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How should taxes be designed to encourage entrepreneurship? ☆

Roger Gordon ^{a,*}, Sarada ^b^a UCSD, United States of America^b University of Wisconsin, United States of America

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ABSTRACT

This paper examines how tax policy should be designed to best encourage entrepreneurial activity in start-up firms. We begin by describing several presumed market failures affecting entrepreneurial firms that would lead to an under-provision of entrepreneurial activity: 1) information spillovers from innovations in entrepreneurial firms to other firms, 2) positive externalities to consumers from innovative new products sold by these firms, and 3) lemons problems in the market for both debt and equity issued by these firms. We then analyze the degree to which various tax policy measures can alleviate these failures. A key complication we focus on is the inability of the government to observe which, and the degree to which, any given start-up firm is entrepreneurial. This forces policy to target behavioral differences between entrepreneurial and non-entrepreneurial start-ups. We presume that start-up firms, to the degree they are entrepreneurial, face upfront costs in developing and marketing a new technology, and in the process face substantial risk. Our analysis then suggests the use of refundable tax savings from business losses in start-ups together with a compensating surtax on the profits of start-ups (needed in the case of lemons problems) to help alleviate the various market failures faced by entrepreneurial start-ups.

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1. Introduction

Economists have long presumed that there is too little entrepreneurial activity.¹ This presumption has justified a long history of attempts, both in practice and in the academic literature, to identify policies that will increase entrepreneurial activity. The objective of this paper is to explore how tax policy in particular can best be used to generate closer to the efficient amount of entrepreneurial activity.

The appropriate design of tax provisions to ease the problem of inadequate entrepreneurial activity inevitably depends on the specific sources of market failure leading to this under-provision. Various underlying market failures have been used to justify this presumption of insufficient entrepreneurship. One is the positive externalities generated from informational spillovers: When any given firm tries out a new product, a novel process, or even just a novel form of internal organization for a business, whether the attempt is successful or not, other firms can observe the outcome and use the resulting information to improve their

own productivity. This externality generates a social rate of return from entrepreneurship above the private rate of return to the entrepreneur.

Patents seem motivated by such informational spillovers: Patents provide protection from competition for a period of years in exchange for a public description of the firm's innovation intended to facilitate these informational spillovers. Yet patent protection, by giving the firm monopoly power in the market for its output, leads to inefficiently low consumption of the resulting product. Patent protection may also unduly restrict use of the new information in other products, given the threat of expensive lawsuits for patent infringement. The patent application process can also be very expensive and time consuming.

To what degree can tax policy be used instead, to at least partially internalize the positive externalities generated from innovative activity? Introducing tax incentives could allow an easing of patent protection (e.g. reducing the number of years of protection granted by a patent) while maintaining or even increasing the extent of entrepreneurial activity. By scaling back patent protection, its associated costs would then be eased.

A second type of market failure used to justify the presumption of too little entrepreneurial activity is utility gains to consumers from a new product. When a firm sells a new product, the firm inevitably faces a downward sloping demand curve, giving it market power (one source of market failure).

In addition, there are fixed costs in designing a new product. Entry is then profitable only if the resulting monopoly profits (while they last) in present value exceed these fixed costs. From a social perspective, though, entry is appropriate as long as the monopoly profits plus the

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* Corresponding author.

E-mail address: rogordon@ucsd.edu (R. Gordon).

¹ In this paper, we define "entrepreneurial activity" more specifically to be innovative activity undertaken in a start-up firm. Of course, existing firms can also pursue innovative activity. But the range of market failures and the policy options differ for new vs. existing firms. This paper focuses on the response to innovation in new firms.

increase in consumer surplus generated by the entrepreneur's efforts exceed the fixed costs of entry. The resulting insufficient entry of entrepreneurial firms is another source of market failure. Given these combined market failures, there will be too few attempts to design new products, and too few consumers gaining access to those new products that are developed due to monopoly pricing. To what degree can tax policy be used to encourage the design and sale of new products?

A third type of market failure that can be used to justify a presumption of too little entrepreneurial activity is a lack of access to outside financing by entrepreneurial firms, whether through the sale of equity or through borrowing. Without access to outside finance, an entrepreneur can pursue a new idea only if he or she has sufficient personal savings to finance start-up costs.² The failure rate among new firms is high, imposing as well substantial risk-bearing costs on an entrepreneur unless these risks can be shared with outside investors through the sale of equity in the firm.

A plausible explanation for this lack of access to outside finance is "lemons" problems arising from asymmetric information. Outside investors find it expensive to learn as much as the entrepreneur knows about the range of possible outcomes for the firm's new venture.³ Asymmetric information then leads on efficiency grounds to too little entry, an inefficient allocation of the resulting risks, and less ambitious new projects.

A further challenge faced in the design of tax policy responses is how best to target tax policy towards those firms that are "entrepreneurial". Only a small fraction of start-ups generate non-trivial informational spillovers, or sell a category of product not already available to consumers. Most all new entrants will face problems with access to outside finance, whether from banks or from equity investors, if only due to asymmetric information about the ability of the manager. However, the severity of these lemons problems are likely much worse in entrepreneurial start-ups due to the large informational asymmetries about the chance of success of the previously untried projects being undertaken in entrepreneurial firms.

Of course, innovative activity occurs as well in large existing firms, and not just in start-ups. For a large existing firm, though, there is no way to distinguish income from innovative activity within the firm from income generated by production using existing technology. Start-ups, in contrast, tend to specialize in either new or existing technologies, opening up the possibility of a more targeted tax policy, the focus in this paper. In addition, existing firms are more likely to have the financial resources to implement and commercialize their innovations, avoiding market failures in the financial market. Given this, the policies aimed at stimulating entrepreneurial activity in start-ups would differ from policies aimed at encouraging innovative activity in large existing firms. We also share the common presumption that start-ups have the potential to be much more innovative than large existing firms (where technological change can undercut the value of existing assets), justifying the focus on start-up firms.

The starting point for the analysis in this paper is that tax policy cannot distinguish directly between entrepreneurial and non-entrepreneurial start-ups, or between entrepreneurial firms pursuing ambitious or relatively minor innovations. Instead, tax policy must rely on behavioral differences among these groups of firms in order to best target any interventions on (more) entrepreneurial start-ups.

² Important citations concerning the importance of liquidity constraints in limiting the number and scale of new entrepreneurial firms include Holtz-Eakin et al. (1994a, b), Evans and Jovanovic (1989), and Cagetti and De Nardi (2006). Even when financing for a new firm is limited to the assets of the entrepreneur, however, the entrepreneur may still borrow using owner-occupied housing as collateral, thereby converting an illiquid asset into liquid funds. Evidence for this role of housing collateral in enabling the observed borrowing by new firms include Black et al. (1996), Fairlie and Krashinsky (2012), Robb and Robinson (2013), and Schmalz et al. (2013).

³ Entrants with the largest potential payoffs from outside finance may be willing to expend the resources needed to provide evidence on the expected profits for the firm in order to attract outside (venture capital) funding. However, only a tiny fraction of new entrants in practice attract venture capital funding (see Puri and Zarutskie, 2012).

What behavioral differences should we expect between entrepreneurial and non-entrepreneurial start-ups? For one, innovative activity is inherently a leap into the unknown, so that one attribute distinguishing an entrepreneurial start-up from a non-entrepreneurial start-up is the extent of risk taking. In our stylized model, we take this intuition to an extreme and assume that only entrepreneurial firms face risk.

Innovative activity also requires upfront investment both in the design of the new process or product and then in how best to manufacture and market this new technology. Motivated by this, we assume that entrepreneurial firms inherently face losses during their initial start-up phase, whereas start-ups using existing technology should be able to earn profits virtually from the beginning.

In trying to correct for each of these potential market failures, we focus on three possible tax provisions. One possible policy response is a differential tax rate on the profits earned by start-up firms.

A second possible policy response deals with the tax treatment of business losses. As of the 2017 tax reform in the U.S., firms can save taxes because of business losses only by offsetting these losses against the firm's profits in some other years. Many start-ups, though, fail with unused tax-loss carryforwards. Prior to the tax reform in 2017, non-corporate firms in the U.S. could deduct business losses from other personal income of the proprietor/partner. However, the progressivity of the personal tax schedule meant that taxes still discouraged risk taking. To what degree would more tax savings per dollar of losses be an effective tool to address the market failures described above?

A third policy we consider is a more favorable tax treatment of inputs employed in a start-up firm. For example, prior to the recent tax reform, the U.S. allowed expensing for up to a half million dollars of new investment per year by a firm, a provision that matters much more for smaller firms than for larger firms. Another U.S. practice is to give closely-held firms discretion in assigning a market value to shares (or options) issued to employees, a practice that reduces the tax liabilities on the resulting income.

Of course, many other policies in principle could differentially affect entrepreneurial and non-entrepreneurial firms. While our paper aims to shed light on the optimal use of this subset of possible policy responses, other types of policy responses might also be of use.

To what degree can this set of tax provisions be used to alleviate each of the market failures described above, generating greater informational spillovers, greater spillover benefits to consumers, more risk-sharing, and/or weaker credit constraints for entrepreneurial firms? In the process, though, to what degree would they distort choices made by non-entrepreneurial firms or alter the behavior of entrepreneurial firms in unintended ways?

Within the model, only entrepreneurial firms face risk and inevitably have tax losses during their initial start-up phase.⁴ In contrast, both non-entrepreneurial and entrepreneurial start-ups can report profits. The model then shows that a more generous tax treatment of losses within a start-up firm is the policy that best addresses the market failures generated by both informational spillovers and externalities to consumers. This policy would reduce net-of-tax start-up costs, thereby raising the expected return to entrepreneurship. The higher expected return should induce more entry of entrepreneurial ventures, while the drop in start-up costs should encourage pursuit of more innovative projects. A lower tax rate on profits generated in a start-up firm, in contrast, encourages as well too much entry and production by non-entrepreneurial start-ups.

When a firm faces lemons problems in the equity market, leading to an inefficiently low reallocation of risk from a start-up firm to outside investors, the policy response suggested by the theory is to share more of the risk with the government through imposing a surtax on ex-post profits. This surtax, though, discourages entry of all start-ups. To counteract this distortion to entry decisions, the surtax on ex-post

⁴ Lacking business-cycle fluctuations within the model, other firms with losses would quickly shut down.

profits can be combined with a subsidy to expenditures on inputs among start-up firms. The result is a narrow tax base and a high marginal tax rate, a finding that goes against the conventional wisdom driving tax policy reforms in recent years.

Finally, when a firm instead faces lemons problems in the bond market, the model suggests a more generous tax treatment of tax losses. The resulting tax savings would reduce the need for outside finance during the initial “start-up” phase for a firm. In the process, though, the policy generates too much risk-taking by unconstrained entrepreneurial firms. The more generous treatment of losses then needs to be supplemented with a higher tax rate on profits of start-up firms in order to reduce excess risk-taking. A higher tax rate on profits, though, discourages entry of non-entrepreneurial start-ups, a distortion that can again be offset by a more generous treatment of inputs used by start-up firms.

Section 2 provides a brief summary of the prior literature. Section 3 then lays out the initial model used in the analysis. This initial model ignores the types of market failures described above, yet still gives individuals the choice of whether or not to open a new firm, and if so how innovative (and risky) a project to pursue. Without the above market failures, market outcomes in a setting with a uniform tax on profits and losses are efficient, ignoring effects on labor supply.

Section 4 then introduces in turn each of the above sources of market failure. In each case, market outcomes are no longer efficient. The paper then examines the optimal use of the above tax policy provisions in alleviating the resulting misallocations.

Section 5 then discusses how the optimal tax policies from Section 4 change when some of the central assumptions are relaxed, while Section 6 concludes.

2. Prior literature

The closest paper in the past literature to ours is Akcigit et al. (2016), a paper written simultaneously with ours. Both our paper and theirs solve for the optimal tax treatment of innovative activity, but in very different settings with some issues appearing only in our paper and others appearing only in theirs. The primary similarity between the two papers is that they both consider policies to address externalities to other firms from innovative activity. However, our paper additionally examines the optimal policy response to several other market failures that can lead to too little innovative activity. Another key difference is that while their paper examines tax effects on innovative activity in all firms, we focus in particular on start-up firms. As a result, a critical element in our paper missing from theirs is the choice by each individual whether to become an entrepreneur. Furthermore, our paper assumes that all expenditures on innovation are observable, through monitoring expenditures during the firm's start-up phase, whereas in their paper only the fraction of innovative expenditures that can be classified as R&D is observable. A key strength of their paper is a fully flexible set of policy instruments (using a mechanism design approach) whereas we focus on a specific set of policy tools under current use.

Of course, there is a huge past literature examining the effects of taxes on entrepreneurial activity. A key challenge faced in this literature is to come up with a concrete measure of “entrepreneurial activity.” The simplest choice, seen for example in Bruce (2000), Chen et al. (2002) and Stenkula (2012), is to view all self-employed individuals as entrepreneurs and to examine the impact of taxes on the number of self-employed individuals. Another commonly used choice is to view all sole proprietorships (or more broadly all firms taxed as pass-through entities) as entrepreneurial firms and to study the impact of taxes on the number of people owning/managing such firms,⁵ or on the rate of entry of these firms.⁶ Other studies attempt to estimate the impact

of taxes on the size of these firms, measured either by income (Bruce et al., 2014) or gross receipts (Carroll et al., 2001).

With such broad definitions for entrepreneurial activity, it is easy for tax policy to target these firms. The common conclusion is that a lower tax rate for the self-employed or for pass-through entities increases the number and size of firms satisfying this definition of entrepreneurship.

Our presumption, though, is that only a small fraction of the self-employed or of pass-through entities are engaged in innovative activity. Lower tax rates for firms in these categories not only favor the subset of these firms that are entrepreneurial, but also distort the choices of the many other non-entrepreneurial firms that either do or can satisfy these definitions but whose choices are otherwise efficient.

What distinguishes start-up firms that are entrepreneurial from other firms in these categories? Innovative activity is inherently risky, leading a number of papers to focus instead on how the tax law affects the degree of risk-taking in start-up firms.⁷ This is the definition used in the current paper. The key element of our model is then the possible effects of tax policy on entrepreneurial risk-taking, including both the choice by each individual whether to become an entrepreneur, and then the subsequent choice concerning how risky (and innovative) a project to pursue.

Another strand of the past literature explores possible effects of tax policy on the availability of debt and equity capital to start-up vs. mature firms, and in particular the effects of taxes on entrepreneurs' access to venture-capital funding.⁸ The challenge we again face is how to design tax provisions that ease the credit constraints or the risk bearing costs for entrepreneurial firms while avoiding (as possible) distortions to the financial decisions of non-entrepreneurial start-ups.

3. Set-up of model: equilibrium with efficient markets

In this initial model, individuals can choose not only whether to be an entrepreneur but also how innovative a project to pursue. Initially, though, we ignore informational spillovers, we consider cost-reducing innovations rather than new products, assume no effects of the innovation on consumer prices,⁹ and assume well-functioning financial markets. Under these assumptions, we show that the market equilibrium will be efficient if the tax system imposes a uniform income tax on all income (or losses), regardless of the career choice of an individual.

3.1. Expected pre-tax income

Consider an economy in which individuals can choose between four careers: being an employee, running an established business, running a start-up business that uses existing technology, or designing a new technology and then starting up a business that uses this new technology. We will take the set of individuals who work as given, and ignore any effects of tax provisions on hours of work or work effort.

Individuals are heterogeneous. Individual i has a skill level as an employee sufficient to earn a pre-tax wage rate of w_i . Her skill level at running an established business (her expected pre-tax profits) is denoted by η_i . Her skill at managing a start-up business (regardless of technology) is denoted by μ_i . If a start-up manager chooses simply to use existing technology, then there are no start-up costs, and her pre-tax income is μ_i . If a start-up manager instead chooses to design a prototype for a possible new cost-saving technology, she faces start-up costs equal to $\sigma_i \rho_i$, where σ_i measure the degree of innovation in a new process while $\rho_i > 0$ measures the effort that must be expended by this individual per unit of innovation to develop such a new prototype. (If a manager of a

⁷ See, for example, Domar and Musgrave (1944), Kanbur (1982), Gordon (1998), Cullen and Gordon (2007), and Asoni and Sanandaji (2014).

⁸ For example, see Keuschnigg and Nielsen (2003, 2004), Poterba (1989), Gompers and Lerner (1998), Gilson and Schizer (2003), and Da Rin et al. (2006).

⁹ To avoid effects on consumer prices, we assume that the efficient scale of the innovating firm is small enough to leave consumer prices set by the marginal costs faced by firms with the prior technology.

⁵ For examples here, see Bruce and Deskins (2012) or Gurley-Calvez and Bruce (2008).

⁶ Examples here include Da Rin et al. (2011), Gentry and Hubbard (2000, 2005), and Asoni and Sanandaji (2014).

start-up firm simply uses an existing technology, then $\sigma_i = 0$ and we refer to her as a “start-up manager”).

In deciding on the degree of innovation, σ_i , several considerations enter. The more innovative is the technology, the higher will be the start-up costs, and in addition the more risk that will be faced when trying to produce using the resulting technology. But the higher will be the expected profits. Expected pre-tax profits in a start-up firm (expressed in first-period dollars) are assumed to equal:

$$P_i \equiv g(\sigma_i)\mu_i \tag{1}$$

Here, $g(\cdot)$ is assumed to be an increasing but concave function of σ_i , with $g(0) = 1$.

Ex-post pre-tax profits equal $P_i(1 + \tilde{\varepsilon}\sigma_i)$, where $\tilde{\varepsilon}$ denotes a random variable with zero mean and unit variance. More innovative projects generate more uncertainty as well as higher expected returns. For simplicity, assume that these $\tilde{\varepsilon}$ are independent, firm by firm, so that there is no aggregate risk.¹⁰

Note the simplifying assumption that the individual designing the prototype must also manage the resulting firm. Without this assumption, individuals would specialize either in developing prototypes or in managing a new firm, but not both, depending on their ρ_i vs. μ_i . With this change, results below are unaffected except in Section 4.3, where we discuss as well this alternative case.

3.2. Taxation of labor income

Labor income in general is subject to a proportional income tax at rate t . If the individual chooses to be an employee, her net-of-tax income equals $(1 - t)w_i$. We will take the tax rate t as given throughout the analysis, assuming it is driven by other considerations.

If the individual chooses to be a manager of an existing firm, she also faces this tax rate t . After-tax profits equal $(1 - t)\eta_i$.

In later sections, the government aims to encourage entrepreneurial activity, which we define to be innovative activity in start-up firms. However, there is no way under the tax law to identify entrepreneurial activity. Instead, we consider a separate tax rate, denoted βt , on the income of the managers of start-up firms, whether they use existing technology or design and use some new technology.

Managers of a start-up firm using existing technology receive net-of-tax income equal to $(1 - \beta t)\mu_i$.

Managers of a start-up firm who develop a new prototype and then use this new process in production are referred to as entrepreneurs. Each entrepreneur faces pre-tax start-up costs of $\sigma_i\rho_i$ in an initial period in creating a working prototype. We assume that the default tax law does not allow any tax savings in response to these start-up costs. In particular, tax-loss-carrybacks would be of no value since the firm has newly entered. For notational simplicity, we ignore the value of tax-loss carryforwards as well, in part recognizing that only a small fraction of entrants ever become profitable. Instead, we introduce another possible tax provision aimed at entrepreneurial firms, allowing immediate tax savings when a firm reports tax losses. Let these tax savings per dollar of tax losses equal αt . Now, after-tax start-up costs equal $(1 - \alpha t)\sigma_i\rho_i$.¹¹

Production then starts in the following period. As with non-entrepreneurial start-ups, the resulting profits are taxed at rate βt . We assume that income starting in the second period is always non-negative, so that restrictions on loss-offset do not matter at this stage of the firm’s lifecycle: If the firm foresees income per year less than could be earned

¹⁰ If instead we allowed for aggregate risk, notation becomes a bit more complicated but there is no substantive change. This aggregate risk in equilibrium would simply be allocated across all individuals until the marginal costs of risk-bearing are equated across individuals.

¹¹ One implicit assumption here is that the prototype phase for an entrepreneurial start-up occurs in a separate tax year from the subsequent production. Any initial expenses for the prototype development that spills over into the tax year for subsequent production will then be taxed at rate βt .

managing a non-entrepreneurial start-up, let alone losses, then it would be expected to shut down. Expected after-tax profits starting in the second period would then simply equal $R_i \equiv P_i(1 - \beta t)$.

One key choice available to entrepreneurs is the fraction of the shares in her firm to sell to outside investors, done to diversify risks. Denote by V_i the total value of the firm as perceived by the financial market, and denote by s_i the fraction of the firm that the entrepreneur chooses to sell. We assume that the tax rate on the resulting income remains equal to βt , to avoid introducing distortions to the decision to sell ownership shares in the firm.

We set the utility function of these individuals equal to a second-order approximation of a general utility function: $EU(\bar{Y}_i + M_i\tilde{\varepsilon}) \approx U(\bar{Y}_i) + .5U''(\bar{Y}_i)M_i^2$. Here, \bar{Y}_i denotes individual i ’s expected after-tax income and M_i captures the sensitivity of this individual’s net income to random events. Assume in addition that individuals have constant relative risk aversion, so that utility can be re-expressed as $U(\bar{Y}_i) - .5U'(\bar{Y}_i)\theta_i M_i^2 / \bar{Y}_i$, where θ_i is the individual’s coefficient of relative risk aversion.

Given the above assumptions,

$$\bar{Y}_i = s_i V_i + (1 - s_i)R_i - (1 - \alpha t)\sigma_i\rho_i, \tag{2}$$

where the first term reflects the revenue received from selling shares in the firm, the second term captures the expected income on the remaining shares, and the third term measures the (net of tax) start-up costs. The above assumptions also imply that $M_i = R_i(1 - s_i)\sigma_i$.

In this initial model, we assume that the individual’s skill parameters, μ_i and ρ_i , and the riskiness of the project, σ_i , are all public knowledge. Nobody knows anything ex ante about $\tilde{\varepsilon}$ other than it has zero mean and unit variance.

3.3. Behavior of the manager of a start-up firm

Consider now the various choices made by someone who chooses to run a start-up firm, the resulting value for the firm, and then the choice whether or not to simply use existing technology.

To begin with, since the risks faced by outside investors can be fully diversified the equilibrium value of V_i equals expected after-tax profits:

$$V_i = R_i. \tag{3}$$

Consider first the choice of riskiness for the project. So far, we assume this choice is observable to outside investors, so affects V_i through its implications for R_i . The resulting first-order condition for σ_i , found differentiating utility with respect to σ_i and simplifying, satisfies¹²

$$\frac{g'}{g} \leq \frac{\rho_i(1 - \alpha t)}{g\mu_i(1 - \beta t)} + \frac{\theta_i M_i (g'\sigma_i + g)}{\bar{Y}_i A_i g} (1 - s_i) \tag{4}$$

with equality when $\sigma_i > 0$. The left-hand side measures the fractional increase in profits when undertaking a riskier project. The first term on the right-hand side measures the higher after-tax start-up costs, as a fraction of expected after-tax profits. The second term captures the increase in risk-bearing costs when pursuing a riskier project.

Based on this first-order condition, we find that risk taking will be higher the larger the fraction of shares sold on the market. It will also be higher the lower the risk aversion of the entrepreneur, as measured by θ_i , and the lower the cost parameter ρ_i .

¹² Here, $A_i = 1 + .5(\theta_i + \theta_i^2)M_i/\bar{Y}_i$.

Consider next the entrepreneur's choice concerning the fraction of the firm's shares to sell to outside investors. Differentiating utility with respect to s_i , we find that at an optimum

$$\frac{U'}{Y_i} \theta_i R_i^2 \sigma_i^2 (1-s_i) = 0 \quad (5)$$

Here, the left-hand side captures the benefits from reduced costs of risk bearing. In this version of the model, there are no offsetting costs, so that entrepreneurial risks will be broadly shared: $s_i = 1$.¹³ Given our assumption of independent risks, there are then no net costs of risk-bearing.

Returning to Eq. (4), given that $s_i = 1$, the first-order condition simplifies to:

$$g' \mu_i (1-\beta t) \leq \rho_i (1-\alpha t), \quad (4a)$$

so that the amount of risk an entrepreneur chooses to pursue depends simply on the resulting increase in expected returns compared to the resulting increase in start-up costs.

Finally, consider each individual's choice to work as an employee, to become the manager of an existing firm, to become an entrepreneur/manager of a start-up firm, or instead to be an entrepreneur.

The choice by managers of new firms to take on risk, and then become an entrepreneur, is governed by Eq. (4a). If her value of ρ_i/μ_i is small enough, she will choose to set $\sigma_i > 0$ and be an entrepreneur, and conversely.

If $\eta_i(1-t) < (1-\beta t)\mu_i$, then the individual will not choose to be a manager of an existing firm.

The choice whether to be a worker or to run a business depends, though, on all of the ability parameters: Individuals choose to be a worker if $w_i > W(\eta_i, \mu_i, \rho, \beta, \alpha)$ for some function $W(\cdot)$.

3.4. Optimal tax policy

Consider next the choice of tax policy. We ignore equity concerns, so that the government's assumed objective is simply to maximize efficiency, as measured by the sum of after-tax incomes of all individuals plus government revenue, but taking as given the tax rate t faced by employees.¹⁴ The government's objective function then equals:

$$\max_{\alpha, \beta} \left[(1-t) \left(\int_{I_w} w + \int_{I_e} \eta_i \right) + \int_{I_m} (1-\beta t)\mu_i + \int_{I_n} U_i + T \right] \quad (6)$$

Here, I_w equals the set of individuals who become employees, I_e is the set of individuals who manage an existing firm, I_m is the set who manage a start-up firm, while I_n is the set who become entrepreneurs. T represents expected tax revenue collected from all of these individuals. There is no risk in the government budget, by the law of large numbers, and therefore no social cost from any randomness in the government budget.

¹³ For simplicity, the current model omits any need to maintain adequate incentives for the firm's manager through linking compensation to share values. In Appendix B, we extend the model to allow entrepreneurial effort to depend on the fraction of shares left with the entrepreneur. Results are substantively unchanged.

¹⁴ Here, we are implicitly building on the results in Diamond and Mirrlees (1971) that the optimal tax structure will preserve productive efficiency. See Rothschild and Scheuer (2013) for a demonstration that this result holds even when individuals have multiple dimensions of skill, as in our model. In our setting, the policy parameter t would be chosen to trade off equity and efficiency, whereas the other provisions we focus on are chosen to ensure productive efficiency, potentially in the face of various market failures.

The first-order condition for a policy parameter x (α or β) takes the form¹⁵

$$\sum_i \left(\frac{\partial T}{\partial \sigma_i} \frac{\partial \sigma_i}{\partial x} + \frac{\partial T}{\partial s_i} \frac{\partial s_i}{\partial x} + \sum_k \frac{\partial T}{\partial I_{ki}} \frac{\partial I_{ki}}{\partial x} \right) = 0 \quad (7)$$

Here, the last term captures any effects of a policy change on an individual's career choice, where $\sum_k \frac{\partial I_{ki}}{\partial x} = 0$ since we ignore any effects of these tax parameters on the choice to be in the labor market.

Since $s_i = 1$ regardless of tax rates, the second term drops out of Eq. (7).

From Eq. (4a), we find that $\frac{\partial T}{\partial \sigma_i} = 0$ if $\alpha = \beta$.

Given that there are no risk-bearing costs, individuals simply choose that career yielding the highest net-of-tax income. If a marginal policy change induces a change in behavior, then at that point after-tax incomes must be equal in the old vs. new careers. Tax payments will also be equal if tax rates are equal on incomes from these alternative careers, requiring that $\alpha = \beta = 1$.

Under our initial assumptions, efficiency is therefore maximized when taxes do not distort occupational choice and do not distort the choice on risk-taking. Optimal policy will then simply set $\alpha = \beta = 1$, yielding production efficiency as in Diamond and Mirrlees (1971). There would be full loss offset, unlike under existing business taxes, and equal tax rates on net income, regardless of career choice. No use would be made of the option to treat inputs to start-up firms differently than inputs to other firms.

4. Tax policy responses to market failures

In the following sections, we introduce each of four possible market failures in turn, and re-solve for the optimal tax policy. Throughout, we assume a world without patent protection or R&D subsidies, so that tax policy is the only available approach for correcting these market failures.

4.1. Information spillovers

We now modify the prior model to allow for informational spillovers. Assume, due to the benefits from informational spillovers, that expected output for an entrepreneur now equals $P_i = h(S)g(\sigma_i)\mu_i$ for some increasing function $h(\cdot)$ of aggregate informational spillovers denoted by S . We assume further that S can be measured by the aggregate increase in expected profits due to innovative activity, with informational spillovers presumed to occur whether each project succeeds or fails.¹⁶ The increase in expected profits for the i 'th entrepreneur due to her own innovative activity now equals $S_i = h(S)(g(\sigma_i) - 1)\mu_i$, which is simply expected profits with innovative activity relative to what would have been earned without innovative activity. Information spillovers then arise due to the sum of these spillovers from all entrepreneurs: $S = \sum_j S_j$.

For simplicity, we assume that these externalities benefit just start-up firms, though this will not matter for the qualitative results. The key assumption, given these externalities, is that the chosen values for the σ_i are now too low on efficiency grounds.

The above model otherwise remains unchanged, so that the government continues to design the tax law to maximize efficiency, as measured by Eq. (6), but now including this updated measure of pre-tax profits. Eq. (7) continues to be the resulting first-order conditions for optimal

¹⁵ Here, any transfer of income per se between individuals and the government has no net effect on efficiency. All that matters is behavioral responses to tax incentives. By the envelope theorem, behavioral responses have no net effect on individual utility, so that the only terms left are the impacts of behavioral responses on government revenue.

¹⁶ Many details are buried in this functional form, $h(\cdot)$. For example, any given innovation would likely have been discovered anyway at some point in the future if this individual entrepreneur had not pursued it, so that the externality simply comes from others learning the information sooner.

tax rates, except there is now an added term $\sum_j h' \frac{\partial S}{\partial x} g_j \mu_j$ capturing the impact of the tax change on aggregate externalities.

Under the above model, Eq. (5) continues to hold, so that $s_i = 1$ regardless of the choice of tax parameters. The second term in the first-order condition for optimal policy choice (Eq. (7)) continues to be zero.

Due to these externalities, from a social perspective too few people become entrepreneurs and each entrepreneur undertakes too little risk. The question is then how the tax law can best induce entrepreneurs to pursue riskier projects, and induce more people to become entrepreneurs. If the choices for the σ_i were observable for tax purposes, then the optimal policy would simply be a Pigovian (pre-tax) subsidy to the expected gain from innovative activity of each entrepreneur, $h(S)(g(\sigma_i) - 1)\mu_i$, with a subsidy rate equal to $e \equiv \sum_j h' g_j \mu_j$. This subsidy captures the full gains other firms receive from a marginal change in any given firm's innovative activity, taking as given the choices made by other entrepreneurs.

If it were feasible to implement the desired Pigovian subsidy to risk-taking, then with this subsidy in place we are back to the framework of the previous section, with $\alpha = \beta = 1$ characterizing the optimal policy. With this Pigovian subsidy, an entrepreneur's pre-tax income rises by $eh(S)(g(\sigma_i) - 1)\mu_i$, and their after-tax income by $(1 - t)eh(S)(g(\sigma_i) - 1)\mu_i$. The only change to the above first-order conditions characterizing the behavior of entrepreneurial firms is that the first-order condition for risk-taking becomes:

$$g'(1 + e) \leq \frac{\rho_i}{\mu_i} \tag{4b}$$

The subsidy adds to the private benefits from added risk taking. It also raises the attractiveness of being an entrepreneur relative to alternative career choices.

While we assume here that outside investors are able to infer expected output, $h\mu_i g(\sigma_i)$, so that equity markets continue to function as above, we assume that the government has no access to verifiable information about a firm's expected output to make such a Pigovian subsidy feasible.

How then can this desired subsidy of $(1 - t)e\mu_i h(S)(g(\sigma_i) - 1)$ best be approximated given available information, about firm profits, firm losses, and firm expenditures on capital and labor inputs? One way is for any subsidy to be confined to start-up firms. But the vast bulk of start-up firms are non-entrepreneurial, so the question becomes how best to pick out that subset of start-up firms that are entrepreneurial and capture the degree to which any given entrepreneurial firm pursues a more or less ambitious innovation.

All start-ups can have profits and can potentially employ capital and labor inputs. Some are more productive (in expectation) because they are entrepreneurial ($\sigma_i > 0$), but others are equally productive simply because their manager has a suitably larger value for μ_i . As a result, a more favorable tax rate on firm income largely affects non-entrepreneurial firms. Within our model, though, only entrepreneurial start-ups have tax losses (during their phase of prototype development). We therefore focus on $\alpha > \beta = 1$ as a possible policy response, to avoid any distortions to the choices made by non-entrepreneurial firms.

To what degree would a subsidy to firm losses, which would take the form $(\alpha - 1)t\rho_i\sigma_i$, approximate the desired subsidy of $(1 - t)e\mu_i h(S)(g(\sigma_i) - 1)$?

Given available tax instruments, Eq. (4a) becomes

$$g' \left(\frac{1-t}{1-\alpha t} \right) \leq \frac{\rho_i}{\mu_i} \tag{4c}$$

Eq. (4c) matches Eq. (4b) when

$$\frac{1-t}{1-\alpha t} = 1 + e. \tag{8}$$

This particular increase in the generosity of tax losses is then sufficient to yield efficient decisions on σ_i .

What tax parameters, though, would be needed to induce efficient entry incentives for entrepreneurs? Under feasible policies, the return to entrepreneurship increases by $(\alpha - 1)t\rho_i\sigma_i$. Entry incentives would then be efficient if α satisfies:

$$(\alpha - 1)t\rho_i\sigma_i = (1 - t)e\mu_i h(S)(g(\sigma_i) - 1). \tag{9}$$

Straight-forward algebra shows that the values of α that satisfy Eqs. (8) and (9) are the same, leading to efficient choices for both risk-taking (internal) and entrepreneurial entry (external) decisions, only when $g(\sigma) - 1 = \sigma g'$, as occurs when $g(\cdot)$ is a linear function of σ . In general, the proposed policy provides too weak entry incentives to the degree that the function $g(\sigma)$ is concave, implying $g(\sigma) - 1 > \sigma g'$. Intuitively, infra-marginal externalities from undertaking more risk exceed marginal externalities.

The optimal choice for α will then trade off intensive vs. extensive distortions to choices made by entrepreneurs.

The choice for β cannot improve on this trade-off. But to the degree that $\beta \neq 1$, choices made by non-entrepreneurial start-ups are distorted.

4.2. Benefits to consumers from new products

We now maintain the same model as in the prior section, but assume that innovations result in new products rather than cheaper production technologies, and ignore information spillovers to other entrepreneurs.

Even without patent protection, an entrepreneur who introduces a new product faces a downward sloping demand curve as long as other firms face real costs in reverse engineering the new product. The resulting market power of the innovating firm creates three sources of inefficiency. First, there will be efficiency losses due to monopoly pricing. Second, since customers are paying less in total than the benefits they receive from purchases of the new product, customers end up with a consumer surplus from the new product, a benefit ignored by entrepreneurs, leading to too few people becoming entrepreneurs and too little risk-taking by those who do become entrepreneurs. Third, a new product can pull sales away from other entrepreneurs, causing a loss in rents (and therefore a negative externality) to other entrepreneurs.

In this section, to keep the analysis as transparent as possible, we focus on how tax policy can best address the first two sources of inefficiency. In Appendix A, we provide assumptions under which the same results on optimal tax policy hold as well in a setting with all three sources of inefficiencies.¹⁷ To do so, we modify the above model to capture externalities to consumers rather than to producers. To separate the analysis of policies to deal with monopoly pricing from those addressing externalities to consumers, we assume that market prices for each good remain unaffected by the policies addressing consumer externalities.¹⁸

Assume now that all innovations are new products rather than new cost-saving technologies. New products vary, though, in the extent to which they differ from existing products. Maintaining our prior notation, let σ_i measure the degree of innovation in a new product. (If a new firm simply sells an existing product, then $\sigma_i = 0$.) Start-up

¹⁷ In general, the size of these positive (to consumers) and negative (to other entrepreneurs) externalities can vary arbitrarily by product, depending on variation in own and cross-price demand elasticities. In the Appendix, we show that when the consumers' utility function is CES, then these cross-price elasticities take a much simpler form, allowing the results from this section to extend to a setting with negative externalities to other entrepreneurs.

¹⁸ The assumptions made in Appendix A are sufficient to assure this.

costs are again assumed to be proportional to σ_i , leading to pre-tax dollar costs in the first period of $\sigma_i \rho_i$.

Assume that the ex ante size of the impact of the new product on consumer surplus is some function of the improvement in the quality of the product, $H((g(\sigma_i) - 1)\mu_i)$.¹⁹ When $\sigma_i = 0$, there is no innovation embodied in the product and there should be no spillovers. We therefore set $H(0) = 0$. To the degree that $\sigma_i > 0$, spillovers occur, captured by assuming that $H' > 0$.

With these assumptions, the model in the prior section continues to apply, yielding the same conclusions about how to choose α to yield close to efficient incentives for both risk taking and entry decisions of potential entrepreneurs.

The analysis in the previous section, though, did not face the further distortions arising from monopoly pricing. Monopoly pricing encourages use of an additional tax instrument. Consider a proportional subsidy to the sales of start-up firms as a group.²⁰ Under the assumptions made in Appendix A, the same subsidy rate suffices to yield the efficient output from all entrepreneurial firms. However, most start-up firms choose $\sigma_i = 0$ and therefore sell an existing product in a competitive market. Any subsidy to the output of a start-up in a competitive industry generates an efficiency loss. A subsidy to output of start-up firms also encourages existing firms to exit and reenter as a new firm. The optimal subsidy rate would then be very small.

4.3. Lemons problems in the equity market

Return now to our initial assumptions: no externalities from the information generated through entrepreneurship and only process innovations, so no externalities to consumers. But now introduce lemons problems in the equity market for shares in entrepreneurial firms.

In order to keep separate our discussions of problems in the equity market from problems in the debt market, we make the following simplifying assumptions:

- 1) The individual has sufficient personal wealth to finance first-period expenditures of $(1 - \alpha t)\rho_i \sigma_i$, implying no liquidity constraints.
- 2) σ_i only becomes publicly observable in period 2, once a prototype is available. (While start-up costs, $\rho_i \sigma_i$, were observable during period 1, ρ_i can only be inferred ex post in period 2 once σ_i becomes known.)
- 3) The entrepreneur's risk aversion, θ_i , is known.
- 4) Outside investors cannot directly observe the entrepreneur's managerial skill, μ_i .

With these assumptions, outside equity investors face just one unknown characteristic (μ_i) in period 2. We explore here a signaling model in which outside investors can infer the value of μ_i in equilibrium based on the fraction of the firm's shares that the entrepreneur chooses to sell.²¹

In valuing the firm, outside investors need to form expectations for the implied value of the firm, $V_i = E(R_i | s_i)$, as a function of the chosen fraction of the firm offered for sale. This expectation will turn out to be a declining function of s_i due to the signaling role of s_i about the entrepreneur's managerial ability μ_i . In particular,

$$\frac{dV_i}{ds_i} = \frac{\partial R_i}{\partial \mu_i} \frac{dE(\mu_i)}{ds_i} \quad (10)$$

¹⁹ With a common price elasticity of demand, this result would hold if there is a larger market for more innovative products.

²⁰ If the subsidy were confined to firms that had initial losses (in an attempt to confine the subsidy to entrepreneurial firms), then non-entrepreneurial firms could simply claim some trivial initial losses in order to qualify as well for this subsidy to future output.

²¹ The window for risk-sharing through the equity market is then during the period after σ_i becomes known but before $\bar{\epsilon}_i$ is learned. In period 1, with two unknowns but only one signal, the equity market would break down.

Based on the entrepreneur's objective function, the first-order condition for s_i becomes²²:

$$V_i + s_i \frac{dV_i}{ds_i} = R_i \left[1 - \frac{\theta_i R_i}{A_i \bar{Y}_i} (1 - s_i) \sigma_i^2 \right]. \quad (11)$$

Our focus is on how the choice for s_i varies with the μ_i of the entrepreneur. The left-hand side depends solely on public information, so cannot depend on μ_i . Since R_i is proportional to μ_i and R_i/\bar{Y}_i is a declining function of μ_i , the right-hand (measuring the costs from selling extra shares) is an increasing function of μ_i . The expected value of the manager's skill level, μ_i , will then be a declining function of the value they choose for s_i . In the dominating equilibrium, the least-skilled entrepreneur will simply set $s_i = 1$. Under the separating equilibrium, managers with higher values for μ_i credibly signal their higher skills by keeping a larger fraction of the firm's shares.

Given that all managers now bear risks from the firm, Eq. (4) implies that entrepreneurs will choose less risky projects than they would with symmetric information. Fewer people will become entrepreneurs. In addition, the market allocation of risk is now inefficient since the marginal cost of risk-bearing for the entrepreneur is positive, yet it is zero for outside investors and the government given that entrepreneurial risk is entirely idiosyncratic.

How can the tax law be designed to improve the allocation of risk bearing?

Consider modifying the neutral tax policy found above by imposing a uniform surtax on the profits (and losses) of start-up firms at rate δ , starting from a neutral tax policy with $\alpha = \beta = 1$. Ignoring behavioral responses, this policy shifts risk from entrepreneurs to the government. Since entrepreneurs are risk averse while the government is risk neutral, overall risk-bearing costs fall.

We see from Eq. (11) that this tax change has no effect on the firm's choice for s_i , since R_i , \bar{Y}_i and dV_i/s_i are all reduced by the same proportion, while A_i is unaffected on net. Eq. (4) shows that there is no effect either on the firm's choice for σ_i .

However, this tax surcharge in itself discourages entry of both entrepreneurial and non-entrepreneurial firms. To offset this distortion, our objective will be to narrow the firm's tax base without reducing the risk sharing with the government, and by enough to compensate for this increase in the marginal tax rate on entry decisions.

To explore feasible ways to narrow the tax base, assume a constant-returns-to-scale production function $g(\sigma_i)a(s_i)f(m_i, K_i \cdot L_i)$, where K_i and L_i represent capital and labor inputs respectively while m_i measures the manager's skill level. The firm chooses inputs to maximize $P_i = pg(\sigma_i)a(s_i)f(m_i, K_i \cdot L_i) - rK_i - wL_i$, where p , r , and w denote the market prices for respectively the firm's output, the firm's capital inputs, and the firm's labor inputs. For any constant-returns-to-scale production function, and given market prices, the firm's profit-maximizing choices for K_i and L_i as well as the residual profits going to the manager will all be proportional to m_i .

In particular, denote the shares of firm revenue spend on hiring labor, paying the annual costs of capital, and compensating the manager in a firm by χ_L , χ_K , and $1 - \chi_L - \chi_K$ respectively. We then infer that

$$P_i = \frac{1 - \chi_L - \chi_K}{\chi_L + \chi_K} (wL_i + rK_i) \quad (12)$$

Consider then combining a surtax at rate δ on ex-post profits with a subsidy to labor and capital inputs at a rate ω sufficient to leave expected net-of-tax profits unchanged:

$$(1-t)(f(m_i, K_i, L_i) - rK_i - wL_i) = (1-t-\delta)(f(m_i, K'_i, L'_i) - rK'_i - wL'_i) + \omega(rK'_i + wL'_i) \quad (13)$$

²² We assume a unique solution for s_i for any given individual.

(Here, K' and L' reflect optimal input choices conditional on the subsidy.) With the same net-of-tax profits, entry incentives for non-entrepreneurial start-ups would be left unaffected. The input subsidy does not in itself affect the allocation of risk, since inputs are non-stochastic, but it does offset the distortion from the higher marginal tax rate that discourages entry of both entrepreneurial and non-entrepreneurial start-ups.

If the firm's production function were Leontief, implying no resulting change in input choices, then no new distortions are introduced. Complications arise, though, when input choices are responsive to incentives. The optimal values of ω and δ would then trade off this distortion to input choices for both entrepreneurial and non-entrepreneurial start-ups with the gains due to a higher marginal tax rate from lessening the misallocation of risk.

In response to these combined tax changes, leading to less net-of-tax risk but close to the same expected income, more individuals enter into entrepreneurship, and risk-taking goes up. These behavioral responses raise welfare further, since they raise expected tax revenue while leaving individual utility unaffected by the envelope condition.

However, entrepreneurs are still left bearing some risk, and so take risk-bearing costs into account when deciding on entry, σ_i , and s_i . While entrepreneurs trade off certainty-equivalent output with any offsetting benefits or costs, government revenue depends on expected output along with these offsetting benefits and costs. As a result, from a social perspective, there is still too little entry of entrepreneurial firms, and too little risk-taking. An increase in α above 1, would help address these concerns.

How would this modeling change if the original innovator does not also have to manage the resulting firm? Now individuals can specialize, with those with low ρ_i/μ_i specializing in the innovation stage, while those with a high ρ_i/μ_i specialize in managing the resulting firms. Now, the initial innovator sells the firm after period 1 to someone who could be an effective manager. We assume that the new manager j 's skill level, μ_j , is still not observable directly, even to the initial innovator. Given that σ_i and μ_j are complements, the efficient allocation of managers would match the highest quality manager to the firm with the most innovative technology. To achieve this, the original entrepreneur can offer a particular contract to a managerial candidate, specifying a price per share and a number of shares the manager needs to buy at that price designed to attract a manager with the appropriate μ_j . (Managers with a high μ_j will be attracted to firms with a high σ_i and with fewer shares sold to outside investors.) With a separating equilibrium in this job market for managers, the market can now infer the new manager's μ_j from the contract the manager agrees to. The market price for the remaining shares that are sold to outside investors then reflects the expected value of μ_j , given s_i .

Note that we have shown that the government, while it cannot observe μ_j directly, can infer information about it indirectly through observing a firm's input costs. Yet we have implicitly assumed that private investors do not use such information about input costs when evaluating a firm's shares. What if investors paid more for firms spending more on inputs, signaling that the firm has a higher μ_i ? The signal to the private sector, however, depends on input costs prior to the sale of shares, whereas there is no such restriction affecting the quality of the signal for tax policy. Any credible signal to private investors would then require a costly deferral of sales of equity, and likely past the time when the uncertainty facing the firm has been resolved.

The optimal policy in this setting with "lemons" problems in the equity market faced by entrepreneurial firms is rather counterintuitive. The best way to address these problems is to raise the marginal tax rate on start-up firms but to compensate for this higher tax rate by narrowing the tax base, in the example here through subsidies to inputs.

4.4. Lemons problems in the bond market

In the previous section, the only misallocation created by lemons problems was a misallocation of risk. In this section, we explore instead

the implications of problems in the loan market. Given the set-up of the model, we can examine this issue even while assuming no lemons problems in the equity market and no informational spillovers or spillovers to consumers from entrepreneurial activity.

In particular, we now assume that μ_i becomes publicly observable at the beginning of period 2, enabling the equity market to function without problem at that point. But we now consider cases where the entrepreneur's assets are insufficient to finance desired start-up costs, and focus on lemons problems when entrepreneurs hope to borrow to help finance their initial start-up costs of $(1 - \alpha)\rho_i\sigma_i$ in the first period.²³

The firm's start-up costs can be financed out of the entrepreneur's own assets, denoted by W_i , and (in principle) supplemented through borrowing. Assume, though, that lemons problems in the market for loans at this point in the firm's lifecycle are so severe that funding for a start-up firm in its first period is capped by the entrepreneur's own assets.²⁴ For example, lenders may not be able to tell whether the potential borrower is a qualified inventor or simply a tinkerer who has little or no chance of coming up with a marketable product. In the latter case, the individual could still enjoy the chance to draw on borrowed funds to receive a salary during that period of tinkering, but would then default on the loan in the next period, lacking any marketable product.

If $W_i > (1 - \alpha)\rho_i\sigma_i$, then the entrepreneur has sufficient funds to proceed with the project, and would do so under the conditions described in Section 3.

If $W_i < (1 - \alpha)\rho_i\sigma_i$, however, then the feasible value for σ_i is reduced, lowering the net payoff to becoming an entrepreneur. If $W_i < W_i^*$, for some cut-off value W_i^* , then the payoff to becoming an entrepreneur would be low enough that the individual would shift to some other career. If $W_i^* < W_i < (1 - \alpha)\rho_i\sigma_i$, then the individual still becomes an entrepreneur but can afford to pursue only a less ambitious project than she would without credit constraints.

How can policy respond? The only available response, given the policy options we consider, is to raise α and thereby lower net-of-tax start-up expenses. Among constrained firms, all of the resulting tax savings would be used to finance a more ambitious project.

This policy response, taken in isolation though, introduces several new distortions.

For one, this policy in itself leads to too much innovative effort by those entrepreneurs who are not credit constrained. As we can see from Eq. (4a), to correct their incentives in choosing σ_i , this increase in α would need to be accompanied by an equal increase in β .

Any increase in β , though, discourages entry of non-entrepreneurial start-ups. As in the prior section, a subsidy to inputs used in start-up firms can alleviate these distortions to the entry decisions of non-entrepreneurial start-ups. These subsidies would be used until the resulting gains from easing the distortion discouraging entry of non-entrepreneurial start-ups are just counterbalanced by the excess entry incentives for unconstrained entrepreneurial firms (who gain as well through the rise in α). These net distortions would be reduced through a smaller increase in β than in α , but at the cost of generating excessive risk-taking by unconstrained entrepreneurial start-ups. All of these distortions could then be eased through a smaller increase in α , but at the cost of less relaxation of credit constraints.

Some policy intervention is still appropriate: A marginal combined increase in α and β , starting from $\alpha = \beta = 1$, leads to efficiency gains

²³ While we assume that σ_i becomes observable to investors in the second period, we also assume that it cannot be contracted on. Otherwise, debt contracts in the first period can include clauses specifying σ_i .

²⁴ Individuals can still borrow, using their own non-business assets (primarily owner-occupied housing) as collateral, enabling them to shift their wealth from housing equity into business investments. Such borrowing does not relax the cap, though, on business financing. Even venture-capital financing typically becomes available after an entrepreneur has a prototype, so in period 2 when she faces the expense of learning how best to manufacture the product and bring it to market.

from the increased innovative effort by constrained entrepreneurs. The resulting drop in entry by unconstrained start-ups generates no *marginal* efficiency costs, though, since their entry decisions were not initially distorted.

5. Discussion

The above model has been simplified along a number of dimensions. The objective of this section is to examine how forecasted policies change when some of the key assumptions used in the above model are relaxed.

5.1. Tax losses among non-entrepreneurial start-ups

One key assumption driving the above analysis is that only entrepreneurial start-ups experience tax losses. The intent was to focus the analysis on a key observable dimension of a firm that should differ between entrepreneurial and non-entrepreneurial firms. But assuming that we can ignore *any* losses among non-entrepreneurial firms is clearly a strong assumption.

Simply due to business cycles or other random events, non-entrepreneurial firms could have losses in some tax years, even if they should be profitable on average given that they choose to remain in business. Losses among non-entrepreneurial firms could also arise due to behavioral responses when tax policies set $\alpha > \beta$. For example, non-entrepreneurial firms may be able (at a cost) to manipulate the timing of their taxable income, shifting enough profits into some tax years so as to leave losses in other tax years. They could push further to reclassify consumption of the owners as a business expense. For those few start-ups that are already multinationals, they could shift losses into the home country and profits abroad. Non-entrepreneurial as well as entrepreneurial firms also have an incentive when $\alpha > \beta$ to invest in risky financial assets to add artificial risk to their overall income, at times leading to tax losses.

Each of these examples of losses generated other than from entrepreneurial risk taking introduces additional considerations when setting the tax rate on business losses. The income-shifting opportunities that open up when $\alpha > \beta$ introduce an offsetting efficiency cost limiting the use of this policy, pushing α down towards β . Some intervention would still be appropriate, even if scaled back in response to these offsetting costs.

In some of these cases, there are further statutory provisions that can limit the size of these offsetting efficiency losses. For example, one way to discourage firms from investing in risky financial assets in order to exploit tax provisions that set $\alpha > \beta$ would be to impose a penalty (surtax) on firms if they retain profits to undertake purely financial investments, as occurs in the U.S. with the accumulated earnings tax (section 531).

Another example of such statutory provisions is U.S. section 1244, which provides a much more generous treatment of capital losses experienced on equity in a small corporation when sold by the initial owners. In particular, such a provision eliminates the opportunity to save on taxes by shifting the timing of income vs. expenses.

What about fictitious tax losses that could arise whenever $\alpha > 0$ as a result perhaps of hobbyists masquerading as a commercial venture? Unlike in the other cases of tax losses described above, the main offsetting cost here is likely to be the threat of future audit and fines, rather than any real resource cost of filing taxes as if the activity were being pursued for profit. But future fines, while a cost to the hobbyist, are not a social cost since they represent a transfer to the government budget. When tax savings now are fully offset at the margin by future payments of fines, there is no net efficiency cost from changes in the choices made by hobbyists in response to tax policy changes, as shown by Chetty (2009).

5.2. Innovative activity pursued in existing firms

The analysis in this paper focused entirely on policies to correct market failures affecting innovative activity in start-up firms. Yet there is also substantial innovative activity pursued by existing firms.

To what degree are there market failures affecting innovative activity pursued by existing firms? Firms such as Google or Apple are unlikely to face serious lemons problems in the equity market, and are unlikely to be credit constrained. But innovations they pursue, or new products they develop, are equally likely to generate externalities to other firms and to consumers as those produced by entrepreneurial start-ups, justifying policy intervention.

The policy response we found above to correct for such externalities involved treating tax losses more favorably than would otherwise be appropriate. But innovative activity undertaken in an existing firm is likely to be only one small component of a diverse range of activities the firm pursues. The profits or losses resulting from this innovative activity certainly generate some uncertainty in the overall profitability of the company, but this uncertainty is unlikely to be of sufficient magnitude to drive the firm out of the top corporate tax bracket. The effective incentives faced when considering innovative activity in a large firm should then be well approximated by those we found in Section 3 where $\alpha = \beta = 1$.

In contrast, the optimal policy for entrepreneurial start-ups, as described in Sections 4.1, 4.2, sets $\alpha > 1$ and $\beta = 1$. When innovative activity faces different tax treatment depending on whether it is pursued in an existing firm versus in a start-up, then yet another tax distortion is created. Flexibility concerning *where* innovative activity is pursued pushes the optimal tax policy for start-ups towards one with $\alpha = \beta = 1$. Even this policy, though, treats losses in start-ups more favorably for tax purposes than current tax law for either corporate or non-corporate firms.

Given the lack of ability to target innovative activity pursued by existing firms through the choice of tax rates, though, the government has to rely instead on other tools to correct for the resulting externalities from innovative activity. One commonly used tool is R&D subsidies. But innovative activity often does not fit the legal definition of R&D activity, e.g. the workplace redesign generating fast-food giants such as MacDonalds.²⁵

At least in the U.S., R&D tax credits only reduce tax payments rather than generate rebates when a firm has tax losses. As a result, R&D subsidies in practice put start-up firms at a competitive disadvantage relative to existing firms, since new entrants typically have tax losses during the period of product design, and may fail before the firm ever has profits against which past subsidies can be deducted. As a result, to avoid distorting the location of R&D activity, tax policy towards innovative activity pursued in start-up firms has to overcome this disadvantage otherwise faced compared to innovative activity pursued in existing firms, leaving pressure towards a policy with $\alpha > \beta$ for start-up firms.

The other obvious non-tax policy used to stimulate innovative activity in existing firms is patent protection. While the benefits from patent protection in stimulating innovative activity have been questioned, this policy certainly targets innovative activity (potentially eligible for a patent) relative to other pursuits within a firm. However, the application for a patent is both expensive and time consuming, generating its own efficiency costs and putting start-up firms at a competitive disadvantage compared to existing firms due to the liquidity constraints often faced by start-ups.²⁶ Again, to avoid distorting the location of R&D activity, tax policy towards innovative activity pursued in start-up firms has to overcome the disadvantage these firms otherwise face to the extent that innovative activity is eligible for patent protection.

²⁵ This distinction between observable and unobservable inputs to innovative activity is a key complication driving the analysis in Akcigit et al. (2016).

²⁶ Attempting to sell the rights to the technology before it is patented to a firm free of such liquidity constraints is unlikely to work well, given the lack of legal protection to the ideas prior to the awarding of a patent.

5.3. Venture capital funding

In the above model, there is no separate role for outside equity investors that takes a form resembling venture-capital funding. In this section, we introduce one aspect of venture-capital activity.

In particular, assume now that an entrepreneur, by spending some amount N , can credibly inform an outside investor (say a venture capital fund) about the entrepreneur's otherwise unobserved value for μ_i . With this information, there would no longer be lemons problems in the market for equity from that firm. Lemons problems are now confined to those firms that choose not to certify the manager's ability. For simplicity, we ignore agency problems in this section, so that entrepreneurs attracting venture capital funding would no longer bear any risk.

The net gain to the entrepreneur is positive if and only if the benefits to the entrepreneur from eliminating risk-bearing costs are greater than the after-tax cost of the added expenditures, N :

$$.5\theta_i \frac{M_i^2}{\bar{Y}_i} > N(1-\beta t) \quad (14)$$

Entrepreneurs attracting venture capital funding will then be drawn predominantly from those with the highest risk-bearing costs, so the highest values for μ_i , who would otherwise have the lowest equilibrium values for s_i yet be running the largest firms. Let μ_i^* denote the value of managerial ability where the firm is just indifferent to certification, e.g. where this expression is satisfied with equality.

Now any policy intervention leads to yet another potential behavioral response: a change in μ_i^* . A drop in μ_i^* per se raises welfare by increasing risk taking and therefore expected tax revenue. How does μ_i^* change in response to the policies used to respond to lemons problems in the equity market (a rise in δ and a compensating rise in ω)?

Under these policies, we found above that σ_i increases and s_i falls. We then see from Eq. (4) that M_i/\bar{Y}_i falls for any given μ_i . Under the proposed policy intervention, \bar{Y}_i goes up, since start-up costs fall while the increase in taxes paid on profits is offset through a subsidy to inputs. The sign of the change in M_i is unclear, though, depending on whether the change in \bar{Y}_i is sufficient in itself to yield the equilibrium fall in M_i/\bar{Y}_i . If M_i rises, then venture capital funding becomes more attractive, causing μ_i^* to fall, and conversely.

5.4. Endogenous tax parameters α and β

The above analysis assumed for simplicity that start-up firms unavoidably face a tax rate βt on profits and αt on losses. This assumption of exogenous tax rates certainly simplified the analysis.

However, firms choose their location. Tax rates vary by location, creating an incentive to locate in a high-tax-rate jurisdiction during a firm's start-up phase, but then to move to a lower-tax-rate jurisdiction once the firm becomes profitable. Certainly, the use of Ireland for tax avoidance by a number of the most profitable recent start-ups makes this issue salient. Now the assumed objective function for the government must be revised, since any future tax revenue generated from increased entrepreneurial activity will no longer be received just by the domestic government. To the extent that domestic taxes on profits are avoided while tax savings on start-up costs are borne in full by the domestic government, the optimal subsidy to tax losses would be reduced to compensate for the avoidance of tax on future profits.

5.5. Policies that target small firms rather than start-up firms

In order to best target tax policy towards innovative activity undertaken in a start-up firm, the analysis focused on tax provisions that applied just to start-up firms. What if eligibility for any of these provisions were restricted instead to "small" firms, e.g. firms with capitalization less than some stated amount?

Now the policy is less well targeted towards start-up firms. But entrepreneurial start-ups almost always start small, waiting to make large investments until more is known about the feasibility of the proposed technology/product, so that the policy would still apply to entrepreneurial start-ups.

The main change is simply that the set of eligible firms that are not entrepreneurial would be yet larger. This creates yet more pressure to avoid distorting the decisions of eligible small firms that are not entrepreneurial. When such distortions are unavoidable, the optimal policy intervention would involve smaller adjustments to tax rates for these eligible firms.

6. Conclusions

In any attempt to use tax policy to generate more entrepreneurial activity, there are two immediate challenges. For one, to best design tax provisions to deal with the problem, we need to identify the market failures responsible for our presumption that there is too little entrepreneurial activity.

In this paper, we focused on four different market failures that seem to underlie our presumption of too little entrepreneurial activity. First, innovations undertaken by one firm can be observed and imitated by other firms, generating positive externalities. Innovations can also generate positive externalities to consumers, to the extent that new products are sold at a price leaving some consumer surplus to those who purchase the good. The other two market failures we explore are lemons problems in the market for both equity and debt issued by an entrepreneurial firm. Due to these lemons problems, entrepreneurs can end up bearing sizeable idiosyncratic risk arising from their venture and can face binding liquidity constraints that limit the scale of the firm they set up.

A second key challenge is that we cannot directly identify that subset of firms that are "entrepreneurial." Even if policy provisions focus on start-up firms, most new firms seem to generate little or no change to existing technologies or to the set of products available to consumers.

We then examine the use of several different tax instruments applied to *all* start-up firms, and not just to those that experiment with some new technology. The immediate question is then what attributes of a start-up firm best differentiate entrepreneurial firms from those start-up firms that simply build on existing technologies. For one, we assume that an entrepreneurial start-up faces initial losses during the period spent designing and learning how best to manufacture and market the proposed new technology/product. Non-entrepreneurial start-ups, in contrast, should earn profits virtually from the beginning, facing a known technology and market for the firm's output.

A second attribute we focus on is the riskiness of the firm's future income. Developing a new technology is inherently a leap into the unknown, and only a fraction of attempts at developing a better technology succeed. Outcomes can remain unknown until after substantial time and expenditures have occurred. In contrast, with a start-up that uses existing technology, the technology is known and the market should be known. There is still some uncertainty about the managerial ability of the person setting up the firm, but this should be revealed quickly and any resulting problems can be contained by hiring someone else to manage the firm.

Building on these observable signals about which firms are entrepreneurial, we end up with the following implications for optimal tax policy:

- 1) When the aim of tax policy is to internalize positive externalities provided either to other firms in the economy through informational spillovers or to consumers, then the best targeted response would be to treat tax losses generated by a start-up firm more generously. This policy raises the return both from entry of an entrepreneurial firm and from the choice to pursue a more ambitious new technology. Such a policy can be implemented in a variety of ways. One would be to make it easier to use tax losses, perhaps through allowing tax

rebates or the sale of tax losses to other firms, as would occur through safe-harbor leasing or through more lax limitations on the transfer of tax losses to an acquiring firm. Another, and one that would likely be even better targeted at entrepreneurial firms, would be to allow greater tax saving on capital losses experienced on the shares purchased by the initial owners of a start-up firm.

- 2) When instead the market failure is lemons problems in the equity market, leading to an inefficient allocation of risk between entrepreneurs and outside investors, the optimal policy response is to raise the tax rate on ex-post profits received in start-up firms, thereby shifting entrepreneurial risks to the government budget. In order to offset the resulting distortion discouraging entry of start-up firms, one feasible response would be to subsidize expenditures on capital and labor inputs in start-up firms. The result of these combined policies is a shift towards a high marginal tax rate and a narrow tax base in order to share more risk with the government while avoiding raising the effective tax rate on expected income.
- 3) When the market failure is liquidity constraints due to lemons problems in the market for loans to a start-up firm, the policy response suggested by our analysis is to allow greater immediate tax savings when a firm experiences tax losses. This policy alone, however, would generate a distortion leading to excessive risk taking by those entrepreneurial entrants that are not credit constrained. To neutralize this distortion, the policy should be complemented by a surtax on the future profits of start-up firms. This surtax on future profits, though, discourages entry of non-entrepreneurial start-ups. This distortion can again be offset through a subsidy to inputs used in start-up firms.

Note that, regardless of the source of the market failure, we do not find that a cut in the tax rate on income accruing to start-up firms (or to business income more broadly as occurred dramatically in the 2017 tax reform in the U.S.) makes sense as a way to stimulate entrepreneurial activity. Such a policy does nothing to ease credit constraints faced during the start-up phase of an entrepreneurial firm. It does not ease lemons problems in the equity market for shares in entrepreneurial firms, yet leaves investors as a whole bearing more net-of-tax risk, exacerbating this market failure. Such a tax cut does lead to more entry of start-up firms (both entrepreneurial and non-entrepreneurial), and to that extent generates added externalities due to increased entrepreneurial activity. But the policy is less well targeted than tax savings linked to reported tax losses, leading to higher efficiency costs for any given stimulus to entrepreneurial activity.²⁷ Note also that, at the time of enactment, a tax cut on income accruing to start-up firms aids pre-existing firms that were successful ex post, where any further behavioral responses are unlikely, whereas a more favorable treatment of tax losses should benefit primarily firms considering entering the market, where behavior can be very responsive to tax incentives.

Appendices: Supplementary Robustness Checks

Supplementary robustness checks for this article can be found online at <https://doi.org/10.1016/j.jpubeco.2018.08.003>.

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²⁷ Note, though, that the 2017 tax reform in the U.S. substantially reduced the tax savings from losses accruing in a start-up firm, no longer allowing them to be deducted against other household income but only carried forward as a deduction against future business income. Since entrepreneurial start-ups frequently fail, these carry-forwards will often never be used. The tax reform also will shift to amortizing R&D expenditures, rather than allowing them to be immediately deductible. While the tax reform may well stimulate business activity overall, for both of these reasons it will likely reduce the amount of entrepreneurial activity.