8)}$$

As the strength of the legal regime increases, the threat of being held responsible for negative externalities increases. Limited liability, thus, provides greater benefits now, and consequently corporations are willing to pay a higher tax for limited liability.

The optimal tax rate would be able to induce the limited liability firm to innovate according to the socially optimal innovation policy given by equation (6) (i.e., align the innovation policy of the limited liability firm's innovation policy with the socially optimal innovation policy).

Proposition 7

The optimal corporate tax rate $T_s(\lambda)$ is the tax rate that aligns private innovation policy to be at the socially optimal level. It depends on λ, the strength of the legal regime, and is characterized

by:

$$T_S(\lambda) = 1 - \frac{p_L(\lambda)}{p_S} = 1 - \frac{I(H-C_H+B_H+C_L)}{(H-C_H\lambda)(I+C_L)} \quad \textbf{(9)}$$

Proof: See Appendix.

Policy Implications: Based on Proposition 2, we know that in the absence of taxes, the limited liability firm in each country i innovates more relative to the socially optimal level, i.e., $p_L < p_S$. In the general case of a legal system $\lambda, 0 < \lambda < 1$, by comparing equations (7) and (3), it is easy to see that $p_L(\lambda) < p_L$. Hence, it follows that $p_L(\lambda) < p_S$. Furthermore, since $p_L(\lambda) > 0$ and $p_S > 0$, it is easy to see based on Proposition 7 that $T_S(\lambda) > 0$ and $T_S(\lambda) < 1$. The proposition above states that the tax rate can be set to the socially desirable tax rate and corporations with limited liability innovate at the socially optimal levels.

Following Proposition 8, it is useful to note an important implication of our framework for which we provide some supporting empirical evidence in Section V.

Proposition 8 *The socially optimal corporate tax rate $T_s(\lambda)$, that induces the limited liability firm to innovate according to the socially optimal innovation policy, is a decreasing function of the legal strength in that country, λ.*

Proof: See Appendix.

The socially optimal tax rate $T_s(\lambda)$, that would induce the socially optimal innovation level, is decreasing with the legal strength. This result follows from the ability of the legal regime to hold the firm responsible for negative externalities in the good state. In other words, law and taxes act as potential substitute instruments for the social planner. In other words, the tax penalty that needs to be imposed on the limited liability firms to curb their excessive innovation (compared to the socially optimal benchmark) is smaller in a stronger (higher λ) legal system.

Proposition 9 *Given the socially optimal tax rate $T_s(\lambda)$, firms would choose the limited liability organizational form to maximize their after-tax firm value anticipating that they would subsequently implement the socially optimal innovation policy.*

Proof: See Appendix.

Thus far, we have focused on the institutional dimensions, such as taxation and legal regimes, across countries and how that might affect innovation policies in their respective countries. We

next build on our framework to draw implications for firm innovation behavior across national boundaries. In addition to MNC strategies taking advantage of differences in taxation and legal regimes, we also examine the effect of subsidies and incentives for MNC formation and investment behavior.

D. Implications for Multinational Corporations

Thus far, our analysis has examined representative firms operating in their respective jurisdictions and legal regimes. We have shown that the optimal tax rates, that align private innovation decision with social optimality, vary depending on the quality of legal regimes. In the framework of institutions and innovation that we have presented, we want to explore the likelihood of formation of MNCs with subsidiaries in host countries different from the home country of the MNC.[25]

Let us consider an innovation in the host country that has a high B_H, the nonmonetized social benefit and hence $\Phi < 0$. In this case, we know from Proposition 2 that there will be underinvestment in the innovation even by the limited liability firms in that country. There are several mechanisms the host country social planner can use to encourage innovation in these technologies with a high B_H. Among them are provision of subsidies, limitation of liabilities, and investment subsidies for local private firms in the host country as we discussed in Section III.F.

However, these incentives mechanisms will not be viable if the required technology and/or the organizational, managerial and human capital skills are not yet readily available in the host country economy. In some cases, the required investment capital is in short supply. In this case, the required capital, technology, and management knowledge have to be transferred from abroad (Bawlya, 2006). In this case, the social planner in the host country can provide various investment incentives to the MNC which has access to the required financial capital, technology and organizational capital (as discussed in Section III.F and propositions 4, 5 and 6). These incentives can take several forms, such as, subsidizing infrastructure, subsidizing programs for development of requisite skills in the host country (e.g., see Liu (2008), providing regulatory concessions and various tax incentives to a multinational firm.[26] As a result, the MNC can expedite the pace of innovation in

[25] For a survey of the literature on MNCs using a broader perspective, see Beugelsdijk and Mudambi (2013). For the role of MNCs in the global diversification, see Gande, Schenzler and Senbet (2009). For additional motivations underlying MNC strategies, see, Buckley and Casson (1998), Dunning and Lundan (2008), and Rugman and Verbeke (2003).

[26] Moreover, Ferdausy and Rahman (2009) provide other examples of incentives directly or indirectly provided by the host country.

the host country consistent with the objectives of the social planner. It can also create other positive externalities, such as employment creation and growth.

Even though, the host country implements incentive schemes to attract the MNC to invest and innovate in the host country, it should be noted that it may not guarantee the creation of positive externalities as expected (see, Narula, 2002). The superior technology of the MNC may not always create the full extent of the nonmonetized social benefit B_H which may require a positive spillover effect (see, Malik, Rehman, Ashraf and Abbas, 2012). The ability of the host country to capitalize the full extent of the positive externality may depend on its "absorptive capacity", a concept developed and advocated by Cohen and Leventhal (1990). Absorptive capacity represents the ability of the host country to recognize the value of newly acquired technology and knowledge and its ability to assimilate such knowledge in the innovative activity of the host country.

So far we have discussed the bright side of MNCs. However, there is a dark side to the MNCs. Even when $\Phi > 0$ and the host country does not provide subsidies and incentives, the MNC might find it attractive to set up subsidiaries in host countries that have desirable institutional structures. For example, suppose the host country has a lower tax rate than the home country. In this case, the MNC can engage in a variety of ways to minimize its tax burden in the home country.[27] Through various transfer pricing and profit shifting arrangements, the MNC is able to take profits and realize its taxable income in a low-tax jurisdiction. It can also move highly profitable innovative activity abroad to lower tax countries.

In addition to tax arbitrage, the MNC can also arbitrage differences in legal institutions between the home country and the host country to its advantage. For example, assume that the MNC is located in a country with a strong legal system, say $\lambda = 1$. The host country has a weak legal system, say $\lambda = 0.2$. In this case, by using appropriate inter-jurisdictional litigation strategies, the MNC may be able to limit its legal liability to $0.2C_H$ instead of C_H. This may also provide an additional incentive for the MNC to move part of its operations to the host country. In addition, since the MNC

[27] The newly enacted 2017 Tax Cuts and Jobs Act (TJCA) ignores the social consequences of externalities by MNCs and focuses on tax competitiveness. It is the most generous corporate tax reform in generations; it reduces the corporate tax rate from 35 to 21 percent. There is evidence that MNCs have already began engaging in tax minimization strategies. In particular, our framework provides an explanation for some of the tax strategies implemented by MNCs to overcome the constraints of the institutional design (e.g., Albertus, Glover and Levine (2019) study how a change from a world-wide to a territorial tax system enacted under TCJA affects the incentives for U.S. multinationals to invest abroad). This idea has interesting policy implications for the regulation of domestic firms and MNCs.

is only held accountable for 20% of the social cost C_H, it may overinvest in projects that produce excessive social costs in the host economy (e.g., environmental pollution) and in activities characterized by lax regulation and weak labor laws.

In our framework, the institutional design implemented by the social planner in country i becomes less effective due to tax avoiding investment strategies unless counter-acting policies are implemented. The resulting implication is that governments should pro-actively close such loopholes. Residually, this calls for increasing the statutory tax rate, such that even after implementing its tax minimizing strategies, the MNC does pay an effective tax rate that equals $T_s(\lambda)$ as specified in Proposition 7.

V. Legal Systems and Corporate Taxes: Cross-Country Empirical Evidence

In this section, we use archival data from 63 countries over 2003-2018 to provide cross-country evidence relating the corporate tax rates to the strength of the legal system. One of our central predictions is the negative relationship between the strength of the legal systems and the corporate tax rates across national boundaries (see Proposition 8).

A. Data and Variables

The primary data for our empirical analysis is from the World Business Environment Survey (WBES) conducted by the World Bank from 63 countries (see Djankov, La Porta, Lopez-de-Silanes and Shleifer (2003)). [28] We also use the KPMG corporate tax database[29], the World Bank's World Development Indicators (WDI) database, the International Monetary Fund (IMF)'s World Economic Outlook (WEO) database, and the Global Innovation Index database. For robustness checks, we have been able to secure another data source (with some time variation) from another World Bank survey conducted in multiple years on measures of legal effectiveness that includes our original set of countries.

[28] In conducting the above empirical analysis, we have implicitly assumed that the strength of the legal system is exogenous. Our rationale is built on the foundation provided by La Porta et al. (1997, 1998) who had argued that legal traditions were typically introduced into various countries through conquest and colonization and, as such, were largely exogenous. In other words, while it is conceivable that countries may be able to make changes to their legal systems, we view that such a change in the strength of the legal system would be relatively slow, and hence the legal strength is likely to be largely exogenous in the short-run.

[29] https://home.kpmg/vg/en/home/services/tax1/tax-tools-and-resources/tax-rates-online/corporate-tax-rates-table.html

To measure the strength of the legal system, we utilize four different measures of judicial efficiency in resolving business disputes, especially in the absence of formal contracts. We use them to proxy for the ease with which non-financial stakeholders can resort to the legal channel for any negative externalities imposed by a corporation on them.

The *first* measure captures the extent to which the country's legal system is honest and uncorrupt in resolving business disputes *(variable: hon_unc)*. The *second* measure captures how affordable the legal system is in resolving business disputes *(variable: affordable)*. The *third* measure deals with whether the court system is consistent in resolving business disputes (*variable: consistent*). The *fourth* measure assesses the extent of public confidence in the legal system *(variable: confidence*). In particular, this measure is intended to capture the extent to which the country's legal system will uphold contracts and property rights in a business dispute.

These four measures are based on the World Business Environment Survey (WBES) conducted by the World Bank, where questionnaires were answered by managers of small firms (below 50 employees) in these countries. We normalize each of these measures to derive a measure between 0 and 1, and then create an index (*Legal*) that averages these four measures (legal strength) so that it is also between 0 and 1. Our evidence is based on the sign and magnitude of the coefficient of *Legal* in an ordinary least squares regression in equation (10) described below.

We utilize corporate tax information for the sample of 165 countries from the KPMG database.[30] The tax rates are from the KPMG's website and their tax rates are checked regularly by KPMG member firms. Their corporate tax rate data are available on an annual basis starting from 2003. The sample period for our analysis is 2003-2018. See https://home.kpmg/vg/en/home/services/tax1/tax-tools-and-resources/tax-rates-online.html for details. We run the following regression:

$$Corporate\ Tax\ Rate_{i,t} = \alpha + \beta Legal_{i,t} + \gamma X_{i,t} + \epsilon, \quad \textbf{(10)}$$

where *Legal* measures strength of the legal system as described above, and $X_{i.t}$ refers to the following control variables: (a) *Lagged Ln (GDP)*: Lagged value of natural log of a country's Gross Domestic Product (GDP), measured in U.S. dollars from the WDI database, (b) *Lagged GDP Growth Rate*, measured as a percent from the WDI database, (c) *Lagged Debt/GDP*, government gross debt as a

[30] While we use an effective tax rate in our model, due to data limitations, we use the statutory rates as a proxy for effective tax rates in our empirical analysis in this study.

percentage of GDP (see, Gan and Qiu, 2019) from the WEO database, and (e) *Year*: to capture any time trend. Later we perform robustness checks through several variations of equation (10).[31]

Our sample consists of 63 countries for which we have data for the variables used in our regressions described above. The list of countries is shown in Table 3. As can be seen, this list is a diversified group of countries from all parts of the world.

<Table 3 here>

B. Empirical Results

Table 4 provides summary statistics for the variables used in the regressions described in the next few paragraphs. The dependent variable in our regressions, namely the corporate tax rate varies between 9% and 42%, with an average of 26.61%. The inference variable in our regressions, *Legal* ranges between 0.08 and 0.96, with an average of 0.41. The control variables used in our regressions are described above.

<Table 4 here>

The results for our baseline specification as per equation (10) described above are shown in Column 1 of Table 5. We find strong evidence consistent with one of our central results (Proposition 8) and our framework. In particular, we find that a stronger legal system is associated with a lower corporate tax rate, as evidenced by the negative sign of the coefficient on *Legal*, and this effect is statistically significant at the 1% level. In addition, the coefficients on the control variables show that higher income countries, fast-growing countries, as well as countries with higher levels of government debt, are all associated with higher corporate tax rates. Interestingly, there has been a secular downtrend in the corporate tax rates as evidenced by the negative coefficient of the time-trend (i.e., *Year*) variable.

<Table 5 here>

C. Robustness Checks

[31] As an alternative to the government debt to GDP, we also considered a gross credit to GDP variable as a control variable. In particular, we used "Domestic credit to private sector (% of GDP)" from the World Development Indicators (WDI) database in lieu of the government debt to GDP variable in the regressions we run in this paper. The results are qualitatively unchanged, i.e., the *Legal* coefficient continues to be negative and statistically significant in all the regressions. The size of the sample was slightly smaller – the number of observations dropped from 861 to 820. These results are available from the authors upon request.

In this section, we examine the robustness of our baseline results. *First*, since statutory corporate taxes rates change rather infrequently, and to control for a potential endogeneity between statutory corporate tax rates and strength of the legal system, we run the regressions using a fixed effects model. Column 2 of Table 5 replaces the *Year* variable in Column 1 of Table 5 and runs the regression with year fixed effects. In Column 3 of Table 5, we augment Column 1 of Table 5 with country fixed effects.[32] Inclusion of the country fixed effects in the regression significantly increases the explanatory power (i.e., an increase in the adjusted r-square from 0.135 in Column 1 of Table 5 to 0.872 in Column 3 of Table 5).

In Column 4 of Table 5, we replace the *Year* variable in Column 1 of Table 5 and run the regression with both year and country fixed effects. The results in Column 4 of Table 5 are almost identical to the results in Column 3 of Table 5, suggesting that the results are invariant to inclusion of a time-trend variable or year fixed effects. Overall, the evidence from columns 2-4 of Table 5 shows that the *Legal* variable continues to have a negative coefficient that is statistically significant at the 1% level in each of these specifications. This evidence provides support for a stronger legal system to be associated with a lower corporate tax rate as predicted by the model in our paper. In regressions that we subsequently run, we will include both year and country fixed effects.

Second, our paper has implications for tax compliance with reference to the strength of the legal system. Tax compliance is a feature of the quality of the legal system, whereby there will be less tax compliance in a weaker legal system. If weaker legal systems have a lower degree of tax compliance, it is possible that we find an inverse relationship between tax rates in general and the strength of the legal system arising from social objectives with a target revenue base. However, in our model, the corporate tax rate (imposed only on the limited liability firm) is specifically designed to align the innovation incentives of the firm with social optimality. In other words, our prediction is on the corporate tax rate that is designed to curb the innovation aggressiveness of the limited liability firm.

We note that our *Legal* variable already includes a component that has an attribute that is related to tax compliance. We conjecture, based on the tax morale and trust literature, that the extent to which the legal system is honest and uncorrupt (*hon_unc*) is directly related to the trust in the legal system.

[32] In our model, we focus on the incentive effect of corporate taxation on the innovation policy of the limited liability firm. Features of the national tax code, such as depreciation tax shields, expensing R&D, and investment tax credits exist in our sample. We also find heterogeneity with respect to these tax provisions among the different countries. Our inclusion of country fixed effects will likely capture such cross-country differences in the tax code. We do find the evidence to be in support of the main predictions of our model.

For instance, Alm and Torgler (2006) show that a higher level of trust leads to a higher tax morale in that country (this in turn could result in lower tax avoidance, and hence greater tax compliance). In particular, they show that an increase in trust in the legal system or in parliament by one unit raises the share of persons indicating the highest tax morale by more than 3 percentage points. We test this by running the regression in Column 4 of Table 5 by replacing *Legal* with *hon_unc* – see column (1) of Table 6. The coefficient on *hon_unc* is negative and statistically significant at the 1% level.

For completeness, we investigate whether the remaining three components have a similar negative relationship with the corporate tax rates, and hence whether they are important contributors to the strong negative relationship between corporate tax rates and the *Legal* variable. That is, we replace the *Legal* variable in Column 4 of Table 5 with each of these components separately. The results are tabulated in Table 6 columns (2) through (4). All components show a negative relationship with corporate tax rates, with two of the three variables statistically significant at the 1% level. Overall, Table 6 shows that all components are important and meaningful contributors of the *Legal* variable.

<Table 6 here>

Third, we investigate how the negative relation between tax rates and legal system varies relative to innovative investment (as compared to old and tried investment). To proxy for the extent of innovative investment at the country-level, we use the most recently available data on Global Innovation Index (https://www.globalinnovationindex.org/Home). The Global Innovation Index is the result of a collaboration between Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO) as co-publishers, and their Knowledge Partners. According to this database, countries are classified into three separate categories: Innovation performance above expectations for level of development (*Higher Innovation*), Innovation performance in line with expectations for level of development (*Medium Innovation*) and Innovation performance below expectations (*Lower Innovation*). To analyze whether the negative relation between tax rates and legal system varies relative to innovative investment (relative to old and tried investment), we augment our baseline regression in Table 5 (i.e., column 4 that includes country and year fixed effects) with an additional indicator variables for *Higher Innovation* and *Medium Innovation*.[33] The results, tabulated in Table 7 show that the negative relation between tax rates and legal system continues to hold even after we control for country-level indicators of innovative investment.

[33] We drop the *Lower Innovation* indicator variable due to linear dependence, i.e., the three indicator variables relating to innovation add upto 1.

<Table 7 here>

Finally, since our sample period overlaps with the global financial crisis, a likely concern is that while the financial crisis may have had its most adverse effect during 2007 and 2008, its effects have lingered well beyond 2007-2008. To address this concern, we augment our baseline regression in Table 5 (i.e., Column 4 that includes country and year fixed effects) with an additional control variables, namely *Post Fin Crisis* that takes a value of 1 in 2007 and beyond, and 0 otherwise, and an interactive variable *Legal*Post Fin Crisis* based on *Legal* and *Post Fin Crisis*. The results, shown in Table 8 are qualitatively unchanged. The coefficient on *Legal* continues to be negative and statistically significant at the 1% level.

<Table 8 here>

There is a possibility of correlation between the country fixed effects and the legal variable. We examine whether such a correlation exists in our data. We don't find significant correlation between the country fixed effects and the legal variable.[34] Nevertheless, for additional robustness, we also run our specification in equation (10) in first differences. The data on legal variable that we have used in Table 5 (from the World Business Environment Survey (WBES) conducted by the World Bank from 63 countries. This data does not have time variation since it is based on a one-time survey conducted in 1999. However, we have been able to secure another data source (with some time variation) from another World Bank survey conducted in multiple years on a measure of legal effectiveness that includes most of our original 63 countries in Table 5. See https://www.enterprisesurveys.org/en/data for details.

In this database, we select two variables that are related to the strength of the legal regime for which we have time series data from 2006-2018. The first variable is called *Business Licensing and Permits* (BLP) refers to the percent of firms identifying business licensing and permits as their biggest obstacle to the current operations of their establishments. It has been documented that countries in which it is difficult to procure a business license or a permit usually have weak institutions, and correspondingly a weak and inefficient legal system. We construct a complement of this variable (1 – BLP) such that it corresponds to λ the variable denoting the strength of the legal system in our framework. A second variable in this survey that we use is called *Labor Regulations* (LR). This

[34] Only two of 63 country fixed effects have a statistically significant correlation with the legal variable at the 5% level of significance, and the average p-value for whether a correlation between a country fixed effects and the legal variable is statistically significant is 0.49.

variable refers to percent of firms identifying labor regulation as their biggest obstacle with the current operations of their establishments.[35] As before, excessive labor protection, e.g., in socialist countries, is often accompanied by weak legal systems. We construct a complement of this variable (1-LR) such that it proxies for λ the variable standing for the strength of the legal system in our framework.

Recall that our original legal variable (*Legal*) was constructed from a combination of four legal variables, namely *hon_unc*, *affordable*, *consistent* and *confidence*. Similarly, we combine both of our legal variables, namely (1-BLP) and (1-LR) to construct our new legal variable, *Legal2* which now has variation across countries and across years. Using this variable, *Legal2*, we now run the specification in equation (10) replacing *Legal* with *Legal2*. The results are shown in Table 9. Similar to our results in Table 5, the coefficient of *Legal2* is negative and statistically significant at the 1% level.

<Table 9 here>

We next run first differences in corporate tax rates on first differences in *Legal2* and first differences in the control variables as in equation (10).[36] The results are shown in Table 10. As anticipated, we find a negative relationship between differences in tax rates and differences in legal quality. The coefficient of delta *Legal2* is negative and statistically significant at the 5% level. These results augment our results on the negative relationship between tax rates and legal strength based on our previous World Bank data.

<Table 10 here>

VI. Extensions

In this section, we discuss some issues related to the central analysis of the paper that have been ignored in the basic models thus far. We begin with a discussion of the consequences of relaxing the risk-neutrality assumption. We then investigate the impact of personal wealth on our results.

A. Risk Aversion

[35] Maggioni, Santangelo & Koymen-Ozer (2019) investigate the role of local labor regulation on MNCs location decisions across different sectors and sub-national regions within a developing country.

[36] We cumulate the first differences over the entire sample period since changes are rather infrequent: most countries have two or three surveys conducted during the entire sample period.

In this subsection we examine the role of risk aversion. For example, corporate investor risk aversion (i.e., a higher discount rate for the firm than the social planner) raises the cut-off probability at which the corporation will invest in the innovation. This is because investor risk aversion would reduce the present value of the net cash flows to the firm in the success state.

Risk neutrality and a zero risk-free rate are assumed for simplicity and to abstract from discounting. We use this commonly made assumption to focus on incentive conflicts between social and private optimality. However, in this extension, we would like to discuss the consequences of relaxing the risk-neutrality assumption on the part of the investors (equity holders and debt holders who are capital suppliers to the firm), the decision-making manager, and the social planner. As to the risk aversion of the investors in the market, the pricing kernel in the underlying well-functioning capital market, and hence the valuation operator would change to reflect the degree of their risk-aversion. Since we are using the market value of the firm as the basis of private optimality, this would only change the computed market value and nothing else of essence. This is also in accord with the foundational corporate finance paradigm which is predicated on shareholder wealth maximization as an objective.

Since the above valuation paradigm takes into account that shareholders are well-diversified while the decision-making manager may not be, the risk-aversion of the manager may turn out to be more important. In other words, a risk-averse manager (i.e., CEO) may take into account her under-diversified human capital risk in the innovation decision. Consequently, the risk-averse manager will take on the innovative project at a higher cut-off probability relative to the private optimality based on risk-neutral and/or value-maximizing shareholders. This problem can now be cast in the form of an agency cost resulting from the difference in risk-aversion of the manager vis-à-vis the well diversified shareholders. There are well-known solutions to this managerial risk-aversion problem using appropriate CEO compensation structures or corporate governance mechanisms. For example, the incentive of the risk-averse manager can be convexified through the use of restricted stocks, and executive stock options (See John and John (1993) and Jensen and Murphy (1990)). Finally, the social planner could be risk-averse with respect to the high social cost that depend on the idiosyncratic outcomes of innovation in the private sector. Conceptually, this would mean that the social objective function would use the expected utility rather than the expected value of the social cost outcomes.

B. Personal Wealth

In this subsection we highlight the impact of the owners' wealth on the benefits and costs of limited liability. Wealth constraints at the corporation owner level can reduce the effective liability of unlimited liability corporations. For example, corporate owners who have no personal wealth are automatically liable for only the aggregate corporate cash flows. More specifically, if the owners combined personal W is such that:

$$0 < W < C_L \lambda, \qquad \textbf{(11)}$$

the costs that the unlimited liability corporation internalizes is now not $C_L \lambda$ but only W. [37]

Therefore, the benefits of opting for limited liability decrease as corporate owners are less wealthy. Effectively then, deficiencies in personal wealth limit the legal liability and reduce the benefits of corporate limited liability.

VII. Conclusions

When private firms impose positive and negative externalities on society at large, the legal structure and the liability structure implied by the organizational form alter the sharing rule between the owners of a corporation and the non-financial claimants. Whether or not the private firm innovates more than the socially optimal level depends on several factors that we analyze, most importantly profitability of a successful innovation, its negative externalities, and its non-monetized social benefits.

It turns out that under certain conditions (i.e., $\phi > 0$), limited liability corporations innovate excessively. In this case, we show that corporate taxation can play an important role in aligning the private innovation policy with socially optimal level. Thus, taxes can be viewed as the price to be paid by corporations for limited liability. Corporations trade off the benefits of limited liability with the potential costs of corporate taxes. This, in turn, provides a rationale for the existence of entity-level double taxation (corporate taxes). Such a rationale was part of the legislative debate over the introduction of the tax in 1909.[38]

[37] The use of non-pecuniary forms of punishment, such as imprisonment, to hold the firm owners responsible would however, reduce the importance of personal wealth.

[38] As Avi-Yonah (2004) points out, Senator Cummins, an opponent of the proposed tax stated that: *If this tax is intended not to create a revenue, but if it is intended for the purpose of supervising and regulating corporations, that*

Our solution has implications for the debate on the mechanisms used for the resolution of the global financial crisis. The role of taxation can be viewed in the same manner as the government taking claims in the private firms. The government, in exchange for bailing out failing financial institutions, is known to have taken equity-like claims, such as preferred stock and warrants, as a mechanism for repaying the tax payer. In this respect, we note that corporate taxation plays two roles. First, corporate taxation of cash flows in profitable states works in a fashion similar to the government holding non-voting equity or warrants in the private firms in a setting of *ex post* resolution of crisis. Second, corporate taxation has *ex ante* incentive effects, since as we show, it can play a role in realigning the innovation incentives of private firms with the goals of the government. Thus, incentives are realigned in the right way without mandating specific innovation levels through invasive regulation.

On the other hand, successful innovations can bring large non-monetized benefits to the society at large. We provide several examples in the paper, including innovations curing cataclysmic diseases, such as cancer, coronavirus (COVID-19), and river blindness. In this case (i.e., $\phi < 0$), the private firms innovate less than the socially optimal level. Our analysis of the relevant institutional mechanisms include subsidies, limitation of liabilities, and investment subsidies.

Our framework provides an explanation for the MNC strategies that arbitrage differences in legal liability structures and corporate taxes across national boundaries. MNCs may use these strategies to evade some of the constraints imposed by corporate taxes and legal liabilities in their home countries. This corresponds to our institutional mechanisms for the case when $\phi > 0$. On the other hand, MNCs can also provide positive externalities, which corresponds to our analysis when $\phi < 0$. In this case, the host country's social planner provides innovation incentives for MNCs when the required technology or capacity is not available locally. Host countries will provide various subsidies and investment incentives to make it attractive for MNCs to locate in the host country. Such innovation incentives are part of our framework and the associated institutional mechanisms for incentivizing innovation in the host country.

In our paper, we show that countries with poor legal structures, on an average, have higher

is quite a different proposition. I should like to know before we get through with this whether it is proposed through this tax to impose supervisory regulation upon all the corporations of the United States...

corporate tax rates. [39] This prediction of our model is also supported by our empirical analysis in Section V. We conduct several additional tests using different proxies for the strength of the legal system, and show that our main result is robust to the legal proxies that we use. Our relationship is also robust to inclusion of country and year fixed effects, and to the analysis of first-differences in the relevant variables. In particular, we conduct our empirical analysis using two different databases and document: the negative relationship between tax rates and our proxies of legal strength.

The rationale for taxation in this paper would imply a stand against the repeal of double taxation through corporations. In addition, this view of taxation presents an interesting ingredient in analyzing social implications when countries compete for innovation and investment based on corporate tax incentives. Recently, the US Government took an important step towards improving US tax competitiveness. The Tax Cuts and Jobs Act was signed into law by President Donald J. Trump on Dec. 22, 2017. A major element of the tax reform include cutting the highest marginal corporate income tax rate from 35% down to 21%. An interesting question to analyze is the effect of corporate taxes on corporate innovation. Moreover, a related research question is the social impact of tax competition between countries that differ in legal strength, e.g., the United States vis-à-vis some of the European nations which have not yet lowered the corporate tax rate.

In the main model of this paper we have assumed that the strength of the legal system (λ) in an economy is exogenously given, and the optimal institutions are designed using corporate taxation and organizational forms as the ingredients. Going beyond the conventional liability structures (limited and unlimited liability), we analyze the general liability structures in which firms are only held accountable for the part of the social costs that are assigned to them by the legal system. This opens up other interesting possibilities in which the social planner can discriminate among industries based on the positive externalities that they generate. Such differential corporate tax incentives and limitation of liability already exist in practice. For instance, the Price-Anderson Act (Public Law 85-256) limits liability from nuclear accidents. In recent times, the current administration in the United States has embarked on providing additional support to certain industries, such as coal mining, steel etc. through rolling back of regulation and imposition of tariffs. A current example is the stimulus

[39] In this paper, we do not examine how low corporate taxes may also provide incentives for multinationals to shift their realization of profits, cash flows or production across the world. See Akamah, Hope, and Thomas (2018) who present evidence that multinational companies with operations in tax havens tend to reduce the transparency of their tax-avoidance activities by aggregating their geographical disclosures. Ting and Gray (2019) illustrate that the tax avoidance motive of multinational firms can incentivize managers to locate profits in low-tax jurisdictions without affecting the locations of their real operations.

package of $2 trillion related to the coronavirus (COVID-19) that includes generous corporate subsidies.

In addition to providing a menu of liability structures, the social planner can also optimally choose, as an additional instrument, the strength of the legal enforcement (λ). Although our framework is general enough to allow for an analysis of institutional design in which λ is endogenously chosen by the social planner, such a task is left for future research.

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Appendix: Proofs

Proposition 1

Proof is provided below the Proposition 1, see Section III, page 11.

Proposition 2

A straightforward comparison of the relevant cut-off probabilities in equations (1) and (3), implies the result. We also obtain $p_L < p_s$ is equivalent to $\Phi > 0$.

Proposition 3

Equating p_T in equation (5) to p_S in equation (1) and simplifying yields the given expression for the optimal tax rate T^*. The comparative statics results with respect to C_L and p_L follow readily from the form of the expression for T^*. For $\Phi > 0$, Φ is decreasing in B_H and hence T^* is decreasing in B_H.

Proposition 4

Equating p_L in equation (3) to p_S in equation (1) and simplifying yields the expression for the optimal subsidy S^* given in Proposition 4. Rearranging, S^* can also be written as

$$S^* = \frac{\left[B_H - \frac{C_L(H - C_H - I)}{I}\right]}{\left[\frac{C_L}{I} + 1\right]}.$$

The numerator of S^* is smaller than B_H and the denominator is greater than 1. Therefore S^* is strictly less than B_H.

Proposition 5

In addition to the limitation of liability in the state of failure of the innovation, there is an additional limitation of liability such that the liability in the success state of the innovation is only fC_H, which is equivalent to a subsidy of $(1\text{-}f)C_H$. Therefore, the optimal subsidy $\hat{S}$ now required is lower than S^* by an amount $(1\text{-}f)C_H$. The inequalities follow in a straight forward manner.

Proposition 6

Substitute $\alpha^* = \left[1 - \frac{p_S}{p_L}\right]$ into the innovation policy of the limited liability firm to obtain

$p_L(\alpha^*) = \frac{I(1-\alpha^*)}{(H-C_H)}$ = p_S. The innovation policy of the limited liability firm is equal to the socially optimal level.

Proposition 7

A straightforward comparison of the relevant cut-off probabilities in equations (6) and (8), and rearranging terms implies the result.

Proposition 8

Equation (9) shows directly that the socially optimal tax rate is decreasing in λ. An alternate way of looking at this is that the socially optimal tax rate T_s (λ) is an increasing function of (p_S - p_L), the difference between the socially optimal innovation policy and the innovation policy of the limited liability corporation. Since p_S is independent of λ and p_L is increasing in λ, (p_S - p_L) is decreasing in λ. Therefore, the socially optimal tax rate T_s (λ) is decreasing in λ.

Proposition 9

Given the tax rate T_s (λ), corporations in the legal system λ will find that their firm value as a limited liability firm (implementing the privately optimal innovation policy) will exceed their firm value as an unlimited liability firm (implementing *its* privately optimal innovation policy). Hence, the privately optimal organizational form turns out to be the limited liability organizational form. Of course, the subsequent privately optimal innovation policy will coincide with the socially optimal innovation policy (by design).

TABLE 1
Numerical Calibration

For a given set of values of I=100, C_H = 100, C_L=100, we vary B_H on the vertical axis from 0 to 1000 (in increments of 100), and we vary H on the horizontal axis from 200 to 1200 (also in increments of 100) separately. We then calculate the two terms of the wedge Φ where Term 1 = $\frac{(H-C_H-I)}{I}$ and Term 2 = $\frac{B_H}{C_L}$. The highlighted cells in the matrix below denote $\Phi > 0$, i.e., Term 1 > Term 2.

	200	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
0	(0,0)	(1,0)	(2,0)	(3,0)	(4,0)	(5,0)	(6,0)	(7,0)	(8,0)	(9,0)	(10,0)
100	(0,1)	(1,1)	(2,1)	(3,1)	(4,1)	(5,1)	(6,1)	(7,1)	(8,1)	(9,1)	(10,1)
200	(0,2)	(1,2)	(2,2)	(3,2)	(4,2)	(5,2)	(6,2)	(7,2)	(8,2)	(9,2)	(10,2)
300	(0,3)	(1,3)	(2,3)	(3,3)	(4,3)	(5,3)	(6,3)	(7,3)	(8,3)	(9,3)	(10,3)
400	(0,4)	(1,4)	(2,4)	(3,4)	(4,4)	(5,4)	(6,4)	(7,4)	(8,4)	(9,4)	(10,4)
500	(0,5)	(1,5)	(2,5)	(3,5)	(4,5)	(5,5)	(6,5)	(7,5)	(8,5)	(9,5)	(10,5)
600	(0,6)	(1,6)	(2,6)	(3,6)	(4,6)	(5,6)	(6,6)	(7,6)	(8,6)	(9,6)	(10,6)
700	(0,7)	(1,7)	(2,7)	(3,7)	(4,7)	(5,7)	(6,7)	(7,7)	(8,7)	(9,7)	(10,7)
800	(0,8)	(1,8)	(2,8)	(3,8)	(4,8)	(5,8)	(6,8)	(7,8)	(8,8)	(9,8)	(10,8)
900	(0,9)	(1,9)	(2,9)	(3,9)	(4,9)	(5,9)	(6,9)	(7,9)	(8,9)	(9,9)	(10,9)
1000	(0,10)	(1,10)	(2,10)	(3,10)	(4,10)	(5,10)	(6,10)	(7,10)	(8,10)	(9,10)	(10,10)

TABLE 2
Numerical Calibration
(Social Optimality versus Private Optimality)

For a given set of values of I=100, C_H = 100, C_L=100, we vary B_H on the vertical axis from 0 to 1000 (in increments of 100), and we vary H on the horizontal axis from 200 to 1200 (also in increments of 100) separately. We then calculate and report the socially optimal and privately optimal cut-off probability values p_s and p_L: see equations (1) and (2) in the paper for details. The highlighted cells in the matrix below denote $p_s > p_L$.

	200	300	400	500	600	700	800	900	1000	1100	1200
0	(1,1)	(0.67,0.5)	(0.5,0.33)	(0.4,0.25)	(0.33,0.2)	(0.29,0.17)	(0.25,0.14)	(0.22,0.13)	(0.2,0.11)	(0.18,0.1)	(0.17,0.09)
100	(0.67,1)	(0.5,0.5)	(0.4,0.33)	(0.33,0.25)	(0.29,0.2)	(0.25,0.17)	(0.22,0.14)	(0.2,0.13)	(0.18,0.11)	(0.17,0.1)	(0.15,0.09)
200	(0.5,1)	(0.4,0.5)	(0.33,0.33)	(0.29,0.25)	(0.25,0.2)	(0.22,0.17)	(0.2,0.14)	(0.18,0.13)	(0.17,0.11)	(0.15,0.1)	(0.14,0.09)
300	(0.4,1)	(0.33,0.5)	(0.29,0.33)	(0.25,0.25)	(0.22,0.2)	(0.2,0.17)	(0.18,0.14)	(0.17,0.13)	(0.15,0.11)	(0.14,0.1)	(0.13,0.09)
400	(0.33,1)	(0.29,0.5)	(0.25,0.33)	(0.22,0.25)	(0.2,0.2)	(0.18,0.17)	(0.17,0.14)	(0.15,0.13)	(0.14,0.11)	(0.13,0.1)	(0.13,0.09)
500	(0.29,1)	(0.25,0.5)	(0.22,0.33)	(0.2,0.25)	(0.18,0.2)	(0.17,0.17)	(0.15,0.14)	(0.14,0.13)	(0.13,0.11)	(0.13,0.1)	(0.12,0.09)
600	(0.25,1)	(0.22,0.5)	(0.2,0.33)	(0.18,0.25)	(0.17,0.2)	(0.15,0.17)	(0.14,0.14)	(0.13,0.13)	(0.13,0.11)	(0.12,0.1)	(0.11,0.09)
700	(0.22,1)	(0.2,0.5)	(0.18,0.33)	(0.17,0.25)	(0.15,0.2)	(0.14,0.17)	(0.13,0.14)	(0.13,0.13)	(0.12,0.11)	(0.11,0.1)	(0.11,0.09)
800	(0.2,1)	(0.18,0.5)	(0.17,0.33)	(0.15,0.25)	(0.14,0.2)	(0.13,0.17)	(0.13,0.14)	(0.12,0.13)	(0.11,0.11)	(0.11,0.1)	(0.1,0.09)
900	(0.18,1)	(0.17,0.5)	(0.15,0.33)	(0.14,0.25)	(0.13,0.2)	(0.13,0.17)	(0.12,0.14)	(0.11,0.13)	(0.11,0.11)	(0.1,0.1)	(0.1,0.09)
1000	(0.17,1)	(0.15,0.5)	(0.14,0.33)	(0.13,0.25)	(0.13,0.2)	(0.12,0.17)	(0.11,0.14)	(0.11,0.13)	(0.1,0.11)	(0.1,0.1)	(0.09,0.09)

TABLE 3
Sample Countries

This table below lists all the 63 countries included in our sample.

Argentina	Georgia	Poland
Bangladesh	Ghana	Portugal
Bulgaria	Guatemala	Romania
Bolivia	Honduras	Russian Federation
Brazil	Croatia	Senegal
Botswana	Hungary	Singapore
Canada	Indonesia	El Salvador
Chile	India	Slovenia
China	Italy	Sweden
Cote d'Ivoire	Kazakhstan	Thailand
Colombia	Kenya	Trinidad and Tobago
Costa Rica	Lithuania	Tunisia
Czech Republic	Mexico	Turkey
Germany	Malawi	Tanzania
Dominican Republic	Malaysia	Uganda
Ecuador	Namibia	Ukraine
Egypt, Arab Rep.	Nigeria	Uruguay
Spain	Pakistan	United States
Estonia	Panama	Venezuela, RB
France	Peru	South Africa
United Kingdom	Philippines	Zambia

TABLE 4
Summary Statistics

This table reports the summary statistics of the variables used in this study. *Hon_Unc* captures the extent to which the legal system is honest and uncorrupt in resolving business disputes. *Affordable* measures how affordable the legal system is in resolving business disputes. *Consistent* measures the extent to which the country's court system is consistent in resolving business disputes. *Confidence* measures the extent to which the country's legal system will uphold contracts and property rights in a business dispute. The variables are described in more detail in the paper in Section V (pages 29-34).

Variable Name	Obs	Mean	Std. Dev.	Min	Max
Corporate Tax Rate	861	26.61	6.31	9.00	42.00
Legal	861	0.41	0.19	0.08	0.96
Hon_Unc	861	0.39	0.24	0.00	1.00
Affordable	861	0.47	0.22	0.00	1.00
Consistent	861	0.34	0.23	0.00	1.00
Confidence	861	0.42	0.22	0.00	1.00
Lagged Ln (GDP)	861	25.85	1.77	22.21	30.60
Lagged GDP Growth Rate	861	3.89	3.72	-17.67	19.68
Year	861	2011.31	4.31	2004	2018

TABLE 5
Corporate Tax Rate and
Strength of the Legal System

This table reports the coefficient estimates, and the level of statistical significance (***, **, and * denote 1%, 5% and 10% significance level respectively) of an ordinary least squares regression that includes an intercept term, where the dependent variable is the Corporate Tax rate of a country during 2003 thru 2018. The independent variables are described in more detail in the paper in Section V (pages 29-34). The standard errors associated with the t-statistics are adjusted for heteroscedasticity.

	(1)	(2)	(3)	(4)
Legal	-3.324***	-3.322***	-11.814***	-11.814***
	(-3.25)	(-3.25)	(-3.55)	(-4.47)
Lagged Ln (GDP)	0.593***	0.603***	-0.842*	0.023
	(5.19)	(5.17)	(-1.71)	(0.04)
Lagged GDP Growth Rate	0.148***	0.161***	-0.041*	-0.087***
	(2.75)	(2.67)	(-1.96)	(-3.75)
Lagged Debt/GDP	0.047***	0.046***	-0.021***	-0.022***
	(5.98)	(5.80)	(-2.69)	(-2.86)
Year	-0.340***		-0.273***	
	(-7.36)		(-6.15)	
Year Fixed Effects		Included		Included
Country Fixed Effects			Included	Included
Adjusted R-square	0.135	0.123	0.872	0.874
Number of Observations	861	861	861	861

TABLE 6
Corporate Tax Rate and Components of Strength of the Legal System
(includes Year Fixed Effects & Country Fixed Effects)

This table reports the coefficient estimates, and the level of statistical significance (***, **, and * denote 1%, 5% and 10% significance level respectively) of an ordinary least squares regression that includes an intercept term, where the dependent variable is the Corporate Tax rate of a country during 2003 thru 2018. The independent variables are described in more detail in the paper in Section V (pages 29-34). The standard errors associated with the t-statistics are adjusted for heteroscedasticity.

	(1)	(2)	(3)	(4)
Hon_Unc	-17.33***			
	(-4.47)			
Affordable		-9.984		
		(-1.54)		
Consistent			-12.54***	
			(-4.47)	
Confidence				-15.14***
				(-4.47)
Lagged Ln (GDP)	0.0228	0.0228	0.0228	0.0228
	(0.04)	(0.04)	(0.04)	(0.04)
Lagged GDP Growth Rate	-0.0867***	-0.0867***	-0.0867***	-0.0867***
	(-3.75)	(-3.75)	(-3.75)	(-3.75)
Lagged Debt/GDP	-0.0224**	-0.0224**	-0.0224**	-0.0224**
	(-2.86)	(-2.86)	(-2.86)	(-2.86)
Year Fixed Effects	Included	Included	Included	Included
Country Fixed Effects	Included	Included	Included	Included
Adjusted R-square	0.874	0.874	0.874	0.874
Number of Observations	861	861	861	861

TABLE 7
Corporate Tax Rate and the Strength of the Legal System
Controlling for Country-Level Innovation
(includes Year Fixed Effects & Country Fixed Effects)

This table reports the coefficient estimates, and the level of statistical significance (***, **, and * denote 1%, 5% and 10% significance level respectively) of an ordinary least squares regression that includes an intercept term, where the dependent variable is the Corporate Tax rate of a country during 2003 thru 2018. The independent variables are described in more detail in the paper in Section V (pages 29-34). The standard errors associated with the t-statistics are adjusted for heteroscedasticity.

	Corporate Tax Rate (Percent)	
Variable	Coeff.	t -Stat.
Legal	-14.345	-9.42***
Lagged Ln (GDP)	-0.184	-0.32
Lagged GDP Growth Rate	-0.088	-3.73***
Lagged Debt/GDP	-0.025	-3.17***
Higher Innovation	-0.723	-1.16
Medium Innovation	-0.266	-0.37
Year Fixed Effects	Included	
Country Fixed Effects	Included	
Adjusted R-square	0.873	
Number of Observations	861	

TABLE 8
Corporate Tax Rate, Strength of the Legal System and Post Financial Crisis

This table reports the coefficient estimates, and the level of statistical significance (***, **, and * denote 1%, 5% and 10% significance level respectively) of an ordinary least squares regression that includes an intercept term, where the dependent variable is the Corporate Tax rate of a country during 2003 thru 2018. The independent variables are described in more detail in the paper in Section V (pages 29-34). The standard errors associated with the t-statistics are adjusted for heteroscedasticity.

	Corporate Tax Rate (Percent)	
Variable	Coeff.	t -Stat.
Legal	-14.787	-3.68***
Lagged Ln (GDP)	-0.051	-0.09
Lagged GDP Growth Rate	-0.082	-3.59***
Lagged Debt/GDP	-0.022	-2.85***
Post Fin Crisis	-0.057	-0.07
Legal*Post Fin Crisis	-1.890	-1.30
Year Fixed Effects	Included	
Country Fixed Effects	Included	
Adjusted R-square	0.875	
Number of Observations	861	

TABLE 9
Corporate Tax Rate and the Strength of the Legal System
Using an Alternative Database
(includes Year Fixed Effects & Country Fixed Effects)

This table reports the coefficient estimates, and the level of statistical significance (***, **, and * denote 1%, 5% and 10% significance level respectively) of an ordinary least squares regression that includes an intercept term, where the dependent variable is the Corporate Tax rate of a country during 2003 thru 2018. The independent variables are described in more detail in the paper in Section V (pages 29-34). The standard errors associated with the t-statistics are adjusted for heteroscedasticity.

	Corporate Tax Rate (Percent)	
Variable	Coeff.	t -Stat.
Legal2	-25.640	-2.98***
Lagged Ln (GDP)	-1.343	-2.04**
Lagged GDP Growth Rate	-0.044	-1.76*
Lagged Debt/GDP	-0.017	-1.45
Year Fixed Effects	Included	
Country Fixed Effects	Included	
Adjusted R-square	0.932	
Number of Observations	525	

TABLE 10
Corporate Tax Rate and the Strength of the Legal System
Based on First-Differences using an Alternative Database

This table reports the coefficient estimates, and the level of statistical significance (***, **, and * denote 1%, 5% and 10% significance level respectively) of an ordinary least squares regression that includes an intercept term, where the dependent variable is the first difference of the Corporate Tax rate ($\Delta Corporate\ Tax\ Rate$) in the country during 2003 thru 2018. The independent variables are also first differences (i.e., $\Delta Legal2, \Delta Lagged\ Ln(GDP), \Delta Lagged\ GDP\ Growth\ Rate, \Delta Lagged\ Debt/GDP$), as described in more detail in the paper in Section V (pages 29-34). The standard errors associated with the t-statistics are adjusted for heteroscedasticity.

	Corporate Tax Rate (Percent)	
Variable	Coeff.	t -Stat.
ΔLegal2	-82.616	-2.36**
ΔLagged Ln (GDP)	2.788	1.67
ΔLagged GDP Growth Rate	-0.157	-1.18
ΔLagged Debt/GDP	-0.003	-0.15
Adjusted R-square	0.087	
Number of Observations	55	