Demographics and Entrepreneurship

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Abstract

Entrepreneurship requires creativity and business acumen. Creativity may decline with age, but business skills increase with experience in high level positions. Having too many older workers in society slows entrepreneurship. Not only are older workers less innovative, but more significant is that when older workers occupy key positions they block younger workers from acquiring business skills. A formal theoretical structure is presented and tested using the Global Entrepreneurship Monitor data. The results imply that a one-standard deviation decrease in the median age of a country increases the rate of new business formation by 2.5 percentage points, which is about forty percent of the mean rate. Furthermore, older societies have lower rates of entrepreneurship at every age.

1. Introduction

Few doubt the role of entrepreneurship in fostering economic growth. Without new business creation, it is difficult to imagine that game-changing technologies can make their way into the economic environment. Existing companies can modernize and update their products and techniques of production, but the major innovations tend to be associated with entrepreneurship and the formation of new companies.

Many significant inventions of the last 150 years illustrate the point. Thomas Edison invented the light bulb and founded General Electric. The inventor of the automobile was Karl Friedrich Benz, followed closely by Gottlieb Wilhelm Daimler. Daimler-Benz is the product of their inventions. Alexander Graham Bell invented the telephone and founded AT&T. Guglielmo Marconi, the inventor of radio, was a founder of Wireless Telegraph & Signal in Britain. The Wright Brothers founded The Wright Company, which later became Curtiss-Wright. Steven Wosniak, who invented the personal computer, teamed up with Steve Jobs to form Apple. The list goes on.

In the last 50 years, most of the developed world has experienced a dramatic demographic shift. Japan is a case in point. Almost immediately after World War II, Japan's fertility rate fell rapidly and dropped below replacement level in the 1960s. Currently, Japan's fertility rate is one of the lowest in the world at 1.3, which means each generation will shrink by 40%. Similarly, the fertility rates of the European countries also fell in the 50-60s, and currently are at around 1.6 on average, which means each generation will shrink by 20%. In fact, the U.S. is the only major developed country with replacement level fertility and some major developing countries, like China, also have below replacement fertility rates. In the near future, an aging and shrinking workforce likely will be the norm for most of the world.

The general trend towards an aging and shrinking workforce is unprecedented. Its impact on future economic development can be profound. Standard economic theory views the effect

of aging on the economy primarily through its effect on reducing the size of the labor force, and through the fiscal drain associated with government support of a larger fraction of the population. This effect can be offset at least partially by extending the retirement age, as many countries have already done.[1,2]

The focus here is on another mechanism by which not only the supply of workforce, but also the age structure of the workforce, can have a significant impact on economic performance through the channel of entrepreneurship. Some studies already attribute Japan's "lost decades" to its "entrepreneurship vacuum" since the 1990s. But what causes this vacuum? Age structure is the answer emphasized here. A worker in a country with a younger workforce, like the United States, will be more entrepreneurial than a worker in a country with an older workforce, like Japan.

The argument is that entrepreneurial capability depends on two types of abilities: creativity and business acumen. Although the results offer no direct test of either of the effect of creativity or business acumen on entrepreneurship, the findings are in complete alignment with the predictions of the theory based on these two factors. Furthermore, some of the borne-out predictions are subtle and are not produced in a coherent fashion by other hypotheses.

Creativity refers to the ability to think in novel ways so as to break away from products and production methods of the past. In the theory, younger workers are assumed to be more creative. Additionally, business skill is acquired through on-the-job experience, which depends on the jobs to which individuals are assigned. Workers who do low-level, menial tasks are unlikely to acquire the kind of business skill that will make them successful entrepreneurs. Workers who are placed in roles that give them decision making authority

[1] Schwarz and Demirgue-Kunt (1999) document 17 countries around the world that extended their mandatory retirement age during 1992 to 1998. Many of these are OECD countries, e.g., Czech Republic (change from 60 to 62), Ireland (65 to 66), Italy (60 to 62), and New Zealand (60 to 65). Examples occurring after 1998 include France, changing from 60 to 62 in 2010, and Germany, changing from 65 to 67 in 2012.

[2] In fact, many scholars hold the view that the threat of aging has been overstated. Proposed solutions to deal with the labor shortage problem include: extension of retirement age (Herrmann, 2012), attracting international migration from labor-surplus countries (Bloom, Canning, and Fink, 2010, Herrmann, 2012), accumulation of human capital and increases in labor productivity (Prettner, 2013), etc. A recent paper by Vogel, Ludwig, and Borsch-Supan (2013) evaluates these alternative methods and finds that policies promoting human capital formation in combination with an increase in the retirement age are effective in reducing welfare loss due to demographic transitions.

and the experience of different management situations acquire more business skills that translate into operating a successful firm.

The skill acquisition factor, which derives from Becker's seminal work on human capital (e.g., Becker, 1962, 1975), accounts for the bulk of the findings. Becker postulated that workers would acquire human capital through on-the-job training and that the augmentation of their stock of human capital would affect their productivity and earning capacity. That same view is adopted here. Workers may begin with raw talent and inherent creativity, but the acquisition of skills at work is essential to their founding a business. It is for that reason that the young are not the ones most likely to start businesses, even if they are the most creative. They must have time to obtain the skills on the job that will allow business that they found to succeed.

Becker (1960) emphasized the ability of economics to explain fertility and demographic structure. Becker showed how prices, the most important of which was the implicit price of time as captured by the wage rate of the mother, affected desired fertility. This analysis takes the demographic structure as given, but allows demographics to affect the rate of skill acquisition. It is this interaction between demographics and skill acquisition that allows the economic framework below, which is in the spirit of Becker, to explain how entrepreneurship rates vary across countries, by age, and over time.

As an extension of the Becker notion of human capital accumulation on the job, it is hypothesized that rank in the firm affects an individual's exposure to experiences that produce the human capital necessary to start a business. Rank proxies the opportunity to encounter the relevant experiences. Workers in higher positions shoulder more responsibility, have more interaction with other decision makers and are in positions to see the larger picture. The higher one is in an organization, the more opportunity to gain experience that will be useful in starting an enterprise.

It is for this reason that the demographic structure of a country affects human capital formation. The probability of being in top positions depends on the age structure of the workforce. If a firm has an old workforce, it is less likely that the younger workers will be

given much management opportunity because the slots are already occupied by the more senior workers. In young firms, even top positions are held by relatively young people. It is for that reason that the age structure of a country is potentially an important determinant of entrepreneurship. A young society provides more opportunity for the young and most creative to acquire the skills necessary for entrepreneurship. Combining the notion that the young may be more creative with the Becker idea that skills are acquired on the job, over time, and only when the environment for learning is right, generates two important predictions.[3]

First, the relation of entrepreneurship to age is inverted u-shaped. The very young do not have the requisite human capital and the very old have lost their creativity. The second prediction links demographics directly to entrepreneurship. Workers are less likely to become entrepreneurs in a country where the cohort size is shrinking over time. In an aging country, there is a higher proportion of senior workers, which slows down promotion of junior workers. As a consequence, human capital accumulates more slowly for the younger workers because they must wait longer to be in those positions that are most conducive to skill production. As a result, in steady-state, workers at every age have less of the human capital required to start businesses and entrepreneurship is suppressed. This mechanism is labeled the "rank effect," and is new to the literature.

The model is tested using a unique dataset on cross-country entrepreneurship called the Global Entrepreneurship Monitor (Global Entrepreneurship Research Association, GERA, 2010). It is, at this point, the only large-scale cross-country dataset on entrepreneurial activity and age. The cross-country regressions support the theory laid out below and the effects of demographics are large. The estimates imply that a median age that is one standard deviation

[3] See Galenson (2001). Acemoglu, Akcigit and Celik (2014) find that innovation is related to a society's openness to disruptive ideas. They find that manager and inventor age are negatively related to the innovativeness of an invention. The general willingness to accept disruption may also be inversely related to the age of a society. The specific implications that are derived by our theory are not part of their argument. For example, the inverted u-shape relation of entrepreneurship with age and the fact that younger countries have a less pronounced u-shape pattern, derived below, come directly from the theory in this paper, but not from other theories absent additional modifications.

lower is associated with a 2.5 percentage point higher country rate of entrepreneurship, which is about 40% of the mean rate. This effect is significant both statistically and economically, and is robust across different specifications, alternative measures of entrepreneurship, and among OECD and non-OECD countries.

To better understand this point estimate, it is important to distinguish the "rank" from the simple "creativity" explanation, the latter merely saying that young people are more innovative. Most directly, without the rank effect or some other considerations [4], entrepreneurship would fall monotonically with age. The youngest individuals in the labor force would be the ones starting businesses. In fact, that is not the case. Although there is variation across countries, Figure 1 (discussed in more detail below) makes clear that the likelihood of starting a business rises at least until the 30s and in some countries, later in life. To explain this, it is necessary that other attributes necessary for business creation rise with age.

An alternative would be to simply assume that the relation of creativity to age is inverted-u-shaped. The second piece of evidence provides the strongest support for the rank effect. *Within* every age group, the entrepreneurship rate is lower in countries that are older. This can have nothing to do with entrepreneurship rates that vary between ages, but must instead be explained by something that relates entrepreneurship at a given age to the demographic structure of the country. Although there may be other factors that are captured by a country's demographic structure that could affect entrepreneurship, it will be shown that the specific predictions of the theory that links human capital acquisition to the age distribution is completely consistent with the findings in ways that other views are not.

The data used provide no direct evidence on creativity and rank (or skill acquisition) effects.[5] However, as mentioned, the model gives very specific predictions, all of which are supported by the data. Of course, there may be alternative mechanisms that could yield

[4] For example, the ability to obtain physical capital for investment might be age related.

[5] In a typical seniority based firm, with a larger older cohort, young workers are promoted much more slowly. In 1976, 32% of the "Manager" grade workers were younger than 35; in 1994 the ratio dropped to only 16% (Dore, 1996). Consistent with the human capital acquisition notion, the age earnings profile has flattened. For workers born from 1945 to 1949, real wages at age 35 are about 2.6 times the starting wage. For workers born 20 years later, real wages at age 35 are only 2.0 times the starting wage (Shire, 2008).

similar implications. An attempt is made to address some alternative theories, which do not seem to be supported by the results. The theory presented below is logical, straightforward, and supported by the evidence.

As an empirical matter, the rank effect is more important than the composition effect. Although the young may be more creative than the old, the fact that the young are denied training opportunities afforded by higher rank accounts for the low rate of entrepreneurship in an aging society. Cross-country within-age group variation does the bulk of the work, not the fact that the young are more entrepreneurial than the old in the average country.

2. The Effect of Age on Entrepreneurship

2.1. A Motivating Anecdote: Japan's Entrepreneur Vacuum and the Lost Decades

The Japanese economy grew rapidly in the 1970 and 1980s, and many economists predicted that it would soon over-take the U.S. in terms of GDP per capita. However, after the bust of real estate bubble in 1991, the Japanese economy stagnated during the following 20 years, while the U.S. economy pulled ahead again, benefiting from a vigorous high-tech industry. Hot debates about the cause of Japan's lost decades are still going on, but one possible explanation of slow growth is the lack of entrepreneurship and the failure to develop a dynamic IT industry as the U.S. did during the last 30 years. Five of the top 10 high tech companies in the U.S. were founded after 1985, and their founders were also very young when they established these companies, with an average age of only 28. By contrast, in Japan, none of the top 10 high-tech companies were founded in the last 40 years. New firm entry rate dropped from the 6 to 7% range in the 1960s and 1970s to 3% in the 1990s (Acht, Thunik, and Verheut, 2004), which amounts to less than 1/3 of that in the U.S. and trails all the other OECD countries (Karlin, 2013). According to the entrepreneurship survey used in this paper, entrepreneurial propensity in Japan is the lowest among all the developed countries. In the US, 4.9% adults between the ages of 18 and 64 are working actively to establish new businesses, as compared to only 1.9% in Japan.

Interestingly, it should be noted that Japan's "entrepreneur vacuum" is not due to the lack of technological investment. The country's R&D spending accounts for about 3% of its GDP, ahead of all the other OECD countries. Japan still enjoys considerable patent advantages in Asia (Karlin, 2013). However, many of these patents are significantly underutilized. Perhaps the cause of Japan's lagging in entrepreneurship is not the dearth of ideas or opportunities, but the dearth of necessary capabilities to recognize and exploit these opportunities and to convert the innovative ideas into creation of new firms.

2.2. Determinants of Entrepreneurship over Lifetime

Among all the determinants of the decision to engage in entrepreneurship, age is among the most obvious factors to consider (see Parker, 2006, p106). Data from the Global Entrepreneurship Monitor, Figure 1, which divides countries into young, middle, and old, show the changes in entrepreneurial propensity at different ages. One noticeable stylized fact is that all three curves are inverted U-shaped, with the likelihood of becoming entrepreneur peaking for the young-middle aged people. This observation is consistent with many existing studies (e.g., Blanchflower and Meyer, 1994; Blanchflower and Oswald, 2009; Modragon-Velez, 2009).

[Figure 1 is here]

Some attributes necessary for successful entrepreneurship clearly decrease over the life cycle. As a logical matter, the productivity-age pattern for virtually all work activities must be an inverted-u. Young children do not have the skills, strength or wisdom to be very productive. The very old possess neither the energy, stamina, nor mental acuity to carry out complex assignments. The issue is determining the peak of the U and how the shape of the productivity-age relationship varies with the activity in question. There is much research, primarily outside economics, on age-productivity patterns. For example, Ruth and Birren (1985) discuss the decline in the ability to conduct logical thinking and reasoning as an individual ages. Florida (2002) argues that creativity can wane with aging. The young have advantages in the ability to store and process information, solve problems, deal with

complexity, and adjust to new situations (Kaufman and Horn, 1996; Ryan, Sattler, and Lopez, 2000). A recent paper by Acemoglu et al.(2014) studies the relationship between creativity and age of the inventor and the manager, and find that inventor and manager age are negatively correlated with creativeness of the invention.

Still, successful entrepreneurship must require more than the energy and creativity of youth or the entrepreneurship rate would peak among fresh graduates (around 20 years old). Lazear (2004a) found that entrepreneurship demands a diverse set of skills, rather than specialized knowledge. Many of these skills need to be accumulated through work, social interactions, and learning-by-doing. For example, "tacit knowledge" accumulated over a lifetime peaks when a person is in his or her 50s (Wang and Kaufman 1993; Kaufman and Horn 1996; Ryan, Sattler, and Lopez, 2000). Moreover, it is helpful for aspiring entrepreneurs to develop a strong social network, which is assists their ability to access resources in different phrase of establishment process (Granovetter, 1985). The importance of networks in launching a business has been well documented by empirical studies in different cultural settings (e.g, Greve and Salaff, 2003; Wellman, 1999).

2.3. Demographic Structure and Entrepreneurship

Another pattern apparent in Figure 1 is that entrepreneurship in countries with a younger workforce first-order dominates those in countries with an older workforce. At every age, the entrepreneurship rate of the older countries is lower than that of middle and younger countries. This implies that the propensity to become an entrepreneur at any given age is lower when the country has a higher median age. Furthermore, the effect is especially pronounced for middle-aged individuals between 30 and 40 years of age. Both empirical findings, that older countries have lower entrepreneurship at every age and that the differences are greatest for middle age workers, are direct implications of the model below (and do not follow easily from alternative explanations).

3. Model

3.1. Age structure of the Workforce

Suppose a country's cohort size by age is given by

$$f(a,r) = N_0 \frac{r}{e^r - 1} e^{ra} \quad (1)$$

where N_0 is the country's population size, a is age, and r is the shrinkage parameter that relates the size of one cohort to another.[6] Normalize age a such that $a=0$ is age 20, i.e. which might be a typical starting work age, and $a=1$ is age 65, i.e., a typical retirement age. Then the fraction of workforce under age a, or the age distribution c.d.f.,[7] is given by the following expression:

$$F(a,r) = \frac{e^{ra} - 1}{e^r - 1} \quad (2)$$

Figure 2 compares the age distribution of a balanced workforce ($r=0$) to the age distributions of shrinking ($r=0.22$) and growing workforces ($r=-2.18$). (These two values of r are chosen to reflect the empirical parameter estimates for Japan and Uganda, respectively, which are at the two extremes of shrinking and growing populations.)[8]

[Figure 2 is here]

Two properties of the population c.d.f. are important for deriving the propositions that follow later.

First,

Lemma 1. For $F(a,r) = \frac{e^{ra} - 1}{e^r - 1}$, There exists an $a_m \in [0,1]$ such that for all $a < a_m$, $\frac{d^2F}{drda} < 0$, and for $a > a_m$, $\frac{d^2F}{drda} > 0$.

Proof: See appendix.

[6] This exponential form in age is a simplified version of the conventional function that captures the stable age distribution. See Lotka (1922).

[7] The corresponding formula for the c.d.f. is: $F(a,r) = \int_0^a S(a,r)da / \int_0^1 S(a,r)da$

[8] The estimation of r is discussed below in section 5.1.

Lemma 1 says that the rank of the middle-aged workers shifts more with a reduction in the population growth rate than the rank of the very young and very old.

Second, and more important for the logic of the propositions that follow later, is lemma 2.

Lemma 2. *For* $F = \frac{e^{ra}-1}{e^{r}-1}$ and $0<a<1$, $\frac{dF}{dr} < 0$

Proof: See appendix.

This states that the proportion of people below age *a* decreases in *r* for all ages (0 and 1 excepted, of course). This is shown in figure 2(b) as a downward shift in the c.d.f. for as *r* increases.

3.2. The Value of Starting a Business

To model business formation, think of each person getting a random draw of an idea for a new product or method of production in each period. The novelty of the idea affects its market value. An idea is not sufficient, though, to create a successful business. In order to be successful, an idea must be implemented and the probability of successful implementation depends on the skills that a worker has acquired. Some luck is involved in getting a good idea, but skill and creativity affect the ability to come up with a significant innovation.

The expected value of an idea combines luck, ability and youth as follows. Let *v* denote the expected value of an idea relative to a worker's current wage. Then

$v = V(h, q)\ \xi$ (3)

where ξ is a random variable that captures luck, h reflects business skills and q captures creativity so that $V_1>0$ and $V_2>0$.

Assume that ξ is distributed over the range $(1,\infty)$. Or equivalently, $1/\xi$ is distributed over the range (0,1) with a c.d.f. $P(1/\xi)$. The risk-neutral worker will choose to start a business if

$v > 1$ or if $V(h,q) > 1/\xi$ (4)

The probability of starting a business is therefore *P(V(h,q))*.Although it is unnecessary to specify the nature of the ξ distribution, the general structure allows for a wide range of possibilities. For example, one possibility is to allow[9]

$$\xi = A + u_t \quad (5)$$

where *A* is a specific person's ability (like IQ), which remains constant over time, and u_t is luck of that the individual encounters in period *t* in getting an idea. At one extreme, the variance in *A* could be zero, in which case there would be independence of business formation across people over time. History of entrepreneurship would say nothing about the likelihood of starting a new business. At the other extreme, were the variance u_t equal to zero, then there would be serial entrepreneurship, where a person who started a business in one period would be the one who starts a business in subsequent periods. All of the variation in entrepreneurship would be across people, with none over time.[10]

Other than luck, there are two factors that affect the expected value of an idea. The first, *q*, is creativity and is determined by the function *q=Q(a).* Creativity is assumed to decrease with age, $Q'(a) < 0$.The second factor, *h*, reflects the stock of business skills, which is a reflection of past acquisitions of human capital. As argued earlier, a worker's ability to acquire skills depends on his position in the firm, which depends on his rank, defined as the proportion of workers younger than he. Let *s* denote rank. Then, *h=H(s)* with $H'>0$. If everyone is younger than someone of age *a*, then that individual has had the most opportunity to acquire the skills necessary to start a business. Conversely, if everyone is older than someone of age *a*, other cohorts have occupied the positions in the firm that provide the experience most valuable for entrepreneurship.

Assuming that the age distributions of every firm are the same as that of the general population, then $s \equiv F(a,r)$. The intuition is clear. Within each age group, the larger is the proportion of individuals who are younger than a worker, or equivalently, the smaller the proportion who are older than a worker, the more likely is that worker to hold positions that provide him with business skills. Also, lemma 2 implies that if $r_0 < r_1$ then $F(a, r_0) > F(a, r_1)$

[9] This transitory and permanent ability structure was used in Lazear (2004b).
[10] See LaFontaine and Shaw (2014).

$\forall a$. This implies that the worker who has more opportunity to gain business skills today also had more opportunity to gain those skills in the past because fewer are older than every cohort with r_0 than with r_1.

3.3. Entrepreneurial Activity

Recalling equation (4), a risk-neutral individual[11] will start a business if

$V(h,q) > 1/\xi$

with $V_1, V_2 > 0$. So the fraction of the workers at age *a* that start a business (denoted as *E(a,r)*) is given by:

$$E(a,r) = P(V(H(F(a,r)),Q(a))) \quad (6)$$

where $P(x)$ is the probability that $x>1/\xi$.

Equation (6) provides the basis of the theoretical propositions and empirical implications, which are tested below. It says that the entrepreneurship rate for any cohort *a* depends on the age distribution of the population as summarized by *r*, the shrinkage rate of the population.

The primary results to be tested and the empirical motivation for the analysis follow.

Proposition 1. Entrepreneurship at any given age *a* is decreasing in the population parameter, r. As r rises, reflecting both a declining and aging population, entrepreneurship falls. Specifically,

$$\frac{\partial E(a,r)}{\partial r} =< 0 \quad (7)$$

Proof: This follows directly from (6) since

$$\frac{\partial E(a,r)}{\partial r} = P' V_1 H' F_2$$

with $P' V_1 H' > 0$ and $F_2 < 0$ from (1).

[11] Alternatively, if we assume a constant relative risk aversion, the results in the model are essentially unchanged. Moreover, we can assume risk aversion increases with age. The effect is similar to having a steeper declining *Q* function, which will further reduce entrepreneurship of the older group.

Entrepreneurial activity decreases for every age group when *r* increases. An increase in *r* tilts the age distribution in favor of older workers. This corresponds to the fact, discussed in the introduction for selected countries, that the entrepreneurship propensity is lower at every given age for country with higher *r*.

Next, define s_a as the share of the population in a country that is below age *a* so $s_a = F(a,r)$ (the i subscript for country i is suppressed). Then

Corollary 1. For any given age group, *a*, the entrepreneurship rate rises in s_a or $\frac{\partial G(a, s_a)}{\partial s_a} > 0$.

Proof: Noting that $s_a = F(a,r)$, rewrite (6) as

$G(a,s_a) = P(V(H(s_a),Q(a)))$ (6')

Then

$$\frac{\partial G(a, s_a)}{\partial s_a} = P'V_1H' > 0$$

Propositions 1 and Corollary 1 relate to the rank effect. In aging societies, a worker at every age has a smaller proportion of the workforce below him. Because more slowly growing populations are disproportionately older, the ability of each age group to acquire the business skills necessary to become an entrepreneur is reduced. Consequently, the rate of business creation slows for every given age group.

Another corollary also follows.

Corollary 2. $\frac{\partial G(a, s_a)}{\partial a} < 0$

Proof: $\frac{\partial G(a, s_a)}{\partial a} = P'V_2Q' < 0$ because Q'<0 .

Corollary 2 says that older age groups should have lower entrepreneurship rates for any given share of the population that is below the group. Put simply, thirty-year-olds in country A should have lower rates of entrepreneurship than 29-year-olds in country B when s_{30} in country A equals s_{29} in country B. (Note that this does not contradict the earlier point that entrepreneurship rates first rise and then fall in age. In that comparison, s_a is not held constant.)

Proposition 1 and its corollaries are not sufficient to guarantee that the rate of entrepreneurship for the country as a whole declines with *r*. To make that statement, it must also be true that aging of the workforce does not shift the age distribution (sufficiently) in the direction of those age groups that are most likely to engage in entrepreneurial activity. Were this to happen, it is possible that the entrepreneurship rate for the country as a whole could rise from the change in composition of age groups, despite the fact that within every age group, entrepreneurship rates declined.

To derive the effect of changes in population growth on overall entrepreneurship, first integrate equation (6) over ages to obtain the total number of entrepreneurs as a fraction of the workforce in a country

$$\bar{E}(r) = \int_0^1 E(a,r)dF(a,r) \qquad (8)$$

Then the following proposition relates the country- (average-) level of entrepreneurship to population growth.

Proposition 2. The number of entrepreneurs as a fraction of the workforce decreases as the population ages, i.e., $d\bar{E}/dr < 0$.

Proof. See Appendix A.

Proposition 2 says that the average rate of entrepreneurship for the country as a whole declines as the population shrinks and ages. The expected rate of entrepreneurship varies with population growth rates both through the combination of the rank effect and the composition

effect of weighting groups with higher rates of entrepreneurship differently as the population parameter, *r*, changes. The latter is the standard composition effect that influences all averages across groups. It also yields the following corollary, which can be used in the empirical analysis.

Corollary 3. The number of entrepreneurs as a fraction of the workforce decreases with the population's median age.

Proof: See appendix.

Additionally, the entrepreneurial activity of the middle-aged group will be affected the most by a reduction in the population growth rate. By lemma 1, the rank distribution shifts down the most in the middle. It is also true that the entrepreneurship rate shifts down the most in the middle, as shown in Figure 1and formalized by Proposition 3.

First note that entrepreneurship varies with age and under certain conditions, peaks in middle age. From (6)

$$\frac{\partial E(a,r)}{\partial a} = (P')(V_1 H' F_1 + V_2 Q') \qquad (9)$$

Since P', $V_1 H' F_1$, and P_2 are all positive and $Q' < 0$, the sign of $\partial E/\partial a$ is indeterminate. This is as it should be because it is expected that the propensity to start businesses first rises with age and then declines.

More concretely, sufficient conditions can be specified that guarantee that $E(a,r)$ first rises in a and then declines. The conditions are, first, that creativity does not decline much with age for the youngest individuals, specifically,

$$\lim_{a \to 0} Q'(a) = 0$$

and second, that the increment to business skills declines to zero as rank goes to one

$$\lim_{s \to 1} H'(s) = 0$$

The logic behind the latter condition is that once a cohort is older than most of the population, it already has sufficient seniority to hold the top jobs. At that point, additional seniority has little value for entrepreneurship training.

Given that Q'(0)=0,

$$\frac{\partial E(0,r)}{\partial a} = (P')(V_1 H' F_1) > 0$$

Also, since $s=1$ when $a=1$,

$$\frac{\partial E(1,r)}{\partial a} = (P')(V_2 Q') < 0$$

Thus, entrepreneurship first rises in age and then eventually declines in age. Thus, it is possible to state the following proposition.

Proposition 3

Given the assumptions that

$$\lim_{a \to 0} Q'(a) = 0$$

and that

$$\lim_{s \to 1} H'(s) = 0$$

the entrepreneurship rate rises in age initially and then declines in age at the end of life. Furthermore, there exists an age a_m with $0 < a_m < 1$ such that $E(a_m, r) > E(a, r) \; \forall \; a \neq a_m$.

Proof: It has already been shown that $\frac{\partial E(0,r)}{\partial a} > 0$, which means that there exists some $a_m > 0$ for which $E(a_m, r) > E(0, r)$. Similarly, because $\frac{\partial E(1,r)}{\partial a} =< 0$, it is also true that $E(a_m, r) < E(1,r)$. Simply define a_m to be that value of a that maximizes the rate of entrepreneurship.

Proposition 3 implies that there is a peak age of entrepreneurship somewhere in the middle of life.[12] Very young workers are less entrepreneurial than those at peak entrepreneurial age because they have not acquired the business skills. Very old workers are less entrepreneurial than peak age because they have lost their creative edge. The inverted u-shape relation of entrepreneurship to age distinguishes the theory set out here from other possible explanations of cross-country correlations between entrepreneurship and population demographics, as discussed in section 5, below.

The effect of demographics on the entrepreneurship rates is greater for some middle ages than it is for very old and very young ages. Specifically, it is certain that there is some age greater than zero and less than one at which the effect of r on E is more negative than it is at either ages of 0 or 1. This is formalized in the following proposition.

Proposition 4. There exists some a_M, $0<a_M<1$ such that $\frac{\partial E(a_M,r)}{\partial r} < \frac{\partial E(0,r)}{\partial r}$ and $\frac{\partial E(a_M,r)}{\partial r} < \frac{\partial E(1,r)}{\partial r}$ under the conditions that the first and second derivatives of V, H, Q exist and are bounded and that the first derivatives of V and H are greater than some small constant ε.

Proof. See Appendix A.

This proposition says that entrepreneurship rates of the middle-aged workers are the ones most sensitive to cross-country demographic differences.[13] In aging countries, it is the middle aged workers, as defined by age equal to a_M, who are most prone to decrease their rates of entrepreneurship as the population ages. Again, as spelled out in section 5, other theories that link entrepreneurship to demographics do not provide that implication without additional ad hoc assumptions.

[12] Without additional assumptions, it cannot be guaranteed that there is only one peak age. It is certain, however, that there exists some a^* between 0 and 1 at which $E(a^*,r) \geq E(a,r) \; \forall \; a \neq a^*$.

[13] Note that entrepreneurship declines in r so Proposition 4 says that the effect gets closer to zero at the two extreme ages of zero and one.

3.4.Country Level Aggregation and Summary of Empirical Predictions

Proposition 1 and its corollaries give the key predictions to be examined using the cross-country data. These theoretical statements imply that the rate of entrepreneurship within any age group is directly related to the rate of population growth and that holding constant the share of the population below any age group, older groups have lower rates of entrepreneurship than younger groups.

At the country level, demographics affect aggregate entrepreneurship through two channels – composition and rank. The effect of composition works through *Q(a)*. By assumption, younger workers are more creative. The proportion of the workforce that is young is determined by *F(a,r)* so increases in r imply a smaller proportion of young workers, which means less overall creativity in the population.

The effect of rank works through *H(F(a,r))*. An older workforce prevents young workers from obtaining the learning opportunities that help them start businesses. This skill deficiency stays with them throughout their careers relative to the stock of skills that they would have at any age had they acquired them when young. Aging populations generate low transmission of business skills to the young, creative members of society.

The empirical implications are clear and follow directly from the theory. They are:

1. Within any country, the effect of age on entrepreneurship is negative, holding the share of those below that age group constant. This is the implication of Corollary 2.

2. Holding age constant, the higher is s_a the higher is the rate of entrepreneurship. Stated differently, within any given age group, countries that have higher proportions of the population below that age should have higher rates of entrepreneurship. This is the implication of Corollary 1.

3.Countries that are aging more quickly, captured by higher levels of *r*, should have lower rates of entrepreneurship at any given age. This follows from Proposition 1.

4. Categorizing countries by their *r*, those with higher values of *r* should have lower rates of entrepreneurship overall. This is Proposition 2.

5. It also follows that countries with higher median ages should have lower entrepreneurship rates. This is the result of corollary 3.

6. Within a country, entrepreneurship rates rise with age and then decline after some point. This holds under the assumptions $\lim_{a\to 0} Q'(a) = 0$ and $\lim_{s\to 1} H'(s) = 0$. This is the result of Proposition 3.

7. The entrepreneurship rates of the middle-aged are most sensitive to cross-country changes in *r*. This follows from Proposition 4.

4. Data

4.1 Measures of Entrepreneurship

The primary data source for the cross-country comparisons is the Global Entrepreneurship Monitor (GEM), collected by a not-for-profit company, Global Entrepreneurship Research Association (GERA), in UK. Starting from 2000, GERA conducted telephone and face-to-face individual level interviews with representative sample of adult sample across a wide range of countries, evaluating their entrepreneurial activities, aspirations, and attitudes. The dataset has several features that suit the purpose of this study.

First, unlike other datasets that measure entrepreneurship at the firm level, GEM dataset captures entrepreneurial choices and decisions at the individual level, which is consistent with the theoretical modeling framework. Second, GEM has a wide range of coverage, including both developed countries and developing ones.[14] The 2000-2010 GEM dataset used contains more than 1.3 million individuals aged between 15 and 60 in 82 countries. It provides considerable cross-country variation in the age distribution, which is helpful for testing the hypothesis that demographic structure affects entrepreneurship. Third, GEM questionnaires are designed under a uniform framework with the goal of producing data that are comparable across countries.

[14] GEM is an ambitious project, with an estimated global budget of nearly $9 million . Its 2013 survey is designed to cover 75% of world population and 89% of world GDP (Bosma et al., 2012).

There are a number of different entrepreneurship rates that are reported in the GEM. For most of the empirical analysis, entrepreneurship is defined as "manages and owns a business that is up to 42 months old and pays wages". For robustness, section 5.6 reports results based on three alternative definitions of entrepreneurship. The first alternate definition, "all new businesses" includes businesses that have died in the last twelve months in addition to those already included by the 42 month criterion. Although the start date of a business that failed is not reported, it is well-known that new business are much more likely to fail than old ones so the deaths are probably dominated by newly formed firms. The second definition looks only at startups, defined as an owner actively involved in a startup effort that is not currently paying wages. The final definition, "total early stage entrepreneurship," includes startups that do not yet pay wages in addition to those managed and owned that are up to 42 months old. Businesses that failed are omitted from this definition. The qualitative conclusions are not sensitive to the choice of definition of entrepreneurship.

GEM also provides information on the aspiration levels of the entrepreneurs. First, the questionnaire asks about the number of employees expected to be hired in the next five years for the early-stage entrepreneurial activities. We construct two variables showing entrepreneurs if they intend to hire more than five (75 percentile) and more than 10 (90 percentile) worker, as two alternative measures of entrepreneurs with high aspiration. Second, GEM also asks the respondents to state whether the newly-created business that they are running involves new products or services. This is supposed to capture those entrepreneurs with innovative ambition.

Other than entrepreneurial activities, basic demographic information such as age of the interviewees is recorded as well. This study focuses on the population aged 20 to 64.

The survey was carried out in different countries in different years from 2001 to 2010. Many countries were surveyed multiple times, but the panel is an unbalanced one. (Refer to table B1 in Appendix B for detailed information on countries, timing of the survey, and sample size in the GEM data.) The total number of observations used at the individual level, which is confined to those between 20 and 64 years of age, inclusive, is 1.3 million. The

number of country-year cells is 393, and the number of country-age-year cells is 16,661. The entrepreneurship rate can be constructed at each cell level.

4.2 Demographics

The population statistics come from the U.S. Census Bureau's International Data Base (IDB).[15] The IDB is updated routinely and contains estimates and projections for over 200 countries and areas of the world. The IDB provides population counts by age from age 0 to 100-plus for each of the countries every year. The age-specific population detail contained in the IDB data is used by GEM as one important source to calculate its sampling weights (Bosma et al., 2012, page 56). Every country in the GEM sample from 2001 to 2010 can be matched with information from the IDB dataset to construct $s_{a,it}$, which is the share of the population below any age a in country i in year t .

4.3 Other Country Characteristics

Four country level attributes serve as controls in some of the analyses. First, year- and country-specific GDP-per-capita is obtained from Penn World Table, version 7.1 (Heston, Summers, and Aten, 2012). The data are PPP adjusted and deflated at the 2005 price level to make the numbers comparable across countries and over time. Second, the country- and year-specific rates of completed tertiary education among the adult population are obtained from a newly constructed education attainment dataset by Barro and Lee (2010). Third, year- and country-specific "start-up costs," defined as the cost to register a business as a percentage of gross national income (GNI) per capita in 2010, is available from the World Bank database.[16] Fourth, an international property rights index (IPRI) of is obtained from Property Rights Alliance (Strokova, 2010). It is constructed based on Legal and Political Environment, Physical Property Rights (PPR), and the Intellectual Property Rights (IPR) situation in each country. The index ranges between 0 and 10 and serves as a barometer of the security of property rights. This variable is available for all countries in the sample only in

[15] Available at: http://www.census.gov/population/international/data/idb/index.php
[16] Available at http://data.worldbank.org/

2010. As a result, the same value is assumed to hold in that country in all years. Last, we obtain the length of compulsory military service for each country in our sample from Wikipedia.[17] Table 1 presents the summary statistics (in 2010) of the main variables used in this paper.

[Table 1 is here]

5. Empirical Implementation

The theory provides specific implications about what should be observed empirically. In what follows, those theoretical implications are tested using the Global Entrepreneurship Monitor data.

Equation (6) implies that the entrepreneurship rate of each age group is affected by population growth parameters and in particular, by the age distribution of the population. The age distribution of the population is observable for each country, as is the entrepreneurship rate.

There are two variables of interest. The first is the age of the particular group. Younger individuals are hypothesized to be more creative, which works through $Q(a)$ directly. Additionally, the rank effect says that for any given age group, a, the higher the rank s of that group in the overall population, the higher is the entrepreneurship rate because those individuals have had better opportunities to acquire the skills necessary for entrepreneurship. This works through $H(s)$, or equivalently, through $H(F(a,r))$. As described in the data section, both a and s are observable in GEM and Population census data, respectively, a being the normalized age, which is a number between zero and one, and s being the proportion of individuals in a country who have ages younger than a.

The basic approach then is to estimate a model that captures the essence of equation (6). This requires examining the cross-country differences within an age group as well as differences within the "typical" country as age varies.

For most analyses, the unit of analysis is the country-age group because there is no variation in the independent variables at levels of aggregation more fine than that. Because

[17] Available at: http://en.wikipedia.org/wiki/Military_service. Accessed in Dec, 2014.

age and the proportion of the population below that age are the key variables, and because they do not vary at the individual level, the proper level of aggregation for most purposes is the age-country cell.[18]

5.1. Summarizing the Demographic Structure

The model of the demographic structure is simple where one parameter, *r*, captures the entire demographic structure (see equation (1)). This structure is not necessary because the actual s_a from the population data rather than the predicted ones as dictated by equation (1) can be used to create the explanatory variables. There is no need to rely on a single population statistic because the data pertinent to each country-age cell are readily available.

Still, it is useful for two reasons to see whether the demographic model postulated in (1) does a reasonable job of fitting the data. First, if it does, then the theoretical predictions of the model that are stated in terms of *r* are more applicable to the actual countries studied. Second, comparative statics, which are intuitive and straightforward in terms of the single parameter *r*, or almost equivalently as will be shown, median age, have clear interpretations.

There are a variety of ways to show the goodness-of-fit of the *r* model. For any given year, in each country, *r* can be estimated using the 45 age groups for that particular country. Using the c.d.f. form of equation (2), *r* is fitted for each country and each year taken separately, using non-linear least squares (NLS), where the dependent variable is the actual value of s_a for each age group within that country and the independent variable is simply *a*, with *r* to be estimated. There are 45 observations for each country corresponding to each age group within the country in a given year.

For the purposes of testing goodness-of-fit, the data from 2010 are used. Non-linear estimation generates $\hat{r}$ for each country. Given $\hat{r}$, a predicted s_a can be obtained for each of the 45 age groups in each country as

$$\hat{s}_a = \frac{e^{\hat{r}a} - 1}{e^{\hat{r}} - 1} \qquad (10)$$

[18] All estimates of standard errors are based on clustering at the country level, which is the level of treatment, in order to take into account that errors might not be independent, especially given the relatively fine partition of age. Additionally, standard errors are derived after weighting for cell size.

Then the actual s_a is regressed on the predicted $\hat{s}_a$ using the 57 countries included in the 2010 GEM data. There are 2,561 observations.[19] The regression generates an r-square of .998, which means that the share of the population below any given age *a* is predicted almost perfectly for the 2,561 age-country cells by the form where the age is the actual age (normalized) of the group in question and *r* is the country-specific *r*. Thus, the model of equation (1) and (2) fits the actual demographic data very well.[20]

Additionally, *r* is an almost perfect predictor of the country's median age. The country-size weighted correlation between *r* and median age across the 57 countries in 2010 is 0.98. As a consequence, representing the country's age structure by the more commonly used median age instead of *r* is likely to accurate for most purposes.

5.2. Country level analysis

It is first instructive to examine the raw data at the country level. Figure 3(a) plots a country's entrepreneurship rate against the median age (among those 20 to 64) of a country in 2010. Figure 3(b) is the same as Figure 3(a), but replaces median age with the country estimated *r*. The figures show 57 points, one for each country. The clear pattern is that the older the country's population, the lower is the entrepreneurship rate.

[Figure 3 is here]

The raw data appear to support proposition 2, which states that higher *r* (older) countries should have lower entrepreneurship rates. The various panels plot the entrepreneurship rate against *r* and against median age. They appear the same, which is not surprising since *r* and median age are so highly correlated. The pattern holds across all countries and also just within the OECD countries in panels 3(c) and 3(d), although the statistical relation for OECD countries in the single year of 2010 alone, which is what is shown, is not statistically significant.

[19] In principle, there should be (45 age groups) x (57 countries) = 2,565 age-country cells. But four of these cells with age above 60 are empty, which leaves us 2,561 cells.

[20] Much of this is because s_a is highly correlated with *a*. Even if cross-country variation is omitted and the mean value of *r* is used to predict $\hat{s}_a$, the r-squared is .96. Despite the correlation, s_a and *a* have independent and important effects on entrepreneurship rates, as shown below.

As a starting point, Table 2 reports the results of a more systematic analysis, presenting results of reduced form regressions at the country level of aggregation. Each observation in this table is a country-year combination, as available in the GEM data. To account for the fact that different countries were surveyed in different years and some countries were surveyed more years than other countries, year dummies are included in all specifications. Standard errors are clustered at the country level.[21]

[Table 2 is here]

Columns 1 and 2 regress the country's entrepreneurship rate on *r*, as estimated above. Column 1 does this for all countries, whereas column 2 restricts the analysis to OECD countries only. The results are clear - the higher the value of *r*, the lower the entrepreneurship rate. This is true in the full sample and also in the OECD restricted sample, albeit somewhat weaker in the OECD sample.

Columns 3 and 4 repeat the analysis, but replace *r* with the median age (among 20-64 year-olds) in the country. The results are similar.

Columns 5 and 6 add other explanatory variables. They are: the log of per-capita GDP, the five-year per-capita average growth rate, the tertiary education completion rate, an estimate of start-up costs as a percentage of gross national income, an index of intellectual property and a dummy for whether the country has more than one year of compulsory military service.[22] Although one or more of these variables sometimes enter significantly (depending on the subsample used), it remains true that *r* continues to be an important explanatory variable. The demographic structure does not appear to be a proxy for the other potential explanatory factors, at least the obvious candidates for which data are available. This is important because it suggests that other interpretations of demographics, like the average age of the population proxying the growth potential of the country, do not find strong support in the data. The more refined analyses below add more credence to this result.

[21] Counry-year clustering was also done, when relevant. None of the results on the demograhic variables was affected in any subtantive way.

[22] The logic of requiring more than one year of service is that soldiers cannot be expected to rise to a leadership position where they are given significant responsibility in less than one year.

One interesting result is that compulsory military service is positively related to entrepreneurship, both alone and interacted with *r*. This is consistent with the view of human capital acquisition posited by the theory. The military is one institution where very young people are given significant managerial responsibilities, primarily because the military has very few older individuals. As a consequence, being in the military is like working in a firm that has few older workers. The interaction with *r* is consistent with military service being an offset to to living in an older country. Although it tough for young workers to acquire the skills necessary to start a business in an older country, one way that this is accomplished is by having the young in positions of responsibility in the military.

Finally, column 7, 8, and 9 repeat the analysis of column 1, 2, and 3, respectively, but include country fixed effects. The precision of the estimates declines, but the coefficients on *r* in both subsamples remain important and significant. The fact that coefficients remain significant is somewhat surprising because most of the variation in *r* is between countries, not within countries over time. Apparently, the demographic structure changes sufficiently in some countries over the period to pick up the demographic effect.

The magnitudes obtained in Table 2 are substantial and suggest an important quantitative relation of entrepreneurship to demographic structure. Based on the estimates in column 1 of table 2, a country with r=0.22 (Japan's value in 2010) would have a predicted entrepreneurship rate of 0.023. A country with r=-0.10 (the United States' value in 2010) would have a predicted entrepreneurship rate of 0.037, which is 61% higher. At the extreme, a very young country with an r=-2.18 (Uganda's value in 2010) would have a predicted entrepreneurship rate of 0.12.

Recall from Corollary 3 that the analysis can be expressed in terms of median age, rather than *r* (see empirical implication 5). Using the estimates from column 3 of table 2, a one-standard deviation decrease in median age (equal to 3.5 years) results in a 2.5 percentage point increase in the entrepreneurship rate which is over 40 percent of the mean entrepreneurship rate across countries (equal to .061 in 2010). Based on this result, the

difference in the entrepreneurship rate between the youngest (age=31) and oldest (age=44) country is predicted to be about 9 percentage points or more than twice the mean rate.

5.3. Country-Age Relationships

The cross-country relation of entrepreneurship to the demographic structure is an useful starting point, but the essence of the theory is best understood at a finer level of detail. Most of the theoretical implications laid out earlier describe the pattern of entrepreneurship as it relates to age within a country or to the age-specific variations in the entrepreneurship rates across countries. In this section, those predictions are tested empirically.

The country-year-age cell is now the unit of observation. The entrepreneurship rate is a continuous variable that describes the rate of entrepreneurship within a country in a given survey year for a particular age group. There are 17,554 observations with a mean entrepreneurship rate of 0.058 and a standard deviation of 0.074 in 2010. About three-fourths of the cells have positive values for the entrepreneurship rate, with the bulk of the mass below a 10% entrepreneurship rate.

As noted earlier, the inverted u-shape relation of entrepreneurship to age is observed in Figure 1. It is also apparent that the entire profile shifts down with the median age of the country, revealing that younger countries have higher rates of entrepreneurship at every age than do middle countries.[23] This graphical representation of the data provides immediate support for the theory, but it is important to test the propositions and corollaries more formally, using the country-age data. Table 3 reports the results.

[Table 3 is here]

As in Table 2, all specifications control for the year with year dummies. Additionally, the measures of demographics, specifically, r, a and s_a, are year-specific. All standard errors are clustered at the country level and the regressions are weighted by the number of observations in the relevant cells throughout the table.[24]

[23] These age cutoffs are chosen so that each group has 20, 21, and 16 countries, respectively, i.e., approximately one-third of the sample for each.
[24] Clustering at the country-year level reduced the standard errors.

The first column in Table 3 provides a weak test of Proposition 1, which states that holding age constant, older countries, as reflected by higher levels of *r*, should have lower rates of entrepreneurship. The dependent variable is the entrepreneurship rate for the country-year-age cell. The two independent variables are age, represented as a variable that goes from zero to one, and *r* as estimated above.[25] Holding age constant, column 1 reveals that countries that have older populations have lower rates of entrepreneurship. Column 2 does the same analysis, but for OECD countries only. The same pattern is observed. The prediction of proposition 1 is stronger than that revealed by columns 1 and 2 because it states that at any given age, countries with higher values of *r* should have lower rates of entrepreneurship. The complete interaction structure that is required to test proposition 1 in its purest form is presented later in Table 4.

Corollaries 1 and 2 of Proposition 1 are addressed by column 3 of Table 3. Corollary 1 is another version of Proposition 1 with two differences. First, s_a replaces *r* as a measure of the demographic structure. Second, *r* varies only across countries but does not vary differently for the different age groups. There is only one *r* per country. But s_a can vary across countries for one age group differently than it varies across countries for another age group. There are 45 s_a values per country in a given year.

The results reported in column 3 show a positive coefficient on s_a, which implies that given age, the larger the share of the population younger than the age group in question, the higher is the entrepreneurship rate.[26] This is a direct implication of corollary 1. Holding *a* constant, the smaller the proportion of the country that is older than the age group in question, the higher the rate of entrepreneurship. This is consistent with the rank effect. In younger countries, younger individuals get more opportunity to acquire the human capital necessary to start a business. As a result, in steady-state, more entrepreneurial human capital is available in younger countries at any given age.

The coefficient on *a* is negative, as predicted by corollary 2. For any given structure of s_a, age enters negatively. This is the creativity effect that is the focus of corollary 2. Were it not

[25] As before, *r* is country-year-specific.
[26] This is true despite the fact that in the entire sample, *a* and s_a have a correlation over .9.

for the necessity of acquiring business skills, younger individuals would have higher rates of entrepreneurship than older individuals.[27] Column 4 repeats the analysis for OECD countries only. The results are qualitatively the same. Corollaries 1 and 2 are both supported within OECD-only countries. More complete tests of corollaries 1 and 2 are reported later using in Table 5, which allows each age group to have its own coefficient on $s_{a,}$ and allows each age to have its own coefficient as well.

Columns 5 and 6 repeat the analysis of columns 3 and 4, but include country fixed effects. The inclusion of fixed effects over-controls for country differences because the demographic structure, insofar as it affects all ages similarly, is picked up by the fixed effect. This is inappropriate when testing whether demographic structure matters. The model of demography, as formally stated, is a one parameter, *r*, model. If one parameter truly captured all demographic variation among countries and entered in the way proscribed by the demographic and entrepreneurship model, then fixed effect estimation would disguise all of the variation that results from demographics (except to the extent that *r* differs within a given country over time and here, only for countries with enough multi-year data). To the extent that a single parameter does a reasonable job at describing the demographic structure, the effect of structure as measured through s_a is suppressed. In fact, the coefficients on s_a in columns 5 and 6 are smaller than those without fixed effects, but maintain the expected signs and remain important.

Column 7 examines the average (across all countries) effect of age on entrepreneurship and allows for non-linearities. The inverted u-shape shown in Figure 1 is revealed by the estimates in column 7, with age entering positively and age-squared entering negatively.

5.4. Age-Specific Estimation

Because there are 45 different age groups per country per year, there are actually 45 tests that can be run. Specifically, for each age group, the relation of entrepreneurship to either *r* or

[27] This could also reflect time horizon effects, i.e., a longer period over which to reap returns when young, but the differences in expected present value is unlikely to vary much for young individuals because the length-of-life effect cuts many years out, when the present value of the differences are small.

s_a can be estimated. Also, because the country-year-age-specific entrepreneurship rate at one age is potentially independent of the year-country-age-specific entrepreneurship rate in the same country-year at another age, there are 45 tests of the theory that can be performed. This is done in Tables 4 and 5.

In Table 4, each age group is allowed to have its own coefficient on *r*, which means that each row in the table provides an estimate of the effect of variations in the age structure, as reflected in *r,* on the age-specific entrepreneurship rate. Age 20 is the omitted age group.

[Table 4 is here]

There are three columns. In the first column, only *r* effects enter. Within each age group, *r* varies across countries.

In column 2, *r* is omitted altogether and only age-dummies enter. This captures the effect of age, per se, but ignores the variation in demographic structure across countries. As such, it combines creativity effect and the rank effect to the extent that they are correlated with age. The rising and then declining age coefficients are another reflection of the inverted-u shape pattern of entrepreneurship to age that was displayed in Figure 1. Column 2 does not exploit cross-country variation because age varies in the same way in all countries and demographic structure is ignored. Consequently, the column 2 estimates merely pick up the average effect of age on entrepreneurship across all countries. The age dummies display the predicted inverted-u-shape pattern. (The omitted age is 20.) The highest levels of entrepreneurship are experienced in the late-twenties through the mid-thirties.

Column 3 includes both age dummies and the age-specific *r* effects. There are strong negative effects of *r* , as predicted by corollary 1. Most important is that the effect of *r* on the age-specific entrepreneurship rate is negative and significant in virtually all cases. Each of these coefficients is based on independent cross-country variation and provides strong evidence that the demographic structure is closely related to the entrepreneurship rates. Within every age group, the effect of having an older population is to lower the entrepreneurship rate for that age group.

Table 4 provides strong support for Proposition 1 that the within-age-group rates of entrepreneurship should vary inversely with *r*. The regressions are run where the observation is at the country-year-age level and the dependent variable is the entrepreneurship rate for that cell. The estimates in column 1 show that countries with older (and declining) populations have lower rates of new business formation at every age level, that is, for every row of the table, as the theory predicts. This prediction comes directly from the rank, or business skills effect and is not related to the simple idea that younger people are more creative. Younger people in older societies form fewer businesses than younger people in younger societies. The same holds true at virtually every age level, although it is less important for older groups than for younger groups.

Column 3 estimates the effect of age and of demographics by including age dummies and country-specific values of *r* . Columns 1 and column 3 of table 4 support the prediction of Proposition 4 that demographic structure matters more near the peak (middle-aged groups) than it does at either end. The absolute values of the negative coefficients on *r* first rise and then decline with age. This is shown in figure 4. Additionally, the creativity effect finds some weak support in the fact that age enters negatively for the oldest ages in column 3 (although there are a couple of negative coefficients for the very young as well).

[Figure 4 is here]

As is clear, the age-dummies alone do not explain much of the variation, whereas the age-specific *r* effects capture most of it. (Compare r-square values across columns.) Specifically, in column 1, there is a single constant term and the estimates of *r* are based on cross country variations in the age composition, not on the within country variation in age. As a result, the r-squared in column 1 picks up the effect only of cross-country demographic variation that corresponds to the hypothesized differential business skill acquisition across countries. It is not a result of the within-country variations in entrepreneurship rates at different ages. That effect is captured by the regression in column 2, which has a much lower r-squared (0.09 versus 0.23 in column 1). Finally, the r-squared is higher in column 3 than in column 1, as it must be, but not by much. Including both age dummies and the age-specific *r*

effects only improves r-squared to 0.25 from the 0.23 of column 1. This is an important result. It implies that cross-countries differences in entrepreneurship rates observed in table 2 is not so much a reflection of the young being more creative and entrepreneurial, but of the fact that the every age group is less entrepreneurial in countries that have an old populations.

It is also possible to allow s_a and a to enter directly, which is done in Table 5. These results provide more evidence on the corollaries to Proposition 1. Variations in s_a can only result from variations in the demographic structure across countries because s_a is defined specific to each age.[28] The results of columns 1, 2 and 3 of Table 5 parallel those of columns 1, 2 and 3, respectively, of Table 4. As before, the observation is the county-year-age cell and the dependent variable is the entrepreneurship rate for that group.

[Table 5 is here]

Column 1 of Table 5 supports corollary 1, just as column 1 of Table 4 supports proposition 1. The value of s_a in each age row is the s_a that relates to that age in each of the countries. Countries that have a higher proportion of individuals younger than the group in question have higher rates of entrepreneurship.

These results are compelling support of the rank effect, given that each s_a coefficient is a potentially independent test of that effect. The estimates in column 1 are based on different age-structures in a population. Age itself plays no direct role because the analysis is done within a given age group for every age.

Similarly, column 3 of Table 5 provides support for corollary 2. The age-dummies tend to become more negative (relative to age 20) as age grows. Holding s_a constant, the younger the group, the higher the rate of entrepreneurship. This reflects the pure creativity effect because population structure is held constant by the inclusion of s_a.

Note that as in Table 4, the r-squared for the s_a only regression is 0.18. Allowing only within-country age effects to matter yields an r-squared of 0.09. When both effects are permitted, the r-squared rises to 0.24. Also noteworthy is that using r, as done in Table 4, is better at explaining variations in entrepreneurship than is using s_a directly, as is done in Table

[28] Some of the variation in s_a might reflect variations over time in s_a for a given country when there are multiple years surveyed for that particular country.

5. Recall that *r* is an estimated variable, which might be expected to be noisier than the s_a on which *r* is based. However, the estimated *r* uses the information across all age groups within a country. As a consequence, *r* may be a better indicator of the demographic structure relevant for a given age group than that age group's own s_a.

5.5. Entrepreneurship Rates Peak in Middle Age

Figure 1 showed that a country's entrepreneurship rates rises and then falls with age, as predicted by Proposition 3. The implication also borne out by column 7 of Table 3, where *a* enters positively and a^2 enters negatively resulting in an inverted-U which peaks at age 32.[29]

Column 7 captures the relation of entrepreneurship to age for the average country, but it is also possible to use the estimates to simulate the age-entrepreneurship profile that would exist for any hypothetical country with given age parameter *r*.

The analytic form of equation (10) can be used obtain a predicted value of $\hat{s}_a$ for any hypothetical value of *r*. This value, coupled with the estimates of Table 3, column 3, can be used to derive a predicted entrepreneurship rate at each age, *a*. Then it is straightforward to plot the estimated entrepreneurship rates by age for any country with a hypothetical value of *r* . This is done for a few values of *r* and the results are displayed in figure 5.

[Figure 5 is here]

For *r* = -.5, the rate peaks at age 30 and has the predicted inverted u-shape that shows up in the actual data. This is neither mechanical nor a direct consequence of including non-linear terms. Non-linear terms in *a* are excluded from the direct calculation. The inverted u-shape results because the creativity effect, captured by *a*, initially outweighs the rank effect, captured by s_a . That turns around at some age near 30.

The u-shape depends on the value of *r* and becomes more pronounced as *r* falls. Compare the graphs in figure 5 for r=-2.19 (Uganda) to that for r=-1 and then to that for r=-.5. the entrepreneurship rates are higher and display a more pronounced peak the lower is *r*, as predicted by the theory. The inverted u-shape disappears for higher values of *r*. For

[29] 20+0.045/(2*0.085)*(64-20) = 32

example, the graph for Japan, with r=.22 displays entrepreneurship monotonically decreasing in age. (The actual rates for Japan, however, do display a slight inverted U-shape, as predicted by the theory.)

Finally, Proposition 4 states that middle-age entrepreneurship rates are most sensitive to changes in demographic structure across countries, as reflected in *r*. As an empirical proposition, this holds, again using the estimates from column 3 of Table 3. Because

$$\frac{\partial^2 E}{\partial r \partial a} = \frac{\partial E}{\partial s_a} \cdot \frac{\partial^2 s_a}{\partial r \partial a} = \beta_{s_a} \cdot \frac{\partial^2 F}{\partial r \partial a}$$

and because β_{sa} is positive in column 3 of Table 3, it follows, using lemma 2, that the entrepreneurship rate among the middle-age shift down more with increasing *r* than at older and younger ages. This is also what is observed in the raw data, as was shown earlier in Figure 1.

5.6. Robustness Checks

Recall that entrepreneurship defined an entrepreneurial event as owning a business that is less than 42 months old, which at the time of the survey, pays wages. This section speaks to the sensitivity of the results to the definitions of entrepreneurship chosen.

The results are reported in Table 6. Panel A of Table 6 replicates the regressions of Table 2, columns 5 and 6, for three definitions of entrepreneurship. The specifications of columns 5 and 6, Table 2, are the most general. They included all controls at the country level. Only the coefficients of interest are reported. The alternative definitions include: (1) early-stage entrepreneur plus those businesses that have died in the last twelve months labeled "esentr_shd", (2) nascent businesses that are less than 42 months old but do not pay wages labeled "nascent", (3) nascent plus early-stage entrepreneurs labeled "ttl_esentr."

Altering the definition of entrepreneurship has no substantive effect on the conclusions. The coefficient on *r* remains negative and significant by all definitions, although the magnitudes change somewhat. (Of course, the dependent variables also have different means and variances, which would imply different coefficients on the independent variables even if

the effects were identical.) As before, the higher the population shrinkage parameter, the lower the overall entrepreneurship rate..

Panel B of Table 6 repeats the analysis of Table 3, columns 3 and 4, using the three alternative definitions of entrepreneurship. As with panel A, the findings of Table 3 are robust to alternative definitions of entrepreneurship. The coefficients change somewhat, but the qualitative results remain unaltered.

Special attention is given to high aspirational entrepreneurship using various criteria to define high aspirations. These include entrepreneurial events where the founder plans to hire more than five or more than ten employees during the next ten years, which distinguishes these entrepreneurial events from self-employment where an individual works alone or with a very small number of others.[30] Additionally, individuals who plan to produce new products or services are singled out as entrepreneurs.

The results are reported in Table 7, which parallels the structure of Table 6. Panel A of Table 7 does the cross country comparison and is a robustness check on Table 2, whereas panel B of Table 7 is based on the country- age cells and is a robustness check on Table 3. Once again, the coefficients on r remain negative and significant in the country level regressions (panel A), and the coefficients on s_a remain positive and significant in country-age level regressions (panel B). These findings suggest that the results hold for entrepreneurs with high aspirations as well.

5.8 Summary of Predictions and Findings

The theory yielded specific empirical relations that should be observed in the data. Here, the predictions and findings are summarized.

1. Proposition 1 predicts that at any given age, entrepreneurship decreases as the population ages, as measured by the shrinkage parameter r. Table 3 and especially Table 4 provide strong support. In Table 3, r has the predicted negative effect on entrepreneurship, holding age constant. In Table 4, for column 1, at every age,

[30] Recall, however, that the definition of entrepreneurship used throughout the paper should exclude sole self-employed individuals, because to qualify as an entrepreneur the firm in question must be paying wages.

entrepreneurship rates are negatively related to *r*. The same is almost always true in Table 4, column 3, where each age is allowed to have its own intercept.

2. Corollary 1 states that entrepreneurship should rise in $s_{a,}$ given age. This is borne out by Table 3, columns 3, 4, 5 and 6, and by Table 5, which, analogous to Table 4, shows that entrepreneurship at any given age is negatively related to s_a.
3. Corollary 2 says that entrepreneurship should be inversely related to age, given s_a. Table 3, columns 3, 4, 5, and 6, support this claim, as does Table 5, which shows age coefficients in column 2 tending to decline with age.
4. Proposition 2 predicts that the overall entrepreneurship rate declines as the population ages, as measured by *r*. Table 2, columns 1, 2, 7 and 8 support this prediction.
5. Corollary 3 is a restatement of proposition 2, but cast in terms of median age instead of *r*. Table 2, columns 3 and 4 bear out this prediction.
6. Proposition 3 predicts an inverted u-shaped relation of entrepreneurship to age. Column 7 of Table 2 provides direct support for this proposition as does the raw data shown in Figure 1 and the estimated age-entrepreneurship profiles in Figure 5.
7. Proposition 4 predicts that entrepreneurship rates decline most for middle-aged workers as a population ages. This is borne out by Figures 1 and 5 and by the analytic result that based on lemma 2 coupled with the positive coefficient on β_{sa} in column 3 of Table 3.

5.8 Identification

The approach used is one that assumes the demographic structure is given and pre-determined. There are two potential concerns. First, one might worry that causation might run in the other direction, where entrepreneurship causes the demographic structure, rather than the demographic structure causing entrepreneurship. Second, there may be other factors that are correlated with demographic structure that might generate a relation of entrepreneurship to demographic structure other than the one featured in this analysis.

Before addressing identification at a more technical level, it is important to point out that the demographic theory provides very specific implications (at least seven) that have been

tested and found to hold. Some of these, and especially the collection of them, are not easily generated by other theories. The fact that seven-out-of-seven of the empirical implications are supported strongly by the estimates, irrespective of the country sample and functional form, is helpful, but there are additional reasons why the evidence points toward this theory or some close variant of it.

First, the relation of entrepreneurship to demographics almost certainly reflect the latter causing the former, not the former causing the latter. The demographic structure is determined well before a birth cohort grows to an age sufficient to be entrepreneurs. Except for immigration, the proportion of the population that is over any given age is an exogenous and pre-determined variable from the point of view of the entrepreneurship rate. It would be difficult, if not impossible, to come up with a story that had an exogenously given entrepreneurship rate in 2009 determining the number of births that occurred in a country in 1979. Even the current entrepreneurship rate is unlikely to have any strong effect on current birth and mortality rates.

It is possible, however, that a country that is conducive to entrepreneurship could attract a large number of immigrants, particularly young ones. This effect is likely to be small for two reasons. First, in most countries, the age of immigrants is not so different from the age of the population as a whole. For example, the Department of Homeland Security reports that in the United States, the median age of Green Card holders is five years lower than that of the native born population. Green Card holders are those who have immigrated to the US, but have not obtained citizenship status.[31] Although five years is significant, Green Card holders account for only about one-thirtieth of all those living in the US, which means that the five year difference would lower the median by about 1/6 of a year. Indeed, among the 2010 sampled countries, median ages (among population aging between 20 to 64) range from 31 to 44 years old, with a standard deviation of almost four years. As a consequence, immigration, even on a large scale, is unlikely to cause much bias in the estimates.

[31] Lazear (2013) and Office of Immigration Statistics (2012).

The second point supporting the theory postulated here is that it is difficult to find alternative explanations for the fact that s_a has the predicted positive effect on entrepreneurship, r has the predicted negative effect, and that these effects are pervasive. The next section considers some possible alternative theories.

Alternative Mechanisms

The most novel and compelling finding is that within every age group, older countries have lower rates of entrepreneurship. The interpretation offered in this study is that older workforces reduce the ability of young workers to acquire business skills, but no direct evidence on this interpretation has been offered. There may be other reasons why older countries would have lower rates of entrepreneurship (at all ages) that differ from the one suggested here. A few possibilities come to mind.

An alternative is that countries with older populations are further along in the development cycle and have lower returns to starting new businesses. Although it is not clear that the premise even holds, it is possible to provide evidence that speaks to this hypothesis. Columns 5 and 6 of Table 2 allow other factors to affect the country-wide entrepreneurship rate. Per-capita GDP would seem to be a good proxy for stage of development. It does not have a quantitatively meaningful effect on the results and the coefficient on r remains negative, important, and statistically precise.

A second and related possibility is that even if the country is not further along in the development cycle, the age distribution may reflect the growth potential of countries. Specifically, older countries may not be good places to start new businesses because future growth prospects are poorer than they are in younger countries. If this were the case, then it is possible that at every age, entrepreneurship rates would be negatively related to the median age or to r. The country fixed-effect regressions address this in part because the country fixed effect would tend to pick up the growth prospects. But it is still possible that unanticipated changes in the demographic structure could affect the incentives to start businesses.

Two findings argue against this view. First, columns 5 and 6 of Table 2 include the five-year average GDP growth rate, which one would expect would be a reflection of investment potential. The growth rate does not do much to explain entrepreneurship (and is not significant in the full sample), nor does it eliminate or substantially reduce the importance of *r* in explaining entrepreneurship. Second, some of the implications of the skill acquisition story are not obvious implications of the view that the age structure of a country proxies growth potential. In particular, the inverted u-shape relation of entrepreneurship to age comes about because two effects work in opposite directions. The decline in creativity with age is at first swamped by the entrepreneurship skills that are acquired with work experience, which results in entrepreneurship rates that increase at first in age. When skill acquisition tapers off enough, the declining creativity effect swamps the skill acquisition effect, resulting in declining entrepreneurship rates with age. It is the combination of the two effects that yields the prediction of an inverted u, borne out by the results. There is no obvious reason why an inverted u-shape pattern would be produced in an environment where investment potential was proxied by the age distribution. Similarly, the prediction that *r* affects middle-aged entrepreneurship rates by more than the old or young is not an obvious prediction of the age-distribution-proxying investment potential story, although ad hoc explanations could surely be offered.

5.9 Extensions

Industries

The analysis here is aggregate in the sense that the country's demographic structure is assumed to be relevant for all industries in the country. That assumption is made by necessity because data are not readily available across countries that would relate to industry-specific demographics. Such data could prove relevant and provide interesting extensions of the analysis.

For example, the age structure of the United States might not be a good proxy for the age-structure of the technology industry during the dot.com boom. Because technical skills

in computing were needed and because those skills tended to be concentrated among the young, the median age in the tech industry was lower than that for the working population as a whole. As a consequence, young workers in technology held positions with more responsibility than would have been predicted given their rank in the overall age distribution.

From the point of view of bias, this is not likely to be a problem, at least with respect to table 2. Because this relates to a mismeasured independent variable (*r* or median age), the coefficients reported in that table are biased toward zero. The estimated effects, if anything, understate the true effects.

The more important issue is that more direct tests of the theory are available, at least conceptually. As a result, a useful extension would be to do industry-based analysis, using more appropriately defined demographic variables. The rank and creativity effects can be separated from overall industry effects by doing within-age across industry analysis.[32]

Individuals

It is also possible to use individual-based data to test the hypotheses of the model. A particular individual's experience should be a predictor of entrepreneurship. In Lazear (2004, 2005), having broad prior experience was used as a predictor of entrepreneurial activity. But additionally, the theory of the current analysis suggests that those who had positions that were high up in a firm's hierarchy should be more likely to be entrepreneurs later on.

This prediction can be tested using the Stanford MBA data described in depth in Lazear (2005). Those data contain information on the number of others supervised in prior positions. A simple check reveals that those who supervised more workers on their prior jobs are more likely to have founded a business on subsequent job events. This is consistent with the theory here, but is not conclusive for the obvious reason that those who were assigned to supervisory roles may have already possessed the talents necessary to later found

[32] For example, entrepreneurship is high in technology and technology is a young persons industry for the the same reason: technology is a new field. But the difference between countries in the entrepreneurship rate at any given age, based on that country's age structrure allows the newness effect to be separated from the rank and creativity effects.

businesses. An appropriate test would examine the subsequent entrepreneurial experiences of people who were randomly thrust into supervisory positions.

6. Conclusion

Using a human capital framework like that proposed by Becker, coupled with an economic focus on fertility patterns, again studied by Becker, a connection between demographics and entrepreneurship is proposed. To become an entrepreneur, an individual needs to have an idea for a business, which may be more prevalent among the young. But making a new business a success also requires skills that are best acquired through on-the-job training. In an aging society, the important positions in firms are likely to be dominated by older individuals, whereas in a younger society, young workers may get the opportunity to experience situations that will better enable them to start their own businesses. As a consequence, a young society allows more opportunity for workers to acquire business skills early in their careers, which implies that they will be more skilled at any given age.

The theory proposes a basic demographic equation that relates the age structure of a society to one parameter, namely the population shrinkage (or conversely, growth) rate. The one parameter structure fits the demographic data very well, explaining almost perfectly the demographic structure across a large number of countries. More important, the theory that is based on this structure has a number of testable implications that apply to entrepreneurship, all of which are borne out using an unusual dataset called the Global Entrepreneurship Monitor.

Most basic of the predictions is that the older the population, the lower is the overall rate of entrepreneurship. The model predicts this holds both with respect to the population shrinkage parameter, which measures the speed with which a population ages, as well as the median age of a country. Both relationships show up clearly in the data and are robust to various definitions of entrepreneurship. They are not eliminated, or even substantially weakened, by the inclusion of other variables that might relate to alternative theories linking entrepreneurship to age structure of the population. In particular, the hypothesis that the age structure is a mere proxy for stage of development or growth potential is rejected.

The model implies that entrepreneurship should display an inverted u-shape relation to age. The very young do not possess the business skills necessary to start a business and the very old lack the creativity or energy to engage in entrepreneurship. The inverted u-shape holds throughout and is found in almost all countries sampled.

Perhaps the prediction most specific to this model is that at any given age, countries that have younger populations have higher entrepreneurship rates among that age group than do countries with older populations. This is because of the "rank" effect, which implies that younger countries allow for higher rates of human capital acquisition than older countries. As a consequence, workers in younger countries have more skills relevant for entrepreneurship at every age. This is found to hold strongly and the finding is robust to all empirical specifications. Furthermore, the rank effect accounts for the bulk of the difference in entrepreneurship rates across countries. The age composition effect, which says that younger countries have higher rates of entrepreneurship because they have more younger workers, is much less important in explaining cross country variation in entrepreneurship rates.

Finally, the entrepreneurship rates of the middle-aged are predicted by the framework to be the most sensitive to the rate at which a population is aging. Entrepreneurship rates of the very young and very old are predicted to be more similar across countries than are the entrepreneurship rates of the middle aged. The theory implies that middle-aged entrepreneurship rates should be most sensitive to variations in the demographic structure. This result is found to hold.

The linkage between entrepreneurship and demographics that is studied here goes back to Becker's early work on both human capital and fertility. More than fifty years after the work was done, new implications of his profound theories continue to be discovered and borne out.

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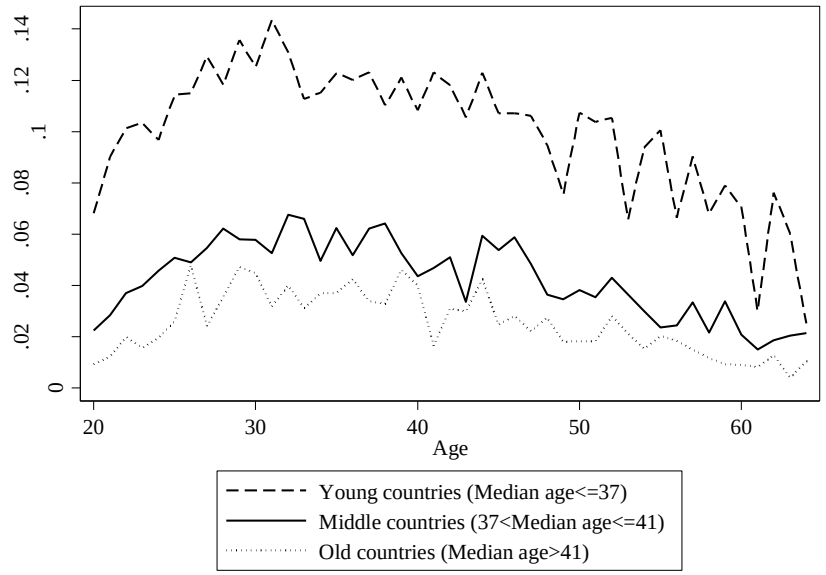
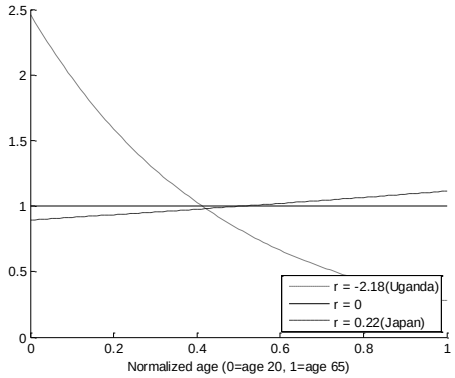
Figure 1. Countries with young and old labor forces

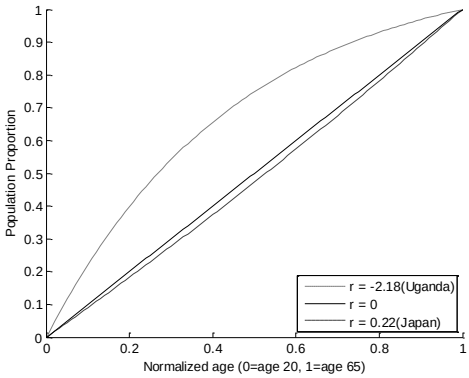


Note: This figure presents the raw relationship entrepreneurship rates and age. Using the Global Entrepreneurship Monitor 2010 data, we group all countries into three categories: (1) young countries, defined as having a median age younger than 38, (2) middle countries, defined as having a median age between 38 and 41, and (3) old countries, defined as having a median age greater than 41. These age cutoffs are chosen so that each group has 20, 21, and 16 countries, respectively, i.e., approximately one-third of the sample for each.

Figure 2. Age Distribution F(a,r)

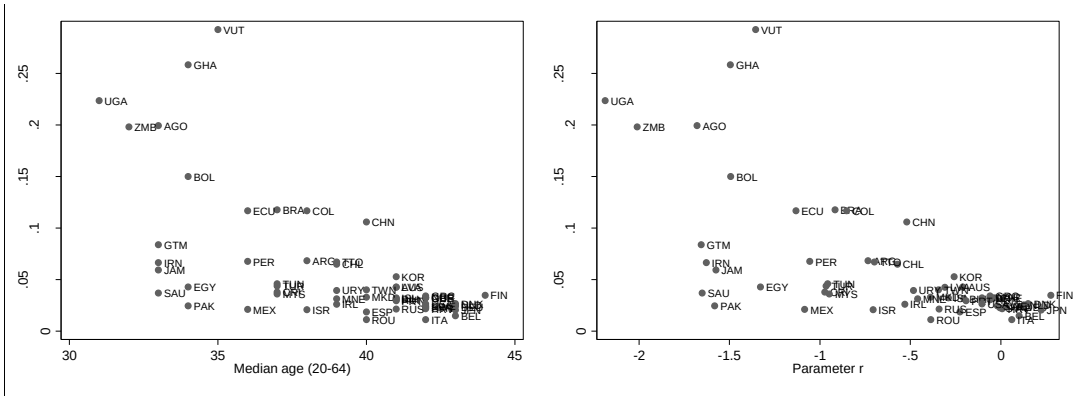


(a) p.d.f

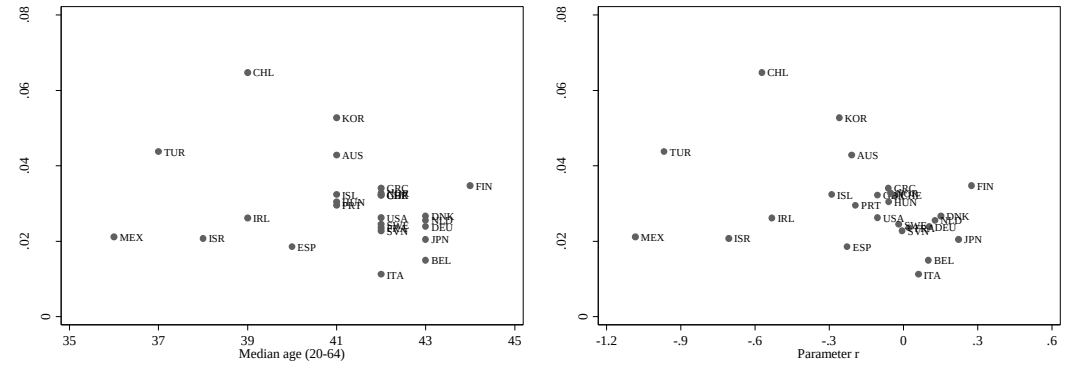


(b) c.d.f

Figure 3. Entrepreneurship Rate and Demographics (2010)

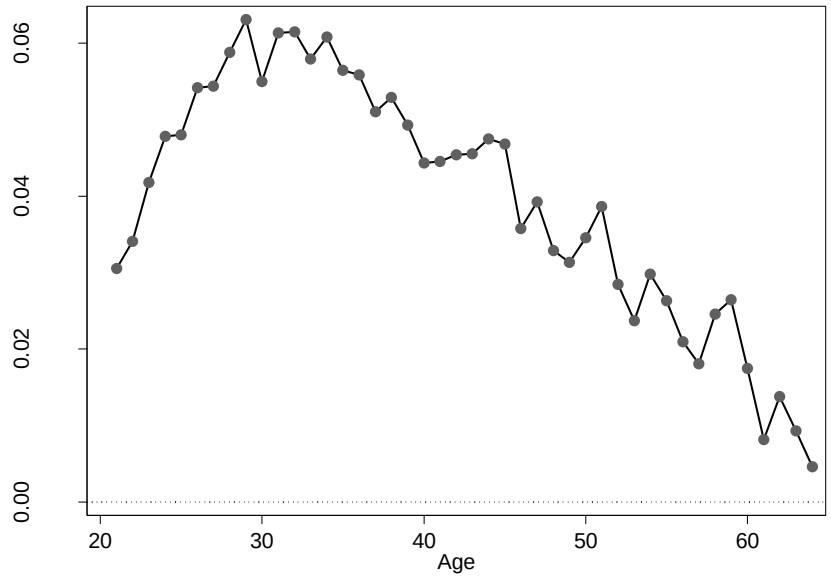


(a) Overall sample (b) Overall sample



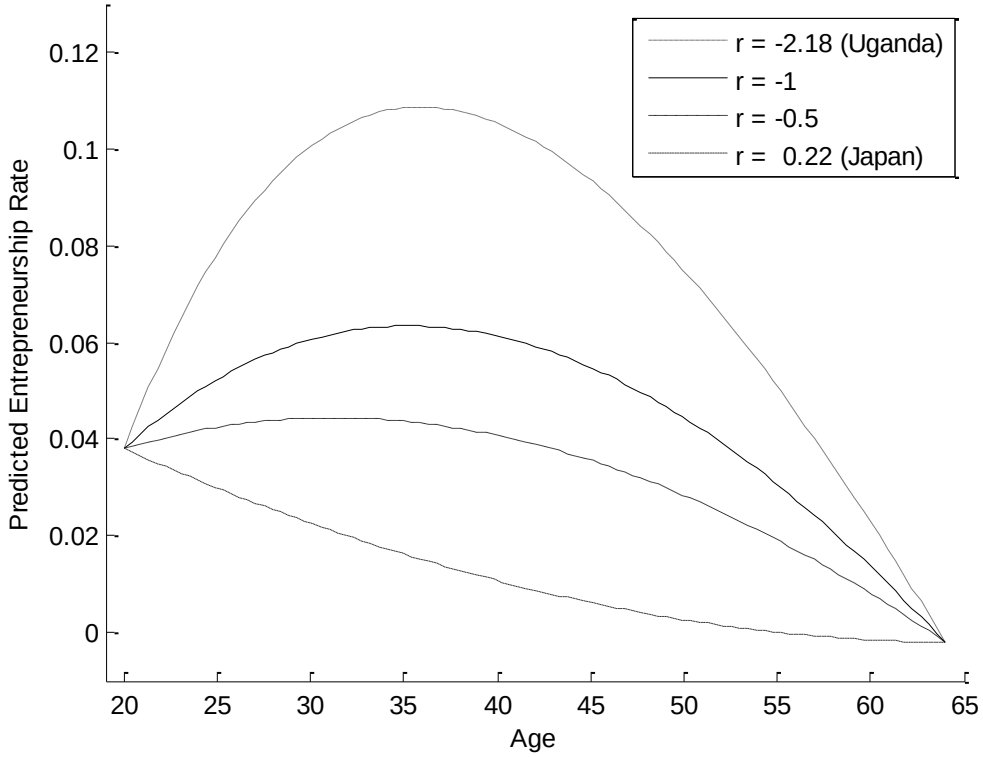
(c) OECD sample (d) OECD sample

Figure 4. Absolute value of the coefficients on *r* by Age in the Age-specific Entrepreneurship Rate Regression



Note: This figure plots the magnitude of the age-specific coefficient on r reported in column 1 of Table 4.

Figure 5. Predicted Effect of Demographics, *r*, on Entrepreneurship and Age



Note: This figure presents the predicted entrepreneurship rate by age for different value of *r*, based on the coefficient estimates in column 3 of Table 3 and the predicted value of s_a.

Table 1. Summary Statistics

		Overall (N=57)		OECD (N=26)		Non-OECD (N=31)	
		Mean	Std	Mean	Std	Mean	Std
Entrepreneurship rate							
Alternative definitions							
Early-stage, pay wage (esentr)		0.061	0.063	0.030	0.012	0.087	0.075
Early-stage + Shutdown (esentr_shd)		0.106	0.107	0.055	0.019	0.150	0.130
Nascent, not-pay wage (nascent)		0.065	0.065	0.035	0.023	0.090	0.077
Total Early Stage (tt_esentr)		0.121	0.108	0.064	0.029	0.170	0.126
With high aspiration							
Plan to hire 5 in 5 years		0.010	0.009	0.006	0.004	0.013	0.011
Plan to hire 10 in 5 years		0.005	0.005	0.003	0.002	0.006	0.006
New product/market		0.011	0.015	0.007	0.006	0.015	0.020
Demographic (among age 20-64)							
Cohort shrink rate (r)		-0.63	0.64	-0.17	0.35	-1.01	0.58
Average age		39.55	2.52	41.34	1.40	38.04	2.25
Median age		38.74	3.50	41.19	1.96	36.68	3.18
Percentage of young (20-45)		0.52	0.09	0.46	0.05	0.57	0.08
Other Characteristics							
GDP per capita	$	19032	13230	30036	9819	9802	7306
College enrollment rate	%	11.23	6.73	15.59	6.28	7.58	4.64
Start-up cost (% of GNP per capita)	%	17.01	34.51	6.47	6.90	25.86	44.80
Property right index		6.02	1.34	7.10	1.00	5.11	0.79
Military service more than a year		0.09	0.29	0.08	0.27	0.10	0.30

Note:

The summary statistics presented in this table are of the countries surveyed in 2010 in GEM. Refer to Table B1 for the list of the countries.

Table 2. Country-Year Level Entrepreneurship Rate Regression

Dep. Var.	Entrepreneurship Rate								
Sample	All	OECD	All	OECD	All	OECD	All	OECD	All
specifics	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
r	-0.041	-0.023			-0.025	-0.030	-0.047	-0.050	
	[0.007]***	[0.007]***			[0.009]**	[0.008]***	[0.024]*	[0.023]**	
Median age			-0.007	-0.004					-0.002
(age 20-64)			[0.001]***	[0.001]***					[0.002]
log(GDPpc)					-0.020	-0.006			
					[0.007]***	[0.009]			
Tertiary					0.062	0.032			
					[0.041]	[0.029]			
Start-up Cost					0.024	0.016			
					[0.015]	[0.018]			
IPRI					0.004	0.008			
					[0.004]	[0.002]***			
GDP growth rate					0.002	0.001			
(Average of the past 5 years)					[0.001]	[0.001]			
Military service > 1 year					0.038	0.042			
					[0.022]*	[0.010]***			
(Military service > 1 years) x r					0.047	0.064			
					[0.016]***	[0.032]*			
Constant	0.010	0.022	0.318	0.17	0.169	0.016	-0.024	0.027	0.128
	[0.004]**	[0.004]***	[0.051]***	[0.043]***	[0.063]***	[0.080]	[0.040]	[0.010]**	[0.071]*
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country FE							Y	Y	Y
Obs	393	230	393	230	393	230	393	230	393
R-square	0.40	0.24	0.37	0.19	0.53	0.38	0.91	0.72	0.90

Note:

Observations are weighted by the number of individuals who make up each country-year cell.

Standard errors clustered at the country level are in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3. Country-Age Regressions

Dep. Var.	Entrepreneurship rate within country-age cell						
Sample specifics	All	OECD	All	OECD	All	OECD	All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
a	-0.028	-0.023	-0.376	-0.191	-0.189	-0.104	0.045
	[0.003]***	[0.003]***	[0.057]***	[0.049]***	[0.025]***	[0.036]***	[0.009]***
r	-0.038	-0.021					
	[0.007]***	[0.007]***					
s_a			0.336	0.164	0.156	0.079	
			[0.054]***	[0.048]***	[0.024]***	[0.036]**	
a^2							-0.085
							[0.008]***
Constant	0.025	0.033	0.038	0.04	0.046	0.04	0.035
	[0.004]***	[0.004]***	[0.003]***	[0.003]***	[0.003]***	[0.002]***	[0.004]***
Year dummies	Y	Y	Y	Y	Y	Y	Y
Country FE					Y	Y	
Obs	17554	10309	17554	10309	17554	10309	17554
R-square	0.26	0.12	0.25	0.12	0.56	0.24	0.11

Note:

Observations are weighted by the number of individuals who make up each country-age-year cell.

Standard errors clustered at the country level are in parentheses.

* Significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4. Age-specific Coefficient on r

Dep. Var.	Entrepreneurship Rate		
	(1)	(2)	(3)
Coefficient on r for age			
21	-0.031***		-0.039***
22	-0.034***		-0.040***
23	-0.042***		-0.046***
24	-0.048***		-0.049***
25	-0.048***		-0.046***
26	-0.054***		-0.047***
27	-0.054***		-0.049***
28	-0.059***		-0.048***
29	-0.063***		-0.050***
30	-0.055***		-0.046***
31	-0.061***		-0.051***
32	-0.062***		-0.049***
33	-0.058***		-0.044***
34	-0.061***		-0.051***
35	-0.056***		-0.047***
36	-0.056***		-0.049***
37	-0.051***		-0.043***
38	-0.053***		-0.045***
39	-0.049***		-0.042***
40	-0.044***		-0.039***
41	-0.045***		-0.041***
42	-0.045***		-0.039***
43	-0.046***		-0.044***
44	-0.047***		-0.044***
45	-0.047***		-0.044***
46	-0.036***		-0.032***
47	-0.039***		-0.042***
48	-0.033***		-0.035***
49	-0.031***		-0.031***
50	-0.035***		-0.040***
51	-0.039***		-0.046***
52	-0.028***		-0.032***
53	-0.024***		-0.026***
54	-0.030***		-0.036***
55	-0.026***		-0.034***
56	-0.021***		-0.027***

57	-0.018***	-0.024***
58	-0.025**	-0.038***
59	-0.026***	-0.041***
60	-0.018**	-0.034***
61	-0.008	-0.021***
62	-0.014**	-0.031***
63	-0.009	-0.025***
64	-0.005	-0.019***
Coefficient on age group dummies		
21	0.006***	-0.015***
22	0.010***	-0.012**
23	0.015***	-0.010*
24	0.020***	-0.007
25	0.022***	-0.004
26	0.028***	0.003
27	0.027***	0.000
28	0.032***	0.007
29	0.036***	0.009
30	0.029***	0.004
31	0.033***	0.006
32	0.035***	0.008
33	0.033***	0.009**
34	0.033***	0.005
35	0.030***	0.005
36	0.029***	0.002
37	0.027***	0.003
38	0.028***	0.003
39	0.025***	0.003
40	0.022***	0.001
41	0.020***	-0.002
42	0.023***	0.002
43	0.020***	-0.004
44	0.022***	-0.001
45	0.021***	-0.003
46	0.016***	-0.001
47	0.014***	-0.009*
48	0.011***	-0.008*
49	0.012***	-0.005
50	0.010***	-0.011**
51	0.012***	-0.013**
52	0.008***	-0.009*
53	0.006**	-0.008*

54		0.007***	-0.012**
55		0.005**	-0.013**
56		0.003	-0.012***
57		0.001	-0.012***
58		0.001	-0.019***
59		0.001	-0.021***
60		-0.005*	-0.023***
61		-0.008***	-0.019***
62		-0.007***	-0.024***
63		-0.009***	-0.023***
64		-0.011***	-0.021***
Year FE	Y	Y	Y
Obs	17,554	17,554	17,554
R-square	0.232	0.086	0.248

Note: Standard errors are clustered at the country level, but not reported to save space. * Significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5. Age-specific Coefficient on s_a

Dep. Var.	Entrepreneurship Rate		
	(1)	(2)	(3)
Coefficient on s_a for age			
21	2.216***		2.783***
22	1.175***		1.449***
23	0.855***		1.132***
24	0.689***		0.928***
25	0.562***		0.717***
26	0.508***		0.608***
27	0.432***		0.559***
28	0.403***		0.491***
29	0.374***		0.476***
30	0.311***		0.406***
31	0.299***		0.415***
32	0.278***		0.384***
33	0.252***		0.328***
34	0.234***		0.368***
35	0.213***		0.336***
36	0.197***		0.347***
37	0.180***		0.304***
38	0.173***		0.316***
39	0.159***		0.292***
40	0.144***		0.273***
41	0.135***		0.291***
42	0.134***		0.277***
43	0.124***		0.327***
44	0.123***		0.326***
45	0.117***		0.333***
46	0.104***		0.252***
47	0.098***		0.347***
48	0.090***		0.296***
49	0.088***		0.291***
50	0.084***		0.354***
51	0.083***		0.425***
52	0.076***		0.293***
53	0.072***		0.278***
54	0.071***		0.391***
55	0.067***		0.406***
56	0.062***		0.385***
57	0.059***		0.329***

58	0.058***	0.544***
59	0.057***	0.709***
60	0.050***	0.671***
61	0.045***	0.568***
62	0.045***	1.028***
63	0.043***	1.278***
64	0.040***	1.949***
Coefficient on age group dummies		
21	0.006***	-0.066***
22	0.010***	-0.066***
23	0.015***	-0.074***
24	0.020***	-0.077***
25	0.022***	-0.072***
26	0.028***	-0.067***
27	0.027***	-0.075***
28	0.032***	-0.070***
29	0.036***	-0.075***
30	0.029***	-0.076***
31	0.033***	-0.085***
32	0.035***	-0.085***
33	0.033***	-0.077***
34	0.033***	-0.101***
35	0.030***	-0.099***
36	0.029***	-0.114***
37	0.027***	-0.106***
38	0.028***	-0.118***
39	0.025***	-0.117***
40	0.022***	-0.118***
41	0.020***	-0.135***
42	0.023***	-0.132***
43	0.020***	-0.171***
44	0.022***	-0.175***
45	0.021***	-0.188***
46	0.016***	-0.148***
47	0.014***	-0.220***
48	0.011***	-0.195***
49	0.012***	-0.197***
50	0.010***	-0.252***
51	0.012***	-0.312***
52	0.008***	-0.221***
53	0.006**	-0.216***
54	0.007***	-0.313***

55		0.005**	-0.336***
56		0.003	-0.328***
57		0.001	-0.287***
58		0.001	-0.486***
59		0.001	-0.645***
60		-0.005*	-0.628***
61		-0.008***	-0.544***
62		-0.007***	-0.992***
63		-0.009***	-1.252***
64		-0.011***	-1.933***
Year FE	Y	Y	Y
Obs	17,554	17,554	17,554
R-square	0.176	0.086	0.238

Note: Standard errors are clustered at the country level, but not reported to save space. * Significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6. Robustness Check: Alternative Entrepreneurship Definitions

Dep. Var.	esentr_shd		nascent		ttl_esentr	
Sample	All	OECD	All	OECD	All	OECD
specifics	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Country level regressions						
r	-0.057	-0.061	-0.032	-0.037	-0.058	-0.069
	[0.013]***	[0.013]***	[0.007]***	[0.014]**	[0.012]***	[0.018]***
Country Characteristics	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Country FE	N	N	N	N	N	N
Obs	230	393	230	393	230	393
R-square	0.33	0.56	0.48	0.43	0.32	0.53
Panel B: Country-age level regressions						
s_a	0.244	0.122	0.123	0.081	0.265	0.158
	[0.039]***	[0.062]*	[0.028]***	[0.035]**	[0.046]***	[0.068]**
a	-0.274	-0.141	-0.157	-0.108	-0.328	-0.208
	[0.040]***	[0.062]**	[0.030]***	[0.036]***	[0.048]***	[0.068]***
Year FE	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y
Obs	17554	10309	17554	10309	17554	10309
R-square	0.69	0.31	0.58	0.36	0.66	0.39

Note:

The dependent variable in column (1) and (2) is "esentr_shd", which is defined as early-stage entrepreneur plus those businesses that have died in the last twelve months; the dependent variable in column (3) and (4) is "nascent", which is nascent businesses that are less than 42 months old but do not pay wages; the dependent variable in column (5) and (6) is "ttl_esentr", which is defined as nascent plus early-stage entrepreneurs.

In panel A, observations are weighted by the number of individuals who make up each country-age-year cell.

In panel B, observations are weighted by the number of individuals who make up each country-year cell.

Standard errors clustered at the country level are in parentheses.

* Significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7. Robustness Check: Entrepreneurship with High Aspiration

Types of early-stage entre.	Plan to hire more than 5 employees in 10 years		Plan to hire more than 10 employees in 10 years		Involve new products/services	
Sample specifics	All (1)	OECD (2)	All (3)	OECD (4)	All (5)	OECD (6)
Panel A. Country level regressions						
r	-0.007 [0.002]***	-0.01 [0.002]***	-0.004 [0.001]***	-0.006 [0.001]***	-0.005 [0.002]***	-0.011 [0.004]***
Country Characteristics	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Country FE	N	N	N	N	N	N
Obs	230	393	230	393	230	393
R-square	0.33	0.23	0.36	0.18	0.33	0.26
Panel B: Country-age level regressions						
s_a	0.039 [0.007]***	0.027 [0.013]**	0.022 [0.005]***	0.016 [0.007]**	0.032 [0.006]***	0.024 [0.011]**
a	-0.049 [0.007]***	-0.035 [0.013]**	-0.028 [0.005]***	-0.02 [0.008]**	-0.04 [0.006]***	-0.03 [0.011]**
Year FE	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y
Obs	17554	10309	17554	10309	17554	10309
R-square	0.23	0.12	0.15	0.09	0.28	0.2

Note:

In panel A, observations are weighted by the number of individuals who make up each country-age-year cell. In panel B, observations are weighted by the number of individuals who make up each country-year cell.

Standard errors clustered at the country level are in parentheses.

* Significant at 10%; ** significant at 5%; *** significant at 1%.

Appendix

A Proofs of propositions

Lemma 1. *For* $F = \frac{e^{ra}-1}{e^{r}-1}$, *there exists an* $a_m \in [0,1]$ *such that for all* $a < a_m$, $\frac{d^2F}{drda} < 0$, *and for* $a > a_m$, $\frac{d^2F}{drda} > 0$.

Proof. Note that

$$\frac{d^2F}{drda} = \frac{e^{ra}}{(e^{r}-1)^2}[(e^{r}-1)(1+ar) - re^{r}] \tag{A1}$$

Therefore

$$\lim_{a\to 0}\frac{d^2F}{drda} = \frac{e^{r}}{(e^{r}-1)^2}[1-e^{-r}-r] < 0 \tag{A2}$$

and

$$\lim_{a\to 1}\frac{d^2F}{drda} = \frac{e^{r}}{(e^{r}-1)^2}[e^{r}-1-r] > 0 \tag{A3}$$

In addition, the function has a unique root

$$a = a_m = \frac{r\cdot e^{r} - e^{r} + 1}{r\cdot(e^{r}-1)} \in (0,1) \tag{A4}$$

Given (A2), (A3), and (A4), [33] it must be true that for all $a < a_m$, $\frac{d^2F}{drda} < 0$ and for $a > a_m$, $\frac{d^2F}{drda} > 0$ Q.E.D.

Lemma 2. *For* $F = \frac{e^{ra}-1}{e^{r}-1}$, *and 0<a<1,* $\frac{dF}{dr} < 0$.

Proof. Note that

$$\frac{dF}{dr} = \frac{ae^{ra}(e^{r}-1) - (e^{ra}-1)e^{r}}{(e^{r}-1)^2} \tag{A5}$$

[33] The inequalities in (A2), (A3), and (A4) hold because $r>1-e^{-r}$ and $r<e^{r}-1$.

Therefore

$$\lim_{a\to 0}\frac{dF}{dr}=0 \tag{A6}$$

$$\lim_{a\to 1}\frac{dF}{dr}=0 \tag{A7}$$

Given (A6), (A7), and Lemma 1, dF/dr<0 for aϵ[0,1]. Q.E.D.

Proposition 2 *Number of entrepreneurs as a fraction of the workforce decreases as the cohort size shrinks, i.e.,* $d\bar{E}/dr<0$.

Proof. Define $G=F^{-1}$ as the inverse of F on variable *a*, such that

$$G(F(a,r),r)\equiv a \tag{A8}$$

Totally differentiate this equation with respect to *r*, we have $G_1F_2+G_2=0$. Hence

$$G_2\equiv\frac{\partial G}{\partial r}=-G_1F_2>0 \tag{A9}$$

The inequality is true because $G_1>0$ and $F_2\equiv\frac{\partial F^{-1}}{\partial r}<0$.

Replace $F(a,r)$ with *s*,

$$\bar{E}(r)=\int_0^1 E(h(s),q(G(s,r)))ds \tag{A10}$$

Given (18) and q'<0, we know $d\bar{E}/dr<0$. Q.E.D.

Corollary 3. *The number of entrepreneurs as a fraction of the workforce decreases with the population's median age.*

Proof: The median age, a_{med}, is defined by $F(a_{med}, r) = 0.5$, or by solving $\frac{e^{ra}-1}{e^r-1}=0.5$.The solution is $a=\frac{1}{r}\ln(\frac{e^r-1}{2})$, which increases monotonically in *r* (The function resembles the standard logistic shape). Since, by proposition 2, $d\bar{E}/dr<0$, it follows that $d\bar{E}/da_{med}<0$

Proposition 4. *There exists some* a_M, $0<a_M<1$ *such that* $\frac{\partial E(a_M,r)}{\partial r} < \frac{\partial E(0,r)}{\partial r}$ *and* $\frac{\partial E(a_M,r)}{\partial r} < \frac{\partial E(1,r)}{\partial r}$ *under the conditions that the first and second derivatives of V, H, Q exist and are bounded and that the first derivatives of V and H are greater than some small constant ε.*

Proof. Notice that

$$\frac{\partial^2 E}{\partial a \partial r} = P'V_1H' \cdot F_{12} + \frac{\partial P'V_1H'}{\partial a} F_2 \tag{A11}$$

Since $F_2(0,r)=0$ and $F_2(1,r)=0$, the value of $\frac{\partial^2 E}{\partial a \partial r}$ is dominated by $P'V_1H' \cdot F_{12}$ when a is closed to 0 or 1. Moreover, as shown by Lemma 1, $F_{12}(0,r)<0$ and $F_{12}(1,r)>0$, therefore

$$\frac{\partial^2 E(0,r)}{\partial a \partial r} < 0 \quad \text{and} \quad \frac{\partial^2 E(1,r)}{\partial a \partial r} > 0 \tag{A12}$$

as long as the first derivatives of V and H are greater than some small constant ε.

Given the continuity of P, V, and H, along with the condition (A12), there exist one[34] $a_M \in (0,1)$, such that $\frac{\partial^2 E(0,r)}{\partial a \partial r} = 0$, i.e., $\frac{\partial E(a_M,r)}{\partial r} < \frac{\partial E(0,r)}{\partial r}$ and $\frac{\partial E(a_M,r)}{\partial r} < \frac{\partial E(1,r)}{\partial r}$. Q.E.D.

[34] There might exist more than one such local minimum point.

B. GEM data coverage

Table B1. GEM Sample Sizes by country and year 2001-2010

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Algeria	-	-	-	-	-	-	-	-	2,000	-
Angola	-	-	-	-	-	-	-	1,518	-	2,167
Argentina	1,992	1,999	2,004	2,003	2,008	2,007	2,018	2,031	2,008	2,001
Australia	2,072	3,378	2,212	1,991	2,465	2,518	-	-	-	2,000
Austria	-	-	-	-	2,197	-	2,002	-	-	-
Belgium	2,038	4,057	2,184	3,879	4,047	2,001	2,028	1,997	3,989	2,000
Bolivia	-	-	-	-	-	-	-	2,000	-	3,524
Bosnia & Herz.	-	-	-	-	-	-	-	2,028	2,000	2,000
Brazil	2,000	2,000	2,000	4,000	2,000	2,000	2,000	2,000	2,000	2,000
Canada	1,939	2,007	2,028	2,004	6,418	2,038	-	-	-	-
Chile	-	2,016	1,992	-	1,997	2,007	4,008	2,000	5,000	7,195
China	-	2,054	1,607	-	2,109	2,399	2,666	-	3,608	3,677
Colombia	-	-	-	-	-	2,001	2,102	2,001	2,055	11,029
Costa Rica	-	-	-	-	-	-	-	-	-	2,003
Croatia	-	2,001	2,000	2,016	2,000	2,000	2,000	1,996	2,000	2,000
Czech Republic	-	-	-	-	-	2,001	-	-	-	-
Denmark	2,022	2,009	2,008	2,009	2,010	10,000	2,001	2,012	2,012	1,957
Dominican Rep.	-	-	-	-	-	-	2,081	2,019	2,007	-
Ecuador	-	-	-	2,010	-	-	-	2,142	2,200	2,077
Egypt	-	-	-	-	-	-	-	2,636	-	2,769
Finland	2,001	2,005	2,005	2,000	2,010	2,005	2,005	2,011	2,004	2,006
France	1,991	2,029	2,018	1,953	2,005	1,909	2,005	2,018	2,019	2,012
Germany	7,058	15,041	7,534	7,523	6,577	4,049	-	4,751	6,032	5,552
Ghana	-	-	-	-	-	-	-	-	-	2,447
Greece	-	-	2,000	2,008	2,000	2,000	2,000	2,000	2,000	2,000
Guatemala	-	-	-	-	-	-	-	-	2,190	2,285
Economy	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Hong Kong	-	2,000	2,000	2,004	-	-	2,058	-	2,000	-
Hungary	2,000	2,000	-	2,878	2,878	2,500	1,500	2,001	2,000	2,000
Iceland	-	2,000	2,011	2,002	2,002	2,001	2,002	2,002	2,005	2,001
India	2,011	3,047	-	-	-	1,999	1,662	2,032	-	-
Indonesia	-	-	-	-	-	2,000	-	-	-	-
Iran	-	-	-	-	-	-	-	3,124	3,350	3,359
Ireland	1,971	2,000	2,000	1,978	2,000	2,008	2,007	2,001	-	2,000
Israel	1,869	2,004	-	1,933	-	-	2,019	2,030	2,073	2,007
Italy	1,973	2,002	2,003	2,945	2,001	1,999	2,000	3,000	3,000	3,000
Jamaica	-	-	-	-	2,180	3,669	-	2,407	2,012	2,298
Japan	1,999	1,999	2,000	1,917	2,000	2,000	1,860	2,001	1,600	2,006
Jordan	-	-	-	2,000	-	-	-	-	2,006	-
Kazakhstan	-	-	-	-	-	-	2,000	-	-	-
Korea	2,008	2,015	-	-	-	-	-	2,000	2,000	2,001
Latvia	-	-	-	-	1,964	1,958	2,000	2,011	2,003	2,001
Lebanon	-	-	-	-	-	-	-	-	2,000	-
Macedonia	-	-	-	-	-	-	-	2,000	-	2,002

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Malaysia	-	-	-	-	-	2,005	-	-	2,002	2,010
Mexico	2,014	1,002	-	-	2,011	2,015	-	2,605	-	2,605
Montenegro	-	-	-	-	-	-	-	-	-	2,000
Morocco	-	-	-	-	-	-	-	-	1,500	-
Netherlands	2,013	3,510	3,505	3,507	3,582	3,535	3,539	3,508	3,003	3,502
New Zealand	1,960	2,000	2,009	1,933	1,003	-	-	-	-	-
Norway	2,874	2,036	2,040	2,883	2,015	1,999	1996	2049	2029	2,002
Pakistan	-	-	-	-	-	-	-	-	-	2007
Panama	-	-	-	-	-	-	-	-	2000	-
Peru	-	-	-	2007	-	1997	2000	2052	2021	2108
Philippines	-	-	-	-	-	2,000	-	-	-	-
Poland	2000	2000	-	2001	-	-	-	-	-	-
Portugal	2000	-	-	1000	-	-	2023	-	-	2,002
Puerto Rico	-	-	-	-	-	-	1,998	-	-	-
Romania	-	-	-	-	-	-	2046	2206	2093	2235
Russia	2012	2,190	-	-	-	1,894	1,939	1,660	1,695	1,736
Saudi Arabia	-	-	-	-	-	-	-	-	2,000	2,000
Serbia	-	-	-	-	-	-	2,200	2,297	2,300	-
Singapore	2004	2005	2008	3852	4004	4011	-	-	-	-
Slovenia	-	2030	2012	2003	3016	3,008	3020	3019	3030	3012
South Africa	1,827	6,993	3,262	3,252	3,268	3,248	-	3,270	3,135	3,279
Spain	2016	2000	2000	16980	19384	28306	27,880	30,879	28,888	26388
Sweden	2056	2000	2025	26,700	2002	2003	2001	-	-	2,492
Switzerland	-	2001	2003	-	5456	-	2148	-	2024	2,002
Syria	-	-	-	-	-	-	-	-	2,002	-
Taiwan	-	2,236	-	-	-	-	-	-	-	2,001
Thailand	-	1,043	-	-	2,000	2,000	2000	-	-	-
Tonga	-	-	-	-	-	-	-	-	1184	-
Trinidad & T.	-	-	-	-	-	-	-	-	-	2,016
Tunisia	-	-	-	-	-	-	-	-	2,000	2,001
Turkey	-	-	-	-	-	2,417	2400	2400	-	2,401
Uganda	-	-	1035	2005	-	-	-	-	2095	2267
United Arab Em.	-	-	-	-	-	2001	2180	-	2056	-
United Kingdom	4899	16002	22010	24006	11203	43033	41829	8000	30003	3000
United States	1,983	7,059	9,197	2,007	2,021	3,093	2,166	5,249	5,002	4,000
Uruguay	-	-	-	-	-	1997	2000	2,027	2001	2,034
Vanuatu	-	-	-	-	-	-	-	-	-	1,182
Venezuela	-	-	2,000	-	2,000	-	1,794	-	1,693	-
West Bank & Gaza	-	-	-	-	-	-	-	-	2080	1992
Yemen	-	-	-	-	-	-	-	-	2,065	-
Zambia	-	-	-	-	-	-	-	-	-	2,039
Total	66602	115770	96712	145189	117833	171,631	155,183	134,990	183,074	176,699

Source: Bosma et al. (2012).