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Risk-Sharing and Entrepreneurship

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Abstract

In this paper, we study the role of risk-sharing in entrepreneurship-driven innovation. Studying entrepreneurship and innovation entails modeling an occupational choice and an effort choice. Risk-sharing may increase the number of individuals who become entrepreneurs by limiting the downside risk. The effort of entrepreneurs may, however, be hampered by high risk-sharing if this limits the returns faced by successful entrepreneurs relative to unsuccessful entrepreneurs. We construct a simple theoretical model where risk-sharing may be either private or provided through the welfare state by means of taxation. We show that, in addition to the occupational and effort choice dimensions, the level of public risk-sharing also matters for the characteristics of entrepreneurs.

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1 Introduction

What is the importance of risk-sharing for entrepreneurship-driven innovation? This question has been widely debated in an effort to understand which policies and institutions best promote innovation. Proponents of a high degree of public risk-sharing argue that it allows more individuals to pursue entrepreneurship, which is inherently risky, while opponents instead have argued that it is important to promote effort by limiting risk-sharing, thus allowing for more inequality. In this paper, we argue that for individuals who choose between venturing into entrepreneurship by opportunity and working in a less risky environment, risk-sharing can play an important role both for the occupational choice and for the choice of whether or not to exert effort. Moreover, risk-sharing can be both public, provided by the welfare state, and private, stemming from private asset holdings. If these two types of risk-sharing are substitutes, an individual's own economic resources may matter more for the occupational choice in the absence of public risk-sharing.

Countries differ in terms of public risk-sharing and inequality, and country rankings based on various innovation measures do not reveal a simple policy recommendation with regard to the optimal degree of risk-sharing, but suggest a potentially important role for both public and private risk-sharing. For example, among the top 10 innovator countries in the years 2013–2020, according to the Global Innovation Index, we find two Anglo-Saxon economies; the United States and the United Kingdom, as well as the Nordic countries; Sweden, Finland and Denmark. Importantly, these countries differ in that the Anglo-Saxon countries are characterized by higher inequality and less public risk-sharing than the Nordic ones. Furthermore, while the United States is home to many "unicorns"[1], Sweden is known for its high share of unicorns in proportion to its population. In fact, Sweden and the United States have innovation clusters that are comparable in terms of start-ups per capita, Stockholm and Silicon Valley (see, e.g., *The Daily Telegraph*, June 2015), but, related to the role of private versus public risk-sharing, anecdotal evidence suggests that they are inhabited by entrepreneurs from different types of backgrounds. The notion that entrepreneurship and innovation in the United States is more accessible if you come from a wealthy background has been put forward in a growing empirical literature on the relationship between inequality and innovation (see, e.g., Celik (2018), Bell et al. (2019)).

The contribution of this paper is twofold. First, to substantiate our understanding of cross-country differences in risk-sharing, we combine cross-country data with results from previous empirical studies to establish a set of key stylized facts. We study a sample of OECD countries between 2005 and 2018. We consider several measures of innovation: patents, a motivational index and innovation indices. We look at unconditional correlations and find that: (1) public risk-sharing is negatively related to inequality, (2) public risk-sharing is positively related to innovation, and (3) inequality is negatively related to innovation. We find that the United States appears to be an outlier in several dimensions with relatively high levels of both inequality and innovation. We argue that one contributing factor could be greater private risk-sharing in the United States as compared to, for example, Sweden. Private risk-sharing, in terms of holding financial assets (or

[1] A unicorn company is a startup firm valued above 1 billion USD.

intergenerational transfers), can be seen as an alternative to the public risk-sharing provided by the welfare state. While both types of risk-sharing may matter for the decision to pursue entrepreneurship as well as for incentives to exert effort, they may impact individuals from different backgrounds in different ways, suggesting that the level of public risk-sharing may matter for the average characteristics of entrepreneurs.

Second, we construct a model of risk-sharing and entrepreneurship, that is motivated by and consistent with these facts, and use the model to study the relationship between innovation, in the form of entrepreneurship, and risk-sharing. While there are many other factors that can matter for prospective entrepreneurs, the model is intentionally kept simple to focus on the key questions related to risk-sharing. To capture the relevant dimensions, the model includes an occupational and an effort choice, inspired by the set-up of the individual's problem in, for example, Acemoglu et al. (2017) and Garcia-Penalosa and Wen (2008). There is scope for risk-sharing to influence both the occupational choice and the effort choice since entrepreneurship is a risky activity. We show that individuals require more public risk-sharing to choose the uncertain path of entrepreneurship if the outside option of being a worker is made more attractive, and, in general, wealthier individuals require less public risk-sharing to choose entrepreneurship, as financial assets can provide a form of private risk-sharing. Entrepreneurial wealth[2] also matters for the decision of whether or not to exert effort. Individuals work harder if the returns are higher or if they have less private risk-sharing. As an illustration, we solve the model for a simulated distribution of individuals - characterized by given initial levels of wages, profits and assets, that are exogenous. We show that risk-sharing matters for both the effort choice and the occupational choice: there is a positive relationship between public risk-sharing and the share of individuals that pursue entrepreneurship, but as taxes – used to finance public risk-sharing – increase, there is a decrease in the share of entrepreneurs exerting effort. Finally, the level of risk-sharing also matters for which individuals choose to become entrepreneurs.

Our paper contributes to the discussion on the relationship between inequality, which is negatively correlated with risk-sharing, and growth.[3] Two opposing arguments have been brought forward. Previous research has argued that inequality may positively affect growth if it promotes effort and hard work (see, e.g., Okun (1975) and Mankiw (2013)). Acemoglu et al. (2017) argue that countries with high inequality will be more innovative. Specifially, they argue that so-called cutthroat economies, such as the United States, are more likely to be at the forefront of innovation, which drives growth, compared to so-called cuddly countries such as the Scandinavian ones. This reasoning is linked to the classification of market economies made by Hall and Soskice (2001), who distinguish coordinated market economies (CME) from liberal market economies (LME).[4] Another argument, linking inequality to a negative impact on growth, has been made, highlighting that in-

[2]Note that entrepreneurial wealth is equal to initial assets among those who choose entrepreneurship and that it is excluding profits.

[3]For empirical evidence see, e.g., Persson and Tabellini (1994), Alesina and Rodrik (1994), Perotti (1996), Barro (2000), Banerjee and Duflo (2000), Neves et al. (2016), and Akcigit et al. (2017).

[4]CME countries are characterized by relatively low inequality and high public insurance, while LME countries on the other hand, exhibit higher inequality and a low degree of public risk-sharing.

equality may cause misallocation of talent in the presence of financial frictions (see, e.g., Banerjee and Newman (1993) and Galor and Zeira (1993)). Closely related are models of occupational choice and wealth inequality comprising Quadrini (2000) and Banerjee and Newman (1993), and Cagetti and De Nardi (2006). Encompassing these ideas in an endogenous growth model with heterogeneous agents, Spiganti (2021) distinguishes between what he refers to as inequality of opportunity and inequality of effort. Our paper has a different angle, zooming in on the role of (public and private) risk-sharing for the occupational choice and – for entrepreneurs – the effort choice. Furthermore, the relationship between risk-sharing and tax rates is highlighted in our model.[5]

Closely related to the role of risk-sharing is the strand of literature on downside insurance and entrepreneurship. The inherited risk associated with entrepreneurship may deter some individuals from pursuing it,[6] but policy may limit this downside risk. Hombert et al. (2020) find that introducing a generous downside insurance for unemployed individuals starting their own businesses in France increased the number of entrepreneurs. In a related study, Bird (2001) finds that a higher degree of redistribution is positively related to measures of risk. Gottlieb et al. (2021) use a natural experiment in Canada and find that increased downside-insurance opportunities, in the form of job-protected leave entitlements, increase entrepreneurship among those entitled.[7,8] Garcia-Penalosa and Wen (2008) provide a theoretical foundation for the importance of downside insurance in occupational choice when agents are risk-averse. In contrast to this study we consider both private and public risk-sharing in an encompassing framework, and allow for both an occupational choice and an effort choice, where the latter is on the "job" and specific for entrepreneurs.

The remainder of the paper is organized as follows. Section 2 combines cross-country data and previous empirical findings on innovation, inequality, and risk-sharing, to identify a set of stylized facts that motivate our theoretical framework. In Section 3, we present a simple model of occupational and effort choice and results from a numerical evaluation of the model are presented in Section 4. Section 5 concludes the paper.

[5] See Akcigit and Stantcheva (2020) for an overview of the margins through which taxes may impact innovation.

[6] See, e.g., Kihlstrom and Laffont (1979).

[7] See, e.g., Parker and Robson (2004) and Koellinger and Minniti (2009) for studies that find a negative relationship between replacement rates and self-employment. Whether benefits are available for self-employed and employed individuals alike matters. See also Kreiner et al. (2015) for an analysis of distortionary effects of taxation.

[8] In Barrios et al. (2020), the authors argue that the arrival of the gig economy serves as a type of insurance.

2 Empirical Motivation

We combine cross-country data and estimates from previous research to establish key stylized facts about risk-sharing and innovation. Specifically, we look at data for OECD countries where we focus on countries that can be characterized as CME or LME countries.[9] We consider several measures of innovative activity and we also study country characteristics related to risk-sharing and inequality.

Measures of innovation The type of innovative activity we have in mind is entrepreneurial, i.e., we are interested in individuals who start their own firms, rather than individuals who are employed, and we think of individuals who choose to forgo a secure income for a riskier outcome. This means that we are not only interested in patents and R&D, but rather in all types of activities that can be classified as entrepreneurial.[10] We do not have cross-country data measuring entrepreneurial activity per se. Instead we combine three different types of measures of innovative activity to cover our definition of entrepreneurship. First, we look at patent applications, filed under the Patent Cooperation Treaty (PCT), per 1,000 inhabitants. Figure 1 shows the evolution of filed patents between 2005–2018. In panel (b), we note that the United States appears to be somewhat of an outlier with more patents than the other countries in the LME group while, in panel (a), most CME groups outperform the OECD average.[11]

Patents have been used in many studies as a proxy for innovation and therefore serve as a natural starting point (for recent examples, see Bell et al., 2019, Aghion et al., 2017, and Celik, 2018). But there are clear drawbacks to using patents as a measure of innovation, since they only measure a narrowly defined type of innovation and, as shown by, for example, Moser (2005), not all innovations are patented. Furthermore, innovation in the form of patents is often carried out in large firms by intrapreneurs. Individual entrepreneurs may not be willing or able to file for a patent. Therefore, we also consider a broader measure of innovation – innovation rankings. These rankings are not perfect measures of innovative activity, being more or less opaque, but they add a broader perspective relative to the patent data. In Table 1, we present recent innovation rankings from the

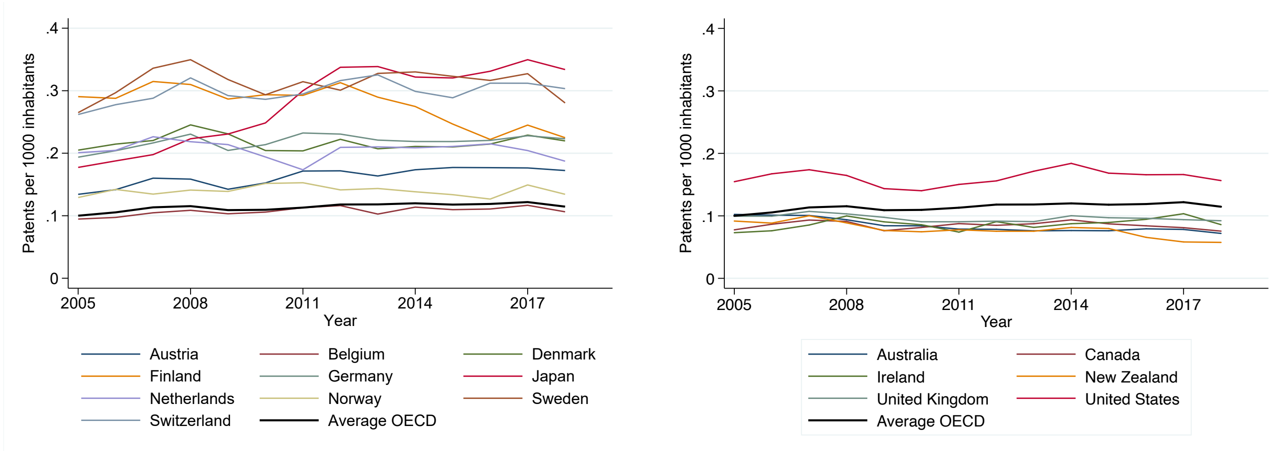
[9]We base the classification on Hall and Soskice (2001). The countries classified as CME are Austria, Belgium, Denmark, Finland, Germany, Japan, the Netherlands, Norway, Sweden and Switzerland, while the LME countries are Australia, Canada, the United Kingdom, Ireland, New Zealand and the United States.

[10]Henrekson and Stenkula (2016) define entrepreneurship as consisting of three parts; (i) to discover and create new economic opportunities, (ii) to introduce ideas in the market under uncertainty, and (iii) to create value. See also Botelho et al. (2021) who survey the literature related to innovation-driven entrepreneurship and highlight the distinction between different types of entrepreneurship and the importance of distinguishing between them.

[11]Data on population and patents come from the OECD, and we look at total patents filed under the PCT by the inventor's country of residence. There are several available measures of patents, and we evaluate two other measures to ensure that they give similar results. The other measures are patents granted by the European Patent Office (EPO) and patents granted by the United States Patent and Trademark Office. These give similar results, and the main difference is that the United States have more granted patents by the USPTO than by the EPO, compared to EU countries. Furthermore, Table B1 in Online Appendix B gives us a snapshot of the top ten countries in terms of patents by application, both in total and by industry (biotechnology, IT, medical technology, pharmaceuticals and nanotechnology) in the year 2018. We find the United States and Sweden in the top ten in all categories, along with both CME and LME countries.

Figure 1: Patent Applications Under the Patent Cooperation Treaty (PCT)

(a) CME-countries (b) LME-countries



Global Innovation Index (GII), the Global Entrepreneurship and Development Index (GEDI), and the Bloomberg Innovation Index. Using these broad innovation measures, both Sweden and the United States are in the top (United States is number 11 in the 2021 Bloomberg ranking).[12]

Table 1: Innovation Rankings (latest year)

Rank	**GII (2020)**	**GEDI (2018)**	**Bloomberg (2021)**
1	Switzerland	United States	South Korea
2	Sweden	Switzerland	Singapore
3	United States	Canada	Switzerland
4	United Kingdom	United Kingdom	Germany
5	Netherlands	Australia	Sweden
6	Denmark	Denmark	Denmark
7	Finland	Iceland	Israel
8	Singapore	Ireland	Finland
9	Germany	Sweden	Netherlands
10	South Korea	France	Austria

Source: Global Innovation Index (2020), Global Entrepreneurship and Development Index (2018), and Bloomberg Innovation Index (2021).

Finally, in Figures 2–3, in addition to patents, we consider survey evidence from the Global Entrepreneurship Monitor, which classifies self-employment as being driven either by necessity or opportunity. Self-employment by opportunity is defined as driven by improvement, with increased income or independence as the main motivation, and it is thus closest to our definition of entrepreneurship. Using this measure, a motivational index, defined as the share of entrepreneurs

[12]In fact, in the Global Innovation Index, Sweden has been in top three and consistently ranked above the United States since 2013.

motivated by opportunity divided by the share who become entrepreneurs by necessity, is constructed.[13] We note that Sweden has a motivational index of 7.17 compared to 4.49 for the United States and 3.79 for the OECD average (see Table A.2 in Online Appendix C).

Innovation and Risk-Sharing The degree of public risk-sharing in an economy can be measured in different ways. Here we consider average replacement rates as a proxy for the type of unemployment insurance that is available for failed entrepreneurs.[14] In Figure 2, we show the (unconditional) relationship between replacement rates and innovation. We note that replacement rates are positively correlated with patents per capita and the motivational index. For both measures, the United States appears to be an outlier, showing that it is possible to achieve high innovation rates without high public risk-sharing. The individual replacement rate generally depends on several factors, such as the family composition and their income level, rendering conclusions from these data potentially ambiguous. Therefore, in Online Appendix A, we also consider four other types of measures: social expenditures, private expenditures on health care (see, e.g., Botelho et al. (2021) for a discussion of how access to health insurance may matter for the decision to become an entrepreneur), income taxes (since taxes can be indicative of the degree of risk-sharing), and public expenditures on education and childcare. Again we find a positive relationship between our measure of risk-sharing and innovation.

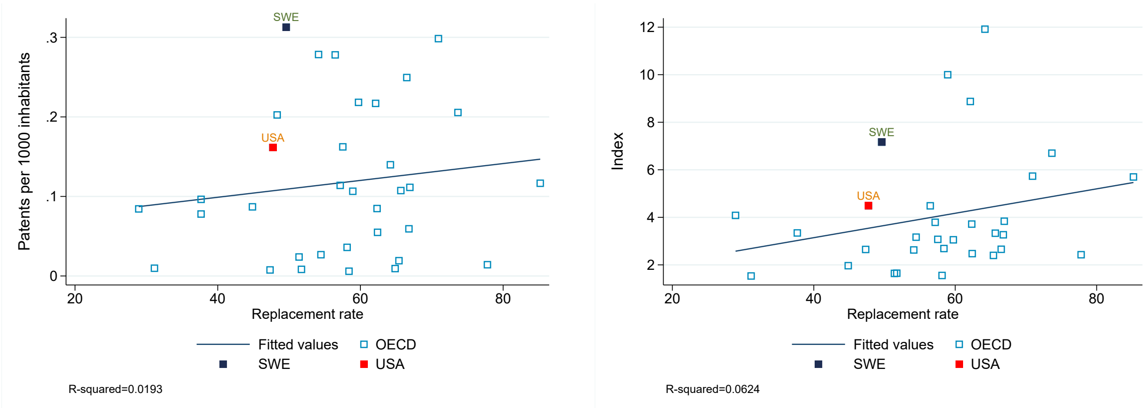
Innovation and Inequality Inequality, which is negatively related to public risk-sharing (see Online Appendix A), has been suggested as a driving force behind innovation. In addition to providing incentives for effort, inequality may matter for innovation through selection to the pool of entrepreneurs. Individuals with more resources are often more likely to become entrepreneurs or inventors. One reason for this may be because financial assets can act as a type of private risk-sharing in case of failure, implying that inequality matters for which individuals are able to choose entrepreneurship. In Figure 3, we see a negative (unconditional) correlation between inequality and

[13] Sometimes, total self-employment is used as a measure of entrepreneurship in the literature. However, individuals can become self-employed for many different reasons that are not necessarily related to the ambition to innovate, grow, and create new products – which is key for the relation to economic growth. Across countries, total self-employment is negatively related with many other proxies for innovation, and has a u-shaped relationship with GDP per capita.

[14] We use OECD data from 2005 to 2018. We plot the average for the full OECD sample where data is available, and separately for countries classified as CME or LME in Online Appendix A. Net replacement rates are defined as the five-year average of the net unemployment benefit (including social assistance and cash housing assistance) for two earnings levels and three family situations (OECD Wages and Benefits, 2015). In addition to different replacement rates, countries differ in terms of how much access a self-employed person has to unemployment insurance. In Sweden, self-employed individuals have access to the same unemployment benefits as those who are employed, under the condition that they do not actively manage their business while receiving benefits. In the United States, fewer entrepreneurs are in general eligible for unemployment benefits. If you run your business as a sole proprietorship (which is the default choice for American entrepreneurs according to the Small Business Administration) you are not eligible for any unemployment insurance. If you register your firm as a corporation and hire yourself as an employee, you will, in most states, be eligible for the same unemployment benefits as an employed individual. The benefit is funded by payroll taxes. See Hassler and Rodriguez-Mora (1999) for an analysis of the political determination of unemployment insurance, departing from observed differences between Europe and the United States.

Figure 2: Innovation and Replacement Rates (average across 2005-2018)

(a) Patents, OECD (b) Motivational Index, OECD



innovation.[15] Again, the United States is an outlier with higher inequality than the rest of the other high-innovation countries. These unconditional correlations suggest that inequality is negatively associated with innovation, but that some high-inequality countries are still quite innovative.[16]

Private risk-sharing and family background Private risk-sharing, in the form of savings or parental transfers, might facilitate entrepreneurship and innovation in an environment with high inequality. Related to this notion, Laitner and Ohlsson (2001) show that average bequests and inter-vivos transfers are larger in the United States than in Sweden.[17] It is possible that family background is more important in countries with a larger reliance on private risk-sharing. For example, Bell et al. (2019) find that having wealthy parents increases the probability of being an inventor in the United States. Children of parents in the top 1 percent of the income distribution are ten times more likely to become inventors than children of parents in the bottom half of the distribution and individuals with parents in the top 5 percent of the income distribution are 3.5 times more likely to become inventors as compared to the mean. In a similar study on Finnish

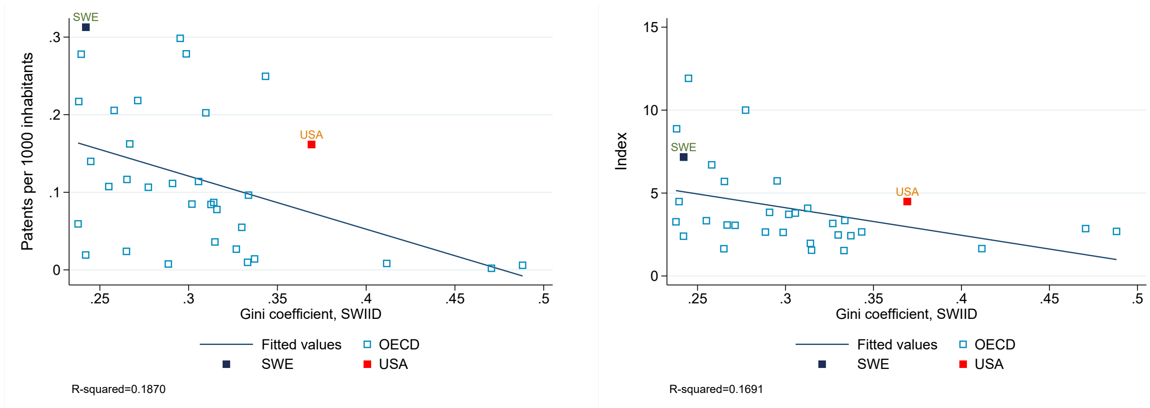
[15] We use the net Gini, which uses the equivalized (square root scale) household disposable (post-tax, post-transfer) income, using Luxembourg Income Study data as the standard, provided by the Standardized World Income Inequality Database (Solt, 2016). Note that Sweden and the United States are much more similar in terms of the Gini coefficient for wealth. We argue that there still is a substantial difference in the amount of public versus private risk-sharing between these two countries.

[16] See Online Appendix A for countries classified as LME or CME countries. While LME countries in general have a higher Gini coefficient, the United States is somewhat of an outlier with more patents and more inequality. There are, of course, clear limitations to studying unconditional correlations at the country level. At the state level within the United States, see Akcigit et al. (2017) who find that broad measures of income inequality are negatively related to innovation but that there is a u-shaped relationship between top income inequality and innovation.

[17] The average inherited amount, conditional on receiving a positive inheritance, was around 28,000 USD in Sweden and 105,000 USD in the United States (adjusted to USD in 2016). In 2016 USD, these amounts can be compared to GDP per capita, which was 57,467 USD in the United States and 51,600 USD in Sweden (data from the World Bank).

Figure 3: Innovation and Inequality (average across 2005-2018)

(a) Patents, OECD (b) Motivational Index, OECD



data, Aghion et al. (2017) also find that the relationship between parent income and innovation is positive. Comparing the estimates in Aghion et al. (2017) to the ones from Bell et al. (2019), the former study finds that having parents in the top 5 percent increases the probability of becoming an inventor 2.4 times, as compared to the mean.[18] However, in Finland, this gap is almost fully explained by other factors such as parental education and individual ability (IQ). In the United States, ability explains less than one third of the innovation gap. Using historic data, Akcigit et al. (2017) show that, in the United States, parental income matters for the probability of becoming an inventor, and that one potential mechanism is through access to education. Furthermore, survey evidence from the International Social Survey Program shows that Americans believe that family background (parental income and education) is more important to become successful than do Swedes (ISSP Research Group, 2018).

Looking at a sample of companies classified as unicorns in the United States and Sweden in 2018, there appear to be differences in the backgrounds of these entrepreneurs.[19] Looking at the characteristics of the founders, several of the Swedish entrepreneurs come from non-privileged backgrounds. Sebastian Siemiatkowski is the CEO and co-founder of Klarna. His parents came to Sweden from Poland and, as he has discussed in numerous interviews, he did not grow up in a privileged environment. His father was partly unemployed and worked as a taxi driver, while his mother was on disability pension. Still, the co-founder of the Swedish unicorn Klarna studied at the

[18] The percent of individuals who are inventors in the United States is 0.21, and in Finland it is 1.35.

[19] Information was gathered in January 2018 from Crunchbase Unicorn Leaderboards. The companies we compare are the top 50 unicorns in the United States (as of January 2018) and Spotify, Mojang, Klarna, King, LeoVegas and Skype for Sweden. In 2018, Klarna was valued at around the same as unicorns in the top 30-40s in the United States, and Spotify was ranked just after the 10th highest valued unicorn in the United States. Note that Mojang, King and Skype are no longer considered to be unicorns since they have been acquired by other companies. Moreover, as of April 2018, Spotify is no longer a unicorn because of its initial public offering, but the valuation is based on data from January 2018. Details of the comparison are available upon request.

Stockholm School of Economics, a prestigious school where he also met his future business partners. Daniel Ek, founder of Spotify, and Markus Persson, founder of Mojang, have no university degrees and grew up far from the privileged academic environment of many of their American counterparts. The American entrepreneurs in this sample are more likely to have attended university and around one third of them attended universities that are ranked top ten in the world. Furthermore, many of the American entrepreneurs on the list come from academic and/or wealthy backgrounds, based on information on their parents' occupations and on their early schooling (from magazine interviews, blogs, podcasts etc.). There are, of course, exceptions, but it is rare to find interviews with these entrepreneurs that, in any way, mention hardship or financial struggles growing up.

Overall, taken together this suggests that parental background and transfers may be a more important determinant of entrepreneurship in countries like the United States, compared to countries with more public risk-sharing, such as Finland and Sweden.

Effort Individual entrepreneurs can affect their own probability of success by exerting effort and their propensity to do so may depend on the level of public risk-sharing. Many entrepreneurs work more hours than the average employee. This appears to be the case both in countries such as the United States and in Sweden. However, recent literature has highlighted large differences in the general hours worked across countries and, in particular, that Europeans work fewer hours than Americans in the aggregate. In a recent study, Bick et al. (2019) utilize data from national labor force surveys to document differences in working hours. They find that Scandinavians work on average 14 percent less hours compared to Americans, and that the main explanation for this, in Scandinavia and Western Europe, is less weekly hours worked. Their data include both employees and self-employed individuals, but the authors argue that the results are robust to defining self-employment as a separate sector. One potential explanation for the difference in hours is differences in policy, and in particular taxes (see, e.g., Olovsson (2009)). Lindbeck and Nyberg (2006) offer a complementary perspective arguing that a generous social insurance appears to weaken parents' incentives to instill norms on work effort in their children. These findings suggest that we should see more individuals choosing to exert effort in a low risk-sharing economy, compared to in an economy with a generous downside insurance.

To summarize, cross-country data suggest that there is a positive relationship between risk-sharing and innovation, while inequality is negatively related to innovation. However, our innovation indicators show that countries with varying degrees of public risk-sharing are represented in the group of top innovators. In particular, the United States is an outlier with low public risk-sharing, high inequality, and high scores on all of our innovation measures. One possible explanation that can reconcile the relevance of public risk-sharing and the performance of countries like the United States is that they are able to compensate for the lack of public risk-sharing with high private insurance, in the form of, for example, savings and parental transfers, and high effort. Next, we incorporate these ideas in a simple model of occupational and effort choice.

3 A Model of Occupational and Effort Choice

To study the importance of risk-sharing for entrepreneurship, we develop a simple static model of occupational choice, where entrepreneurs also choose their optimal effort level, knowing their levels of assets, wages and potential profits.[20] We think of entrepreneurship as a risky activity. With some probability, entrepreneurs are successful and make profits, but there is also a risk of failing.[21] Unsuccessful entrepreneurs are assumed to only receive some level of insurance, or benefits, as a result of risk-sharing.[22] This downside insurance can be either public or private. Public insurance comprises the benefits that the government provides for entrepreneurs without income and is financed by tax revenues. We think of private insurance, on the other hand, as coming from the family or from private savings. In real life, insurance from the family can stem from intergenerational ties, but here we simply assume that private insurance corresponds to holding some level of initial assets. A stronger public welfare system then means that agents are, all else equal, less reliant on private insurance. Downside insurance matters for risk-averse agents, i.e., the income you get in the worst state of the world matters for whether or not you are willing to forgo a certain income. All else equal, since entrepreneurship is a risky activity, a stronger safety net through downside insurance makes risk-averse agents more prone to become entrepreneurs. Compared to the literature that purely focuses on the importance of high powered incentives, i.e., sufficiently high returns for successful relative to unsuccessful entrepreneurs, we add the relevance of downside risk and risk-sharing, both public and private, when there is an occupational choice and agents are risk-averse. Finally, effort may clearly affect returns, for example by affecting the probability of success. When this is the case, the return to putting in effort clearly matters. This motivates the consideration of incentives and the inclusion of an effort choice.

[20] To study the impact of risk-sharing on entrepreneurship-driven innovation, the relevant population for the model consists of individuals who choose between (secure) wage employment and (risky) entrepreneurship. In this sense, we have in mind individuals who choose entrepreneurship by opportunity, not necessity, and thus it is important to consider the occupational choice.

[21] Conceptually, there is an interesting distinction between risk and uncertainty. One may argue that the types of entrepreneurs that may have the biggest (potential) effects on economic growth face uncertainty about the probability of success, rather than simply a known risk. For example, Botelho et al. (2021) highlight that innovation-driven entrepreneurs have risk profiles that are not known in advance, compared to entrepreneurs in more traditional businesses whose risk may be better understood. Here we abstract away from this distinction. The way we think about it is that the entrepreneur has, ex-ante, chosen a product or an idea, and knows what the profit is in case of success. This is clearly a simplification, to highlight the role of risk-sharing for the occupational (and effort) choice, and abstracts from many steps in the decision-making process.

[22] One could imagine settings where the entrepreneur has made some investment that could be lost in case of failure. Depending on the owner structure, however, much of the financial risk for an entrepreneur may be shared by investors. To keep the model simple, we thus abstract from such investments and think of the loss as an income loss (the profit that was not realized). That is also the type of risk that the public risk-sharing may alleviate.

Economic Environment The model is static, and agents work, consume and then die.[23] Agents are characterized by a combination of initial assets, a, wages, w, and entrepreneurial profits, π (all exogenous). We call this combination a type t, where $t = (a, w, \pi)$, and types are distributed according to a function $F(t)$. Agents choose whether to become entrepreneurs, denoted E, or workers, denoted W. Entrepreneurship is risky while working provides a secure income.[24] This occupational decision, broadly inspired by the set-up in Garcia-Penalosa and Wen (2008), described in detail in Section 3.2, is the first decision they make. Then, conditional on choosing entrepreneurship, they also make an effort choice, described in Section 3.1. We solve the effort choice and the occupational choice by backward induction. That is, when the agent makes her occupational choice, she assumes the optimal level of effort.

We follow Acemoglu et al. (2017) in the specification of the agent's effort choice.[25] Exerting effort is costly, but it increases the probability of success. To simplify, we specify this as a discrete choice between either exerting effort or not exerting any effort at all.[26] Specifically, entrepreneurs choose between the two effort levels $e = 1$ and $e = 0$. Let p_1 denote the probability of success when exerting effort and p_0 the probability without effort, with $1 \geq p_1 > p_0 \geq 0$:

$$p(e) = \begin{cases} p_1 & \text{if } e = 1, \\ p_0 & \text{if } e = 0. \end{cases} \tag{1}$$

Choosing to exert effort thus implies a higher probability of success, but it comes at a cost $\eta(e)$. The individual has a total time endowment of 1, and there is an effort cost in terms of foregone leisure time. For the agent who does not exert effort, there is no cost:

$$\eta(e) = \begin{cases} \eta(1) > 0 & \text{if } e = 1, \\ \eta(0) = 0 & \text{if } e = 0. \end{cases} \tag{2}$$

Agents value consumption and leisure. We specify utility for entrepreneurs, U_E, as a CRRA function of consumption and effort.[27] Specifically, consumption is scaled by available leisure time. The utility of workers, U_W, is a CRRA function of consumption only, since workers do not make

[23]It is straightforward to incorporate the mechanisms studied in this paper in a model of endogenous growth. However, this static model captures the main aspects of interest.

[24]In reality, workers clearly also face risk, for example unemployment risk, and may be rewarded for putting in effort. In this simple model we abstract from these features.

[25]Specifically, we use the same utility function and condition to determine when it is optimal to exert effort. They also look at a discrete choice (effort/no effort). Acemoglu et al. (2017) embed the effort choice of entrepreneurs in a model of endogenous technological change with knowledge spillovers. They include the effort choice as a moral hazard problem with a social planner that ultimately decides on the reward structure. The reward structure implies either perfect or imperfect consumption insurance.

[26]This simplification makes the model more tractable, but it would be possible to extend this choice to more levels, with the corresponding cost and probability functions.

[27]One could imagine a different specification that accounts for other non-wage aspects of being an entrepreneur that the individual might value.

an effort choice.

$$U_E(c_E, e) = \begin{cases} \frac{(c_E[1-\eta(1)])^{1-\theta}}{1-\theta} & \text{if } e = 1, \\ \frac{(c_E[1-\eta(0)])^{1-\theta}}{1-\theta} & \text{if } e = 0, \end{cases} \qquad U_W(c) = \frac{c_W^{1-\theta}}{1-\theta}.$$

$\theta > 1$ is the coefficient of relative risk aversion. Note that, because there are no means of saving in the model, agents simply consume their income y_E or y_W.

We take tax rates as given. We solve for the level of public downside insurance, which we call the benefit b, by imposing that the government runs a balanced budget (see details in Section 3.3).

3.1 Effort Choice

The total income of a successful entrepreneur is given by $(1-\tau_\pi)\pi+a$, where τ_π is the tax rate faced by entrepreneurs, π are entrepreneurial profits, and a are initial asset holdings. For an unsuccessful entrepreneur, income is instead $(1-\tau_b)b+a$, where b are benefits and τ_b is the tax rate applied to benefits. To determine when it is optimal to exert effort, we compare the expected utility from putting in effort and the expected utility from not putting in effort, and set up an incentive compatibility constraint. This constraint says that in order to exert effort, the expected utility of doing so must be at least as large as the expected utility of not doing so. The left- and right-hand side below show expected utility for $e = 1$ and $e = 0$, respectively:

$$\begin{aligned} &\frac{1}{1-\theta}\left\{p_1\left[(1-\tau_\pi)\pi+a\right]^{1-\theta}+(1-p_1)\left[(1-\tau_b)b+a\right]^{1-\theta}\right\}\left[1-\eta(1)\right]^{1-\theta} \\ \geq &\frac{1}{1-\theta}\left\{p_0\left[(1-\tau_\pi)\pi+a\right]^{1-\theta}+(1-p_0)\left[(1-\tau_b)b+a\right]^{1-\theta}\right\}\left[1-\eta(0)\right]^{1-\theta}. \end{aligned} \tag{3}$$

Because $\eta(0) = 0$, this is equal to:

$$\begin{aligned} &\frac{1}{1-\theta}\left\{p_1\left[(1-\tau_\pi)\pi+a\right]^{1-\theta}+(1-p_1)\left[(1-\tau_b)b+a\right]^{1-\theta}\right\}\left[1-\eta(1)\right]^{1-\theta} \\ &\qquad \geq \frac{1}{1-\theta}\left\{p_0\left[(1-\tau_\pi)\pi+a\right]^{1-\theta}+(1-p_0)\left[(1-\tau_b)b+a\right]^{1-\theta}\right\}, \end{aligned} \tag{4}$$

which after some algebra boils down to the following condition for the relative return of a successful and an unsuccessful entrepreneur:[28]

$$\frac{(1-\tau_\pi)\pi + a}{(1-\tau_b)b + a} \geq \left(\frac{1 - p_0 - (1-p_1)(1-\eta(1))^{1-\theta}}{p_1(1-\eta(1))^{1-\theta} - p_0}\right)^{\frac{1}{1-\theta}} = \underbrace{\left(1 + \frac{1 - [1-\eta(1)]^{1-\theta}}{p_1[1-\eta(1)]^{1-\theta} - p_0}\right)^{\frac{1}{1-\theta}}}_{\equiv A}. \tag{5}$$

The expression denoted A determines the incentives required to ensure effort. In our calibration - see Section 4.1 - this expression is larger than one, which means that, in order for an individual to choose to exert effort, according to the incentive compatibility constraint, the returns to successful entrepreneurs need to be higher than the returns to unsuccessful entrepreneurs. This is in line with the cutthroat economy from the model in Acemoglu et al. (2017), with imperfect consumption insurance to incentivize effort. To ensure an effort motive, we follow Acemoglu et al. (2017) and use the assumption:

Assumption 1

$$\min\left\{p_1\left(1-\eta(1)\right)^{1-\theta} - p_0, 1 - p_0 - \left(1-p_1\right)\left(1-\eta(1)\right)^{1-\theta}\right\} > 0. \tag{6}$$

This assumption ensures that the right-hand side in equation (5) is larger than one. An individual will then exert effort if the returns to doing so are large enough, i.e., if $\frac{(1-\tau_\pi)\pi+a}{(1-\tau_b)b+a} > 1$. In our calibration, this condition is fulfilled, but Assumption 1 is important for our comparative statics results. Based on the incentive compatibility constraint, we define a threshold for the effort choice:

Proposition 1 *There exists a threshold $\bar{E}$ consistent with the incentive compatibility constraint in equation (4) that defines the cutoff in terms of net of taxes benefits $(1-\tau_b)b$ below which agents choose to exert effort as entrepreneurs:*

$$(1-\tau_b)b \leq \bar{E} = \frac{(1-\tau_\pi)\pi + a}{A} - a. \tag{7}$$

See Proof 1 in Appendix A.1 for details.

Lemma 1 *Under Assumption 1, the threshold $\bar{E}$ is increasing in π and decreasing in a and τ_π. It is increasing in τ_b under some conditions specified in Appendix A.1.*

[28]Specifically, we collect terms to rewrite this expression as:

$$\frac{1}{1-\theta}\left\{p_1\left[1-\eta(1)\right]^{1-\theta} - p_0\right\}\left[(1-\tau_\pi)\pi + a\right]^{1-\theta} \geq \frac{1}{1-\theta}\left\{1 - p_0 - (1-p_1)(1-\eta(1))^{1-\theta}\right\}\left[(1-\tau_b)b + a\right]^{1-\theta}$$

$$\implies \quad \frac{1}{1-\theta}\left(\frac{(1-\tau_\pi)\pi + a}{(1-\tau_b)b + a}\right)^{1-\theta} \geq \frac{1}{1-\theta}\left(\frac{1 - p_0 - (1-p_1)(1-\eta(1))^{1-\theta}}{p_1(1-\eta(1))^{1-\theta} - p_0}\right).$$

See Appendix A.1 for details. The threshold in equation (7) defines the level of (net of taxes) benefits below which agents choose to exert effort. If benefits are too high, no one has an incentive to exert effort, because they know they will be covered if they fail, and the payoff to putting in effort is then too small. Lemma 1 tells us that this threshold is higher if the returns to being an entrepreneur increase, which means that agents choose to exert effort at higher levels of the benefit when net profits go up. This is the case if the profits increase, or if the tax rate faced by entrepreneurs, τ_π, decreases. Moreover, agents exert effort at higher levels of the benefits for lower levels of the private asset a. This is in line with our intuition that assets can be considered a type of private insurance. Under plausible conditions, depending on the relationship between net profits and initial assets, the threshold for gross benefits increases in τ_b. Since higher taxes on benefits leave less net benefits for the failed entrepreneur, they have stronger incentives to put in effort to increase their chances of success.

To summarize, the solution to the effort choice is given by:

$$e(\Omega) \equiv \begin{cases} 1 & \text{if LHS of equation (4)} \geq \text{RHS of equation (4)}, \\ 0 & \text{if LHS of equation (4)} < \text{RHS of equation (4)}\ , \end{cases} \tag{8}$$

with $\Omega = (b, \tau_b, \tau_\pi, \eta(1), \eta(0), \theta, t)$. Note that while t is defined as $t = \{a, w, \pi\}$, the effort choice does not depend on wages, w. The agent then makes her occupational choice taking this optimal effort level into account.

3.2 Occupational Choice

The occupational choice is between becoming an entrepreneur, E, and being a worker, W. Entrepreneurship is risky. In what follows, to simplify the notation, define $p\,(e(\Omega)) \equiv \hat{p}\,(\Omega)$, where $e(\Omega)$ is the optimal effort level according to equation (8). With probability $\hat{p}\,(\Omega)$ agents succeed and make entrepreneurial profits π. The probability of success is thus a function of the effort choice, as defined in equation (1).

The total income of a worker, y_W, is given by $(1-\tau_w)w + a$, where τ_w is the tax faced by workers and w is the wage. For an entrepreneur, income, y_E, is $(1-\tau_\pi)\pi + a$ with probability $\hat{p}\,(\Omega)$, and $(1-\tau_b)b + a$ with probability $1-\hat{p}\,(\Omega)$. We compare the expected utility that agents get if they choose to be entrepreneurs to the utility from being workers (remember that agents consume all of their income). Just like the probability of success, the cost depends on the effort choice through the cost function $\eta(e)$. For simplicity, define $\eta\,(e(\Omega)) \equiv \hat{\eta}\,(\Omega)$, where $e(\Omega)$ again is the optimal effort level according to equation (8). The cost function is defined in equation (2).

Agents choose between being entrepreneurs and workers to maximize their expected utility. We set up the incentive compatibility constraint for this choice. For an agent to choose entrepreneurship, we require that the expected utility from choosing to be an entrepreneur is at least as high as that from choosing to be a worker:

$$\frac{1}{1-\theta}\left\{\hat{p}\left(\Omega\right)\left[(1-\tau_{\pi})\pi+a\right]^{1-\theta}+\left(1-\hat{p}\left(\Omega\right)\right)\left[(1-\tau_{b})b+a\right]^{1-\theta}\right\}\left[1-\hat{\eta}\left(\Omega\right)\right]^{1-\theta}$$
$$\geq\frac{1}{1-\theta}\left[(1-\tau_{w})w+a\right]^{1-\theta}, \tag{9}$$

where we can write the left-hand side as $E[U^{E}(y_{E},e\left(\Omega\right))]$ and the right-hand side as $U^{W}(y_{W})$. The option that gives the highest value according to

$$E[U(y)]=\max\left\{E[U^{E}(y_{E},e\left(\Omega\right))],U^{W}(y_{W})\right\} \tag{10}$$

determines the occupational choice. Next, we solve for a threshold value of net of taxes benefits, $\bar{T}$, for agents to choose entrepreneurship:

Proposition 2 *There exists a threshold $\bar{T}$ consistent with the incentive compatibility constraint in equation (9) that defines the cutoff for public insurance above which agents choose to become entrepreneurs:*

$$(1-\tau_{b})b\geq\bar{T}=$$
$$\left\{\frac{1}{1-\hat{p}\left(\Omega\right)}\cdot\frac{1}{\left[1-\hat{\eta}\left(\Omega\right)\right]^{1-\theta}}\cdot\left[(1-\tau_{w})w+a\right]^{1-\theta}-\frac{\hat{p}\left(\Omega\right)}{1-\hat{p}\left(\Omega\right)}\cdot\left[(1-\tau_{\pi})\pi+a\right]^{1-\theta}\right\}^{\frac{1}{1-\theta}}$$
$$-a. \tag{11}$$

See Proof 2 in Appendix A.2 for details. In order to derive comparative-statics properties for how primitives affect $\bar{T}$, it is useful to define κ as follows:

$$\kappa=\Big\{\frac{1}{1-\hat{p}\left(\Omega\right)}\cdot\frac{1}{\left[1-\hat{\eta}\left(\Omega\right)\right]^{1-\theta}}\cdot\left[(1-\tau_{w})w+a\right]^{1-\theta}$$
$$-\frac{\hat{p}\left(\Omega\right)}{1-\hat{p}\left(\Omega\right)}\cdot\left[(1-\tau_{\pi})\pi+a\right]^{1-\theta}\Big\}^{\frac{\theta}{1-\theta}}.$$

Next, we show comparative statics results conditional on the assumption that $\kappa>0$. This is the case if the following conditions are satisfied:

Assumption 2

$$\frac{1}{\left[1-\eta(1)\right]^{1-\theta}}\cdot\left[(1-\tau_{w})w+a\right]^{1-\theta}>p_{1}\cdot\left[(1-\tau_{\pi})\pi+a\right]^{1-\theta},$$
$$\left[(1-\tau_{w})w+a\right]^{1-\theta}>p_{0}\cdot\left[(1-\tau_{\pi})\pi+a\right]^{1-\theta},$$
$$\theta>1.$$

Lemma 2 summarizes the comparative statics for the expression in (11):

Lemma 2 *Consider parameter values such that Assumption 2 is satisfied. Then the threshold $\bar{T}$ increases in w and decreases in τ_{w}.*

Comparative statics for π, τ_π, τ_b and a require some more thought. A change in any of these variables can also have an impact on the effort choice, and thus on the effective probability of success $p(e)$. For example, the threshold $\bar{T}$ decreases in π. If the agent's optimal effort choice goes from $e = 0$ to $e = 1$, because of the increase in profits, then the effect on $\bar{T}$ is reinforced because of the increase in the probability of success. An increase in τ_π, on the other hand, increases the threshold $\bar{T}$. If effort also goes down, the effect on $\bar{T}$ is reinforced as the probability of success is diminished. Furthermore, higher initial assets lower the threshold as long as they do not push the agent from $e = 1$ to $e = 0$, because the threshold for effort decreases in assets. If the optimal effort level changes, this counteracts the effect on the occupational choice threshold. Finally, the threshold in terms of gross benefits is increasing in τ_b, at a given effort level. Since entrepreneurship is risky, lower net benefits for unsuccessful entrepreneurs makes entrepreneurship a less attractive option. But if higher taxes on benefits shifts the optimal effort choice from $e = 0$ to $e = 1$, there exists a counteracting force. See Appendix A.2 for a verbal proof.

The threshold for the occupational choice, in equation (11), gives us the level of (net of taxes) benefits above which agents choose to become entrepreneurs. If the benefits are too low, agents will choose the safe option of being workers instead. If the return to successful entrepreneurs increases, this threshold decreases and more agents choose entrepreneurship. The opposite is true at higher incomes from being a worker or higher tax rates facing entrepreneurs. Furthermore, if the probability of success is high, agents accept less risk-sharing and the threshold is lower.

Finally, a higher level of initial assets has an ambiguous effect on the occupational threshold, since the level of initial assets can also affect the effort choice. However, if the effort choice is unchanged, a higher level of initial assets imply a lower threshold, and then agents choose entrepreneurship at lower levels of the benefits. This implies that private risk-sharing, in that case, can function as a substitute for public risk-sharing.

The solution to the problem in equation (10) is an indicator function:

$$\mathbf{O}(\tau_\pi, \tau_w, b, \tau_b, \theta, t) = \begin{cases} 1 & \text{if } E, \\ 0 & \text{if } W. \end{cases}$$

3.3 The Government Budget and Taxation

Here, we specify the type of public risk-sharing available in the model and how the benefit level, b, is determined. We model public risk-sharing as benefits from the government, i.e., the financial support received by unsuccessful entrepreneurs. To highlight that wages and profits vary with the type t, we here denote wages w_t and profits π_t. The government operates a balanced budget, which means that expenditures need to equal revenue. Remember that we defined $p(e(\Omega)) \equiv \hat{p}(\Omega)$.

Expenditures are then defined as:

$$
\begin{aligned}
E &= \int b\left[1-\hat{p}\left(\Omega\right)\right]\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt \\
&= b\int\left[1-\hat{p}\left(\Omega\right)\right]\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt,
\end{aligned}
$$

i.e., as the integral over types t, where b are benefits paid out to unsuccessful entrepreneurs (which do not vary with type t), $1-\hat{p}\left(\Omega\right)$ is the share of entrepreneurs who are not successful, as a function of the optimal effort choice, $\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)$ is the indicator function from the occupational choice, i.e., it is one if the agent is an entrepreneur and zero if the agent is a worker, and $F(t)$ is the distribution over types t. Revenues are given by:

$$
\begin{aligned}
R &= \int \tau_\pi\pi_t\hat{p}\left(\Omega\right)\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt \\
&\quad+\int \tau_b b\left[1-\hat{p}\left(\Omega\right)\right]\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt \\
&\quad+\int \tau_w w_t\left[1-\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)\right]F(t)dt \\
&= \tau_\pi\int \pi_t\hat{p}\left(\Omega\right)\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt \\
&\quad+\tau_b b\int\left[1-\hat{p}\left(\Omega\right)\right]\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt \\
&\quad+\tau_w\int w_t\left[1-\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)\right]F(t)dt,
\end{aligned}
$$

where $1-\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)$ is equal to one if the agent is a worker. A balanced budget requires that expenditures equal revenues:

$$
\begin{aligned}
b\int\left[1-\hat{p}\left(\Omega\right)\right]\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt = &\quad \tau_\pi\int \pi_t\hat{p}\left(\Omega\right)\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt \\
&+\tau_b b\int\left[1-\hat{p}\left(\Omega\right)\right]\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt \\
&+\tau_w\int w_t\left[1-\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)\right]F(t)dt. \qquad (12)
\end{aligned}
$$

We solve for b, the benefit that an individual entrepreneur can expect in case of failure, as:

$$
b=\frac{\tau_\pi\int\pi_t\hat{p}\left(\Omega\right)\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt+\tau_w\int w_t\left[1-\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)\right]F(t)dt}{(1-\tau_b)\int\left[1-\hat{p}\left(\Omega\right)\right]\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)F(t)dt}. \qquad (13)
$$

3.4 Equilibrium Definition

Given a population distributed according to the function $F(t)$, an equilibrium of this model is defined by:

1. The effort level of an agent is determined by equation (8).
2. The occupational choice of an agent is defined by $\mathbf{O}(\tau_\pi,\tau_w,b,\tau_b,\theta,t)$, which solves equation (10).
3. The government runs a balanced budget in line with equation (12).

4 A Quantitative Illustration of the Model

We now turn to a quantitative evaluation of the model. Here we solve the model for different levels of taxes on profits and wages, which in turn result in different benefit levels. We look at the share of agents who choose to become entrepreneurs and the share of entrepreneurs who exert effort, as well as the composition of entrepreneurs in terms of assets (private risk-sharing), wages, and profits. For the quantitative evaluation we make the simplifying assumption that $\tau_b = \tau_w$.

4.1 Calibration

Agents are characterized by their type t, i.e., some level of wages w, profits π, and initial assets a. For the calibration of $F(t)$, we first assume that the marginal distributions for these three variables are log-normal and choose parameters from data for the United States. We select μ_w from the log of median earnings and σ_w to match the income Gini in the United States. For initial assets, we use information on net wealth in the United States. The positive part of the net wealth distribution is fairly well represented by a log-normal distribution. Thus, we choose parameter values from the net wealth distribution and assume a log-normal distribution. We select the parameter μ_a from the log of median net wealth in the United States. We select σ_a to match the net wealth Gini coefficient.[29] We also need to specify the distribution for profits. Here, we assume that the μ-parameter for profits is the same as for wages, i.e., that $\mu_w = \mu_\pi$, but that the profits have a higher σ-parameter: $\sigma_w < \sigma_\pi$. Specifically, we assume that $\sigma_\pi = \sigma_w + 0.5$.

We first simulate 1,000,000 values of w, π, and a, which gives us a sample of 1,000,000 individuals, or types. Specifically, we construct the three distributions by first drawing three marginal normal distributions with a specified correlation structure $\mathcal{R} = \{\rho_{w,a} = 0.24, \rho_{\pi,a} = 0.54, \rho_{\pi,w} = 0.09\}$. The baseline correlation structure is based on the information in Rios-Rull and Kuhn (2016), with a lower correlation structure between business income and wage income. Since this information is based on observed data and we would like to think of potential (and not necessarily realized) profits and wages, we also solve the model for other correlation structures ($\rho_{w,a} = 0.4$ and $\rho_{\pi,a} = 0.4$, respectively) and find qualitatively similar results. In the next step we transform the marginal distributions into log-normal variables that are related through the co-variance matrix.[30] This step gives us three log-normally distributed variables with the correlation matrix $\mathcal{R}$. To study the relevant questions, our population of interest consists of individuals who choose between a secure job

[29] Specifically, we select values for median earnings and median net wealth, as well as the respective Gini coefficients, from Rios-Rull and Kuhn (2016). We compute σ_w from the definition of the Gini coefficient, G, for a log-normal distribution:

$$G = \text{erf}\left(\frac{\sigma}{2}\right) \quad \Rightarrow \quad \sigma = 2\text{erf}^{-1}(G).$$

A Gini coeffiicient of earnings of $G_w = 0.67$ then implies $\sigma_w = 1.3776$, and a Gini coefficient of wealth of $G_a = 0.85$ implies $\sigma_a = 2.0358$. We can also compute σ from the formula $\sigma^2 = 2\ln\left(\frac{\text{mean}}{\text{median}}\right)$. Using the mean-to-median ratios from Rios-Rull and Kuhn (2016) (6.49 for wealth and 1.96 for earnings), this method implies $\sigma_w = 1.1601$ and $\sigma_a = 1.9340$. In a robustness check using these values, we find qualitatively similar results.

[30] We use the Matlab-function MvLogNRand for this step.

and entrepreneurship by opportunity. Therefore, we focus on individuals with above mean wages.[31] Finally, we remove individuals in the top 99 percent of the asset distribution, and solve the model for this distribution. The resulting sample consists of around 250,000 individuals. The parameters that remain to be specified are θ, p_1 and p_0, and η. We set θ, the coefficient of relative risk aversion, to 1.5 following Cagetti and De Nardi (2006). In our baseline model, we set $p_1 = 0.5$ and $p_0 = 0.1$, which implies that there is a substantially higher probability of success if the individual entrepreneur chooses to exert effort.[32] In the baseline calibration, we assume that the cost of effort, η, is 0.012, implying that the utility of entrepreneurs who exert effort is scaled by 0.988.[33]

4.2 Results

We solve the model for 15 different values of the tax rate for profits $\tau_\pi \in \{0.10, .., 0.90\}$ and 3 values of the tax rate for wages $\tau_w \in \{0.10, 0.25, 0.40\}$. For each combination of τ_π and τ_w, we iterate on possible values for the benefit, b, to solve equation (13). To find total expenditures and total revenues, we need to know the number of agents who choose to be entrepreneurs and workers, respectively, given a benefit level b. For this purpose, we first solve the effort choice and the occupational choice for the each individual for a given level of b. Then, knowing the probability of success $p(e)$, as a function of the optimal effort choice, we calculate total revenues and expenditures. We update the guess of b until the government budget is balanced. In Figure 4 we present our main findings from the solution to the model in terms of the occupational and effort choice, along with the average characteristics of entrepreneurs.

Finding 1: The relationship between the share of entrepreneurs and the tax rate on profit follows an inverse u-shape. The share of individuals who choose to be entrepreneurs increases in the tax rate on profits up until a turning point (panel (a) in Figure 4), and this pattern is more pronounced the lower τ_w is. Higher taxes on profits also, all else equal and up until a turning point, imply higher benefits that make more individuals willing to choose the risky profession of being entrepreneurs. Since the revenue from taxes is only used to finance benefits to unsuccessful entrepreneurs, incentives to be a worker are weaker at higher tax rates τ_w.

[31] Results are qualitatively similar if we instead use the median as the cutoff.

[32] If an individual is more optimistic about her chances of success, it is more likely that she will choose to become an entrepreneur. The Global Entrepreneurship Monitor surveys individuals across different countries about these types of expectations and shows that American entrepreneurs are more confident in terms of perceived capability, fear of failure, and job creation as compared to Swedish entrepreneurs, which probably affects both their effort and the occupational choice. See Table C.2 in Online Appendix C. In our setting, all these factors boil down to the probability of success.

[33] As a sensitivity analysis we can solve the model for different parameter values. A higher cost of effort, $\eta = 0.05$, implies that the share exerting effort is, not surprisingly, lower than in the baseline specification, whereas a smaller difference in the probability of success, $p_1 = 0.3$ and $p_2 = 0.1$, implies that effort has a more limited effect on the probability of success resulting in fewer individuals exerting effort and choosing entrepreneurship.

Finding 2: The share exerting effort decreases with higher taxes. At higher tax rates, a lower share of entrepreneurs optimally exert effort (panel (b) in Figure 4). As higher tax rates on profits generally increase benefits, this reduces the difference between returns of successful and unsuccessful entrepreneurs and lowers the incentives to exert effort. Furthermore, the share exerting effort is decreasing in τ_w. As taxes on wages increase, the opportunity cost of becoming an entrepreneur goes down, but the level of benefits also increases – weakening incentives to exert effort.

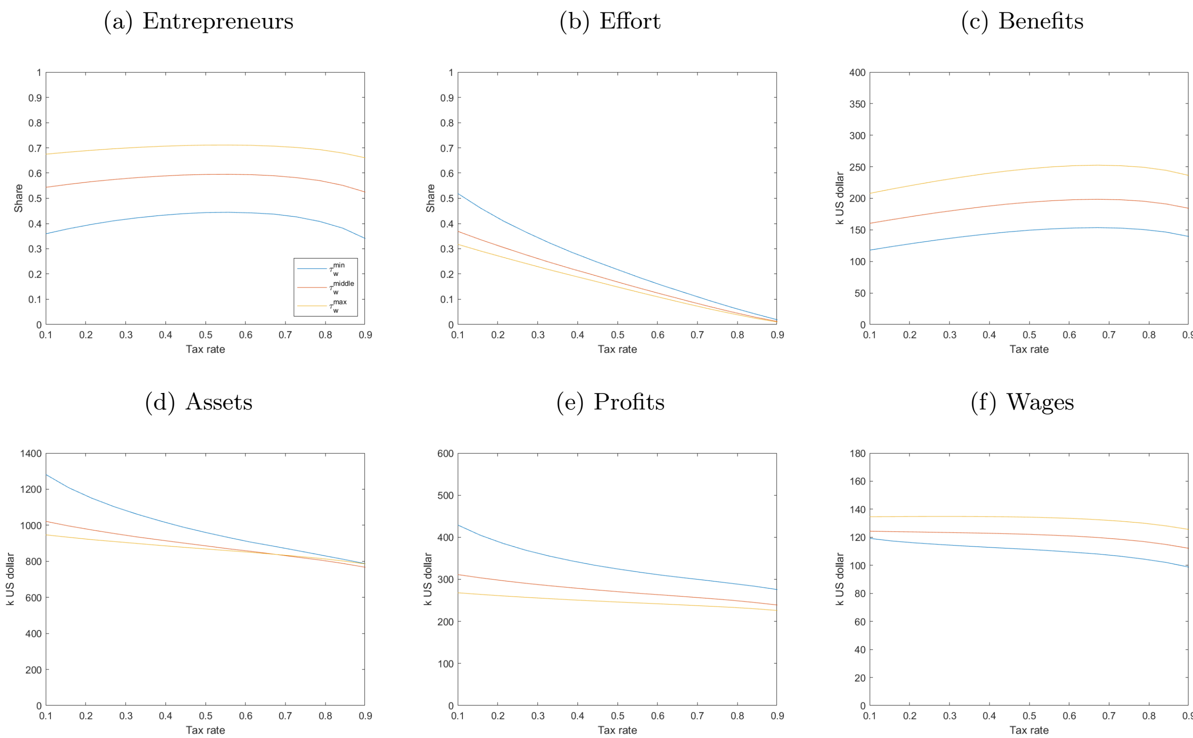
Finding 3: Benefits for unsuccessful entrepreneurs are concave in taxes on profits. The equilibrium benefit level is determined by solving the government's balanced budget, given individuals' effort and occupational choices. In equilibrium, the relationship between benefits and taxes on profits is similar to the share of entrepreurs (Finding 1). Up until tax rates on profits of 60 percent, benefits increase as the tax rate goes up (panel (c) in Figure 4). There is an interplay between the share of individuals choosing entrepreneurship and benefits paid out to unsuccessful entrepreneurs. At the highest tax rates, fewer individuals choose to become entrepreneurs and those who do on average have lower profits (see Finding 5). At the same time, the share of entrepreneurs exerting effort decreases as taxes on profits increase, implying that a larger share will be unsuccessful and require benefits. Finally, in our simple model, benefits are increasing in taxes on wages as higher tax rates, all else equal, can fund higher benefits paid out to unsuccessful entrepreneurs.

Finding 4: Average entrepreneurial wealth decreases with higher taxes. As taxes on profits increase, average entrepreneurial wealth decreases (panel (d) in Figure 4). This is also true for higher levels of taxes on wages. Remember that entrepreneurial wealth is equal to initial assets among those who choose entrepreneurship and that it is excluding profits. In addition to public risk-sharing in terms of benefits paid out to unsuccessful entrepreneurs, we think of initial assets as another type of (private) risk-sharing.

Finding 5: Average profits decrease with higher taxes on profits. There are two reasons why average profits decrease with higher taxes on profits (panel (e) in Figure 4). At lower tax rates on profits (corresponding to lower benefits), when the share of entrepreneurs is still increasing, only individuals with high profits choose to become entrepreneurs. When more individuals choose to be entrepreneurs at higher tax rates (and higher benefits), the average profit among entrepreneurs decreases. At the highest tax rates on profits, fewer individuals choose entrepreneurship, but there is selection in that those who do choose to become entrepreneurs have on average lower profits.

Finding 6: Average wages decrease with higher taxes on profits. Average wages among entrepreneurs are higher when taxes on wages are higher (panel (f) in Figure 4). This is related to the opportunity cost, as individuals with high wages in general have more to lose from choosing entreprenership, but less so when taxes on wages are higher.

Figure 4: Entrepreneurs and their Characteristics



The exercise in this paper is clearly simple, but it sheds light on some important mechanisms. Evaluating the model, we find that the share of entrepreneurs and equilibrium benefits paid out to unsuccessful entrepreneurs increase with higher tax rates on profits, up until tax rates of around 0.60–0.70. In addition, higher tax rates affect the average characteristics of individuals who choose entrepreneurship. In particular, average profits and average entrepreneurial wealth decrease. We do not take a strong stance on the optimal level of entrepreneurship, but in this model there is some selection at play at very high tax rates.[34] The average characteristics of entrepreneurs, of course, depend on the particular distributions that we specify, but if we think of profit as a quality, or an ability-metric of the potential entrepreneur, we do not want those with very low profits, to become entrepreneurs. In our simple model, this is even more of a concern if tax rates are the

[34] We can also briefly consider implications for welfare by defining total utility across the different tax rates. Total utility is defined as the sum of the utility of workers and entrepreneurs:

$$U(\tau) = \sum_{i=1}^{N_W} U_i^W(y_W, \tau_\pi, \tau_w) + \sum_{i=1}^{N_E} E[U_i^E(y_E, e(\Omega), \tau_\pi, \tau_w)] \tag{14}$$

where N_W and N_E are the number of workers and entrepreneurs, respectively. Overall, total utility has an inverse u-shape, similar to the share of entrepreneurs and benefits, and decreases in the tax rate on wages.

same for workers and entrepreneurs, because then – when tax rates are very high – there are no longer any incentives to be a worker (as tax revenue is only spent on unsuccessful entrepreneurs). At the same time, as taxes on profits increase, fewer entrepreneurs choose to exert effort. This is in line with the incentive motive highlighted in Acemoglu et al. (2017), as our calibration ensures that less than perfect consumption insurance is a prerequisite to motivate entrepreneurs to exert effort. Lower effort implies a lower probability of success. If innovation was modeled as a product of the effective number of entrepreneurs, i.e., the number of entrepreneurs times their probability of success, this would, for a given number of entrepreneurs, dampen the innovative output.

That more individuals choose entrepreneurship as taxes increase, up until tax rates of around 0.60, on the other hand, is in line with the literature that highlights the importance of insuring downside risk to ensure that individuals choose to become entrepreneurs; see, e.g., Garcia-Penalosa and Wen (2008) and Gaillarda and Kankanamge (2019). Garcia-Penalosa and Wen (2008) find a higher growth rate with redistributive policies in a model with Schumpeterian growth, operating through the endogenous occupational choice.[35] To relate back to the impact on innovation, if the technology for innovation is again defined by the product of the number of entrepreneurs times their probability of success, then, all else equal, an increase in the number of entrepreneurs also has a positive effect on growth. The total impact from higher tax rates depends on the response along both margins: the extensive margin, through the occupational choice, and the intensive margin, through the effort choice. In our baseline calibration, where effort has a large impact on the probability of success, the number of effective entrepreneurs is strictly decreasing in taxes.

5 Conclusion

Using country-level data we show a positive relationship between risk-sharing and innovation, measured both as patents and self-employment by opportunity. Inequality, on the other hand, is negatively related to innovation. We then build a simple model with two decision margins – an occupational choice and an effort choice – along which we think that risk-sharing matters. This allows us to evaluate the role of private and public risk-sharing. We show that, for a given effort level, if entrepreneurship is made more attractive relative to being a worker, individuals become entrepreneurs at lower levels of the public insurance. Higher initial asset holdings, all else equal, also imply a lower threshold to become an entrepreneur, as these holdings provide a form of private risk-sharing. There is a threshold in terms of the public insurance below which it is optimal for entrepreneurs to exert effort. This threshold is higher if the returns to entrepreneurs are high, or if the level of initial assets is low. Our theoretical exercise, although simple in nature, highlights some important mechanisms and suggests that there can be several ways to promote innovation, including both public and private risk-sharing. In the quantitative evaluation of the model we highlight that higher public risk-sharing in terms of benefits is overall related to a larger share of

[35] Gaillarda and Kankanamge (2019) highlight that ability and wealth are key determinants in the occupational choice in their model and that the type of policy implemented to encourage entrepreneurship has important effects for the pool of entrepreneurs.

individuals choosing entrepreneurship and lower average initial assets of entrepreneurs (our measure of private risk-sharing). But there is a cost to promoting innovation using higher levels of public risk-sharing, both at the intensive margin and through selection. Benefits are funded by taxes and as taxes on profits increase, there is a decrease in the share of entrepreneurs exerting effort. Also, at very high tax rates on profits, the share choosing entrepreneurship goes down and the quality of entrepreneurs (their average profits) decreases.

Our analysis is limited to focusing on the importance of risk-sharing for innovation and entrepreneurship. However, there are clearly other factors that matter for innovation and for incentives to become an entrepreneur, that are likely to differ across countries. Expectations and perceptions are likely to matter for both the occupational choice and the effort choice, possibly beyond what is motivated by rational forward-looking. For example, if the potential entrepreneur is very (and possibly too) optimistic about her chances of success, it is more likely that she will actually choose to become an entrepreneur. It is clear that the perceived probability of success also matters for the effort choice. Furthermore, we abstract from differences in preferences that may motivate also the very wealthy to work hard. For example, a dynamic setting could incorporate a motive to stay wealthy. Finally, we take wages, profits and initial assets as exogenously given and abstract from the formation of these variables. For future work, it can be interesting to model heterogeneity in ability and endogenous human capital formation. These types of extensions would allow a richer analysis of the pool of entrepreneurs.

References

Acemoglu, D., Robinson, J., and Verdier, T. (2017). Asymmetric Growth and Institutions in an Interdependent World. *Journal of Political Economy*, 125(5):1245–1305.

Aghion, P., Akcigit, U., Hyytinen, A., and Toivanen, O. (2017). The Social Origins and IQ of Inventors. Working Paper 23047, NBER.

Akcigit, U., Grigsby, J., and Nicholas, T. (2017). The Rise of American Ingenuity: Innovation and Inventors of the Golden Age. Working Paper 23047, NBER.

Akcigit, U. and Stantcheva, S. (2020). Taxation and Innovation: What Do We Know? Working Paper 27109, NBER.

Alesina, A. and Rodrik, D. (1994). Distributive Politics and Economic Growth. *Quarterly Journal of Economics*, 109:465–490.

Banerjee, A. and Duflo, E. (2000). Inequality and Growth: What Can the Data Say? *Journal of Economic Growth*, 8(3):267–299.

Banerjee, A. and Newman, A. (1993). Occupational Choice and the Process of Development. *Journal of Political Economy*, 101(2):274–298.

Barrios, J. M., Hochberg, Y. V., and Yi, H. (2020). Launching with a Parachute: The Gig Economy and New Business Formation. Working Paper 27183, NBER.

Barro, R. J. (2000). Inequality and Growth in a Panel of Countries. *Journal of Economic Growth*, 5:5–32.

Bell, A. M., Chetty, R., Jaravel, X., Petkova, N., and Van Reenen, J. (2019). Who Becomes an Inventor in America? The Importance of Exposure to Innovation. *Quarterly Journal of Economics*, 134(2):647–713.

Bick, A., Brüggemann, B., and Fuchs-Schündeln, N. (2019). Hours Worked in Europe and the US: New Data, New Answers. *Scandinavian Journal of Economics*, 121(4):1381–1416.

Bird, E. J. (2001). Does the Welfare State Induce Risk-taking? *Journal of Public Economics*, 80:357–383.

Bloomberg Innovation Index (2021). https://www.bloomberg.com/news/articles/2021-02-03/south-korea-leads-world-in-innovation-u-s-drops-out-of-top-10[Accessed June 28, 2021].

Botelho, T. L., Fehder, D., and Hochberg, Y. (2021). Innovation-Driven Entrepreneurship. Working Paper 28990, NBER.

Cagetti, M. and De Nardi, M. (2006). Entrepreneurship, Frictions, and Wealth. *Journal of Political Economy*, 114(5):835–870.

Celik, M. (2018). Does the Cream Always Rise to the Top? The Misallocation of Talent in Innovation. Mimeo.

Gaillarda, A. and Kankanamge, S. (2019). Entrepreneurship, Labor Market Mobility and the Role of Entrepreneurial Insurance. Working Paper 929, Toulouse School of Economics.

Galor, O. and Zeira, J. (1993). Income Distribution and Macroeconomics. *The Review of Economic Studies*, 60(1):35–52.

Garcia-Penalosa, C. and Wen, J.-F. (2008). Redistribution and Entrepreneurship with Schumpeterian Growth. *Journal of Economic Growth*, 13:57–80.

Global Entrepreneurship and Development Index (2018). (https://thegedi.org/global-entrepreneurship-and-development-index/[Accessed March 9, 2020]).

Global Innovation Index (2020). (https://www.globalinnovationindex.org/analysis-indicator[Accessed June 28, 2021]).

Gottlieb, J. D., Townsend, R. R., and Xu, T. (2021). Does Career Risk Deter Potential Entrepreneurs? Working Paper 22446, NBER.

Hall, P. and Soskice, D. (2001). *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*. Oxford University Press.

Hassler, J. and Rodriguez-Mora, J. V. (1999). Employment Turnover and the Public Allocation of Unemployment Insurance. *Journal of Public Economics*, 73:55–83.

Hassler, J. and Rodriguez-Mora, J. V. (2000). Intelligence, Social Mobility, and Growth. *American Economic Review*, 90(4):888–908.

Hassler, J., Rodríguez-Mora, J. V., and Zeira, J. (2007). Inequality and Mobility. *The Journal of Economic Growth*, 12:235–259.

Henrekson, M. and Stenkula, M. (2016). *Understanding Entrepreneurship – Definition, Function and Policy*. Lund: Studentlitteratur AB.

Hombert, J., Schoar, A., Sraer, D., and Thesmar, D. (2020). Can Unemployment Insurance Spur Entrepreneurial Activity? *Journal of Finance*, 75(3):1247–1285.

ISSP Research Group (2018). ('International Social Survey Programme: Social Inequality IV - ISSP 2009.' GESIS Data Archive, Cologne. ZA5400 Data file Version 4.0.0, doi:10.4232/1.12777).

Kihlstrom, R. E. and Laffont, J.-J. (1979). A General Equilibrium Entrepreneurial Theory of Firm Formation Based on Risk Aversion. *Journal of Political Economy*, 87(4):255–283.

Koellinger, P. and Minniti, M. (2009). Unemployment Benefits Crowd Out Nascent Entrepreneurial Activity. *Economic Letters*, 103:96–98.

Kreiner, C. T., Munch, J. R., and Whitta-Jacobsen, H. J. (2015). Taxation and the Long Run Allocation of Labor: Theory and Danish Evidence. *Journal of Public Economics*, 127:74–86.

Laitner, J. and Ohlsson, H. (2001). Bequest Motives: A Comparison of Sweden and the United States. *Journal of Public Economics*, 79(1):205–236.

Lindbeck, A. and Nyberg, S. (2006). Raising Children to Work Hard: Altruism, Work Norms, and Social Insurance. *The Quarterly Journal of Economics*, 121(4):1473–1503.

Mankiw, N. G. (2013). Defending the One Percent. *Journal of Economic Perspectives*, 27(3):21–34.

Moser, P. (2005). How Do Patent Laws Influence Innovation? Evidence from Nineteenth-Century World's Fairs. *American Economic Review*, 95(4):1214–1236.

Neves, P., Afonso, O., and Silva, S. T. (2016). A Meta-Analytic Reassessment of the Effects of Inequality on Growth. *World Development*, 78:386–400.

OECD Wages and Benefits (2015). Tax and Benefit Systems: OECD Indicators. http://www.oecd.org/social/benefits-and-wages.

Okun, A. M. (1975). *Equality and Efficiency: The Big Tradeoff*. Brookings Institution.

Olovsson, C. (2009). Why Do Europeans Work so Little? *International Economic Review*, 50(1):39–61.

Parker, S. C. and Robson, M. T. (2004). Explaining International Variations in Self-Employment: Evidence from a Panel of OECD Countries. *Southern Economic Journal*, 71(2):287–301.

Perotti, R. (1996). Growth, Income Distribution, and Democracy: What the Data Say. *Journal of Economic Growth*, 1(2):149–187.

Persson, T. and Tabellini, G. (1994). Is Inequality Harmful for Growth? *American Economic Review*, 84:600–621.

Quadrini, V. (2000). Entrepreneurship, Saving, and Social Mobility. *Review of Economic Dynamics*, 3(1):1–40.

Rios-Rull, J.-V. and Kuhn, M. (2016). 2013 Update on the U.S. Earnings, Income, and Wealth Distributional Facts: A View from Macroeconomics. Quarterly Review 21247, Federal Reserve Bank of Minneapolis.

Solt, F. (2016). The Standardized World Income Inequality Database. *Social Science Quarterly*, 97. SWIID Version 5.0, October 2014.

Spiganti, A. (2021). Inequality of Opportunity, Inequality of Effort, and Innovation. Unpublished Paper, Ca' Foscari University in Venice.

A Model Appendix

A.1 Effort Choice

Here we show details for Proposition 1 and Lemma 1. First, Proof 1 shows how we solve for the threshold $\bar{E}$.

Proof 1 *For threshold $\bar{E}$ in Proposition 1, consider equation (4) and solve for $(1-\tau)b$:*

$$\frac{(1-\tau_\pi)\pi + a}{(1-\tau_b)b + a} \geq \left(\frac{1-p_0-(1-p_1)(1-\eta(1))^{1-\theta}}{p_1(1-\eta(1))^{1-\theta}-p_0}\right)^{\frac{1}{1-\theta}}$$

$$= \underbrace{\left(1+\frac{1-[1-\eta(1)]^{1-\theta}}{p_1[1-\eta(1)]^{1-\theta}-p_0}\right)^{\frac{1}{1-\theta}}}_{\equiv A}.$$

$$\frac{(1-\tau_\pi)\pi + a}{(1-\tau_b)b + a} \geq A$$

$$\implies (1-\tau_b)b \leq \frac{(1-\tau_\pi)\pi + a}{A} - a. \tag{15}$$

Define the threshold $\bar{E}$ as the cutoff value in equation (15) below which agents' incentive compatibility constraint is satisfied:

$$(1-\tau_b)b \leq \bar{E} = \frac{(1-\tau_\pi)\pi + a}{A} - a. \tag{16}$$

Comparative statics for $\bar{E}$ Here we show the comparative statics described in Lemma 1. We see that the threshold $\bar{E}$ increases in π, and decreases in a and τ_π. The threshold for gross benefits, $\tilde{E}$, depends on some conditions specified below.

$$\frac{\partial \bar{E}}{\partial \pi} = \frac{1-\tau_\pi}{A} > 0, \tag{17}$$

$$\frac{\partial \bar{E}}{\partial a} = \frac{1-A}{A} < 0, \tag{18}$$

$$\frac{\partial \bar{E}}{\partial \tau_\pi} = -\frac{\pi}{A} < 0. \tag{19}$$

To examine the impact of taxes on benefits, τ_b, we define:

$$b \leq \tilde{E} = \frac{(1-\tau_\pi)\pi + a}{(1-\tau_b)A} - \frac{a}{1-\tau_b}, \tag{20}$$

and the derivative is then:

$$\frac{\partial \tilde{E}}{\partial \tau_b} = \frac{1}{(1-\tau_b)^2}\left[\frac{(1-\tau_\pi)\pi + a}{A} - a\right] \gtrless 0. \tag{21}$$

For $\frac{(1-\tau_\pi)\pi+a}{A} - a > 0$, the derivative $\frac{\partial \tilde{E}}{\partial \tau_b} > 0$. The sign of the derivative thus depends on the relationship between net of taxes profits and assets.[36]

[36] If instead taxes on benefits and profits are the same, the derivative is given by $\frac{\partial \tilde{E}}{\partial \tau} = \frac{a[1-A]}{(1-\tau)^2} < 0$.

A.2 Occupational Choice

Here we show details for Proposition 2 and Lemma 2. First, Proof 2 shows how we solve for the threshold $\bar{T}$.

Proof 2 *For threshold $\bar{T}$ in Proposition 2, consider equation (9) and solve for $(1-\tau)b$:*

$$\frac{1}{1-\theta}\Big\{p\left(e\right)\left[(1-\tau_\pi)\pi+a\right]^{1-\theta}+\left(1-p\left(e\right)\right)\left[(1-\tau_b)b+a\right]^{1-\theta}\Big\}\left[1-\eta\left(e\right)\right]^{1-\theta}$$
$$\geq\frac{1}{1-\theta}\left[(1-\tau_w)w+a\right]^{1-\theta}$$
$$\Longrightarrow(1-\tau_b)b\geq\Big\{\frac{1}{1-p\left(e\right)}\cdot\frac{1}{\left[1-c\left(e\right)\right]^{1-\theta}}\cdot\left[(1-\tau_w)w+a\right]^{1-\theta}$$
$$-\frac{p\left(e\right)}{1-p\left(e\right)}\cdot\left[(1-\tau_\pi)\pi+a\right]^{1-\theta}\Big\}^{\frac{1}{1-\theta}}-a. \tag{22}$$

Define the threshold $\bar{T}$ as the cutoff value in equation (22) above which agents' incentive compatibility constraint is satisfied:

$$(1-\tau_b)b\geq\bar{T}=$$
$$\left\{\frac{1}{1-p\left(e\right)}\cdot\frac{1}{\left[1-\eta\left(e\right)\right]^{1-\theta}}\cdot\left[(1-\tau_w)w+a\right]^{1-\theta}-\frac{p\left(e\right)}{1-p\left(e\right)}\cdot\left[(1-\tau_\pi)\pi+a\right]^{1-\theta}\right\}^{\frac{1}{1-\theta}}$$
$$-a. \tag{23}$$

In the following, we will first derive comparative statics relating changes in primitives like π to changes in $\bar{T}$, taking effort choice as given. We then factor in how these primitives affect the effort choice at the very end.

Comparative statics for $\bar{T}$ for given effort choice Here we show the comparative statics described in Lemma 2. To simplify, let κ, for a given effort choice, be defined as:

$$\kappa=\Big\{\frac{1}{1-p\left(e\right)}\cdot\frac{1}{\left[1-\eta\left(e\right)\right]^{1-\theta}}\cdot\left[(1-\tau_w)w+a\right]^{1-\theta}$$
$$-\frac{p\left(e\right)}{1-p\left(e\right)}\cdot\left[(1-\tau_\pi)\pi+a\right]^{1-\theta}\Big\}^{\frac{\theta}{1-\theta}}.$$

We show comparative static results conditional on $\kappa>0$, i.e., under the conditions in Assumption 2. The threshold $\bar{T}$ decreases in π and τ_w, and it increases in w and τ_π.

$$\frac{\partial \bar{T}}{\partial \pi} = -\kappa \cdot [(1-\tau_\pi)\pi + a]^{-\theta} \cdot \frac{p\,(e)\,(1-\tau_\pi)}{1-p\,(e)} < 0, \tag{24}$$

$$\frac{\partial \bar{T}}{\partial w} = \kappa \cdot [(1-\tau_w)w + a]^{-\theta} \cdot \frac{(1-\tau_w)}{1-p\,(e)} \cdot \frac{1}{[1-\eta\,(e)]^{1-\theta}} > 0, \tag{25}$$

$$\frac{\partial \bar{T}}{\partial \tau_w} = -\kappa \cdot [(1-\tau_w)w + a]^{-\theta} \cdot \frac{w}{1-p\,(e))} \cdot \frac{1}{[1-\eta\,(e)]^{1-\theta}} < 0, \tag{26}$$

$$\frac{\partial \bar{T}}{\partial \tau_\pi} = \kappa\pi \frac{p(e)}{1-p(e)} \, [(1-\tau_\pi)\pi + a]^{-\theta} > 0. \tag{27}$$

For the probability of success, $p\,(e)$, and initial assets, a, the following comparative statics hold under additional, plausible, conditions specified below:

$$\begin{aligned}\frac{\partial \bar{T}}{\partial p\,(e)} &= \frac{1}{1-\theta} \cdot \kappa \cdot \frac{1}{(1-p\,(e))^2} \cdot \Big[\frac{1}{[1-\eta\,(e)]^{1-\theta}} \, [(1-\tau_w)w + a]^{1-\theta} \\ &\quad - [(1-\tau_\pi)\pi + a]^{1-\theta} \Big] < 0, \end{aligned} \tag{28}$$

$$\begin{aligned}\frac{\partial \bar{T}}{\partial a} &= \kappa \cdot \frac{1}{1-p\,(e)} \{ \frac{1}{[1-\eta\,(e)]^{1-\theta}} \, [(1-\tau_w)w + a]^{-\theta} - p\,(e)\,[(1-\tau_\pi)\pi + a]^{-\theta} \} \\ &\quad - 1 < 0. \end{aligned} \tag{29}$$

The sign for $p\,(e)$ in equation (28) is conditional on the expression inside the outer brackets being larger than zero (since $\theta > 1$ and, thus, the first term $\frac{1}{1-\theta}$ is negative). The first term in the bracket is multiplied with a factor between zero and one (the denominator is larger than one, when $e = 1$, or equal to one, when $e = 0$). As long as the return from being a successful entrepreneur is sufficiently high relative to the return from being a worker, the derivative is therefore negative. Specifically, we require that:

$$\frac{1}{[1-\eta\,(e)]^{1-\theta}} \, [(1-\tau_w)w + a]^{1-\theta} > [(1-\tau_\pi)\pi + a]^{1-\theta}.$$

The sign for a in equation (29) is conditional on $\theta > 1$, as well as $(1-\tau_w)w + a$ and $(1-\tau)\pi + a$ being larger than one. To see this, rewrite equation (29), including the explicit expression for κ, to show that:

$$\begin{aligned} \kappa \cdot \frac{1}{1-p\,(e)} \{ \frac{1}{[1-\eta\,(e)]^{1-\theta}} \, [(1-\tau_w)w + a]^{-\theta} - p\,(e)\,[(1-\tau_\pi)\pi + a]^{-\theta} \} &< 1 \\ \{ \frac{1}{[1-\eta\,(e)]^{1-\theta}} \, [(1-\tau_w)w + a]^{-\theta} - p\,(e)\,[(1-\tau_\pi)\pi + a]^{-\theta} \} &< \frac{1}{\kappa \cdot \frac{1}{1-p(e)}} \\ \Longrightarrow \{ \frac{1}{[1-\eta\,(e)]^{1-\theta}} \, [(1-\tau_w)w + a]^{-\theta} - p\,(e)\,[(1-\tau_\pi)\pi + a]^{-\theta} \} &< \\ [1-p\,(e)]^{\frac{1}{1-\theta}} \left(\frac{1}{[1-\eta\,(e)]^{1-\theta}} \cdot [(1-\tau_w)w + a]^{1-\theta} - p\,(e)\,[(1-\tau_\pi)\pi + a]^{1-\theta} \right)^{\frac{\theta}{\theta-1}} & \end{aligned}$$

Because $[1-p(e)]^{\frac{1}{1-\theta}} > 1$, and $\frac{\theta}{\theta-1} > 1$, we only require that total returns for a successful entrepreneur and a worker, respectively, are both larger than one. As long as this holds, the expression on the left-hand side is smaller than the expression on the right-hand side.

Finally, to examine the impact of taxes on benefits, τ_b, we define a threshold $\tilde{T}$ in terms of gross benefits:

$$b \geq \tilde{T} = \frac{1}{(1-\tau_b)}\Big\{\frac{1}{1-p(e)} \cdot \frac{1}{[1-\eta(e)]^{1-\theta}} \cdot [(1-\tau_w)w + a]^{1-\theta} - \frac{p(e)}{1-p(e)} \cdot [(1-\tau_\pi)\pi + a]^{1-\theta}\Big\}^{\frac{1}{1-\theta}} - \frac{a}{(1-\tau_b)},$$

The derivative is then:

$$\frac{\partial \bar{T}}{\partial \tau_b} = \frac{1}{(1-\tau_b)^2}\Big\{\frac{1}{1-p(e)} \cdot \frac{1}{[1-\eta(e)]^{1-\theta}} \cdot [(1-\tau_w)w + a]^{1-\theta} - \frac{p(e)}{1-p(e)} \cdot [(1-\tau_\pi)\pi + a]^{1-\theta}\Big\}^{\frac{1}{1-\theta}} > 0. \tag{30}$$

where the sign is conditional on $\kappa > 0$.

Comparative statics for $\bar{T}$ taking effort choice into account For the threshold $\bar{T}$, equation (24) showed that high profits imply a low threshold to become an entrepreneur. However, if profits increase, we know from Lemma 1 and equation (17) that agents exert effort at higher levels of the benefit. If this change shifts the agent from $e = 0$ to $e = 1$, it increases the probability of success. An increase in $p(e)$ then implies a lower threshold for the occupational choice. Thus, if the increase in profits also pushes the agent to exert effort, the probability of success increases, and the threshold for the occupational choice is lowered even more.

The threshold $\bar{T}$ instead increases in τ_π - see equation (27) - the tax rate faced by entrepreneurs. We know that agents only exert effort at lower levels of the benefit for higher tax rates on profits; see equation (19). Thus, if an increase in taxes implies lower effort, then the probability of success goes down, reinforcing the increase in the threshold for the occupational choice.

For assets, a, the derivative for the threshold $\bar{T}$ is also negative, see equation (29). Because higher initial assets lower the incentives to exert effort - see equation (18) - this is, however, only true for agents whose effort choice is not affected. If the effort choice is affected and the probability of success is reduced, this counteracts the decrease in the occupational threshold.