Demographics and Entrepreneurship

James Liang

Peking University

Hui Wang

Peking University

Edward P. Lazear

Stanford University

Entrepreneurship requires energy and creativity as well as business acumen. Some factors that contribute to entrepreneurship decline with age, but business skills increase with experience in high-level positions. Having too many older workers in society slows entrepreneurship. When older workers occupy key positions, they block younger workers from acquiring skills. A theory is formulated and tested using the Global Entrepreneurship Monitor data. A one standard deviation decrease in a country's median age increases new business formation by 2.5 percentage points, which is about 40 percent of the mean rate. Furthermore, older societies have lower rates of entrepreneurship at every age.

I. Introduction

Few doubt the role of entrepreneurship in fostering economic growth. Without new business creation, it is difficult to imagine that game-changing

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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 with the formation of new companies.

Many significant inventions of the last 150 years illustrate the point. Thomas Edison invented the lightbulb 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 Wozniak, 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 the replacement level in the 1960s. Since 2000, Japan's fertility rate remained one of the lowest in the world at about 1.3,[1] which means that each generation will be 35 percent smaller than its parents' generation. Similarly, the fertility rates of the European countries also fell in the 1950s–60s and currently are at around 1.6 on average, which means that each generation will be 20 percent smaller than its parents' generation. In fact, the United States 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 trend toward an aging and shrinking workforce is widespread. 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.[2]

[1] See the World Bank database, available at http://data.worldbank.org/indicator/SP.DYN.TFRT.IN.

[2] Schwarz and Demirgue-Kunt (1999) document 17 countries around the world that extended their mandatory retirement age during 1992–98. 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. 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 extending of the retirement age (Herrmann 2012), attracting international migration from labor-surplus countries (Bloom, Canning, and Fink 2010; Herrmann 2012), accumulating human capital, increasing labor productivity

The focus here is on another mechanism by which not only the supply of the 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: one that grows with age and one that declines with it. The first factor is called "advantages of youth." It may reflect those aspects of creativity that decline with age. The young may generate more ideas as a result of higher levels of social interaction when young. They may be more able to think in novel ways and thereby break away from products and production methods of the past. Alternatively, the young may be more willing to take risk, perhaps because they are less constrained by family expenses. The specific mechanism is not central to the analysis here. All that is required is that this factor has a positive effect on entrepreneurship and the importance of that factor declines with age.

Despite that, the relation of entrepreneurship to age is not monotonically declining because of a second factor that has a positive effect on the ability to start a successful business. Call that factor "business acumen." Business acumen increases with job experience. Additionally, the experience that provides the relevant business skill is specific to 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 and the experience of different management situations acquire more business skills that translate into operating a successful firm.

Although the results offer no direct test of either of the effect of youth or business acumen on entrepreneurship, the findings are in complete alignment with the predictions of the theory based on these two factors, one of which declines and the other of which increases with age. Furthermore, some of the borne-out predictions are subtle and are not produced in a coherent fashion by other hypotheses.

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 cap-

(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.

ital 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, despite possessing the advantages of youth. They must have time to obtain the skills on the job that will allow businesses 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.

Consequently, 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 to acquire the skills necessary for entrepreneurship. The combination of the youth factor with the Becker idea that skills are acquired on the job, and only when the environment for learning is right, generates two important predictions.

First, the relation of entrepreneurship to age is inverted-U-shaped.[3] The very young do not have the requisite human capital and the very old have lost the advantages of youth.[4] The second prediction links de-

[3] There is a literature on the relation of entrepreneurship to age (discussed in Sec. II.B below) and the early evidence is somewhat mixed, but there is no clear evidence of monotonicity. As will be shown, the inverted-U pattern seems general and more consistent with the data.

[4] 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 ages

mographics 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 entrepreneurial 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 detailed data set on cross-country entrepreneurship called the Global Entrepreneurship Monitor (Global Entrepreneurship Research Association; http://www.gemconsortium.org). 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 lower is associated with a 2.5 percentage point higher country rate of entrepreneurship, which is about 40 percent of the mean rate. This effect is significant both statistically and economically and is robust across different specifications, across 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 advantages of youth explanation that young people are more entrepreneurial for any of the reasons mentioned earlier. Most directly, without the rank effect or some other considerations, entrepreneurship would fall monotonically with age.[5] 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 some factor to age is inverted-U-shaped. However, the second piece of evidence provides strong 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 entrepreneur-

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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 without additional modifications.

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

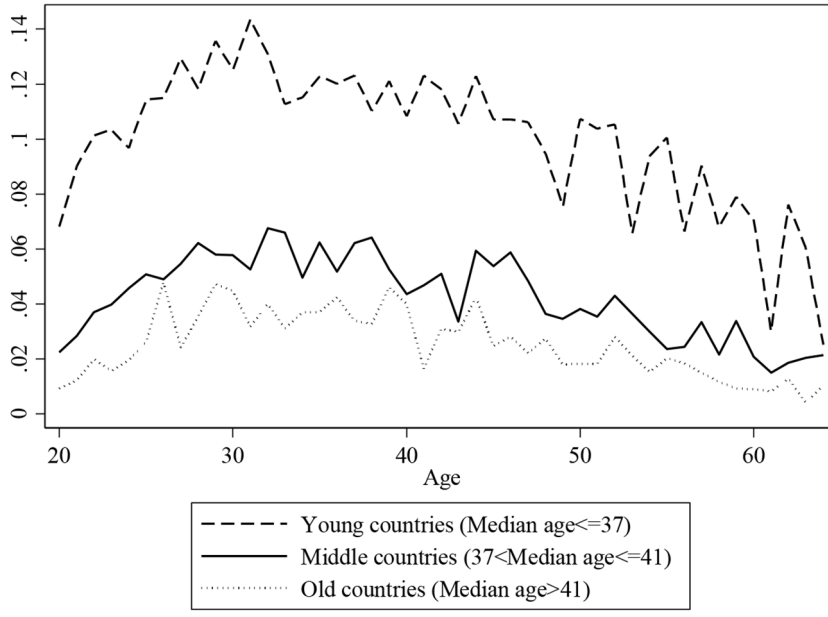

FIG. 1.—Countries with young and old labor forces. This figure presents the raw relationship entrepreneurship rates and age. Using the GEM 2010 data, countries are grouped into three categories: (1) young countries, defined as having a median age younger than 38; (2) middle countries, defined as having 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, that is, approximately one-third of the sample for each.

ship 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 in which other views are not. Furthermore, at the empirical level, inclusion of the most obvious variables that might be correlated with a country's demographics do not alter the findings qualitatively.

As an empirical matter, the cross-country rate differences are not driven much by the fact that younger countries have a higher proportion of younger workers, which one can think of as a composition effect. Instead, younger countries have higher entrepreneurship rates primarily because at any given age, countries with young populations have more entrepreneurship than countries with old populations. This is the rank effect. It is within–age group differences across countries, rather than differences in age group proportions, that account for most of the entrepreneurship variation.

Of course, there may be alternative mechanisms that could yield similar implications. An attempt is made to address some alternative theories. Those alternative theories find no consistent support in the results.

II. The Effect of Age on Entrepreneurship

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

The Japanese economy grew rapidly in the 1970s and 1980s, and many economists predicted that it would soon overtake the United States in terms of GDP per capita. However, after the bust of the real estate bubble in 1991, the Japanese economy stagnated during the following 20 years, while the US 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 information technology industry as the United States did during the last 30 years. Five of the top 10 high-tech companies in the United States 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. The firm entry rate dropped from the 6–7 percent range in the 1960s and 1970s to 3 percent in the 1990s (Acht et al. 2004). This rate is less than one-third of that in the United States 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 United States, 4.9 percent of adults between the ages of 18 and 64 are working actively to establish new businesses, as compared to only 1.9 percent in Japan.

The theory exposited in this paper can be used to explain at least in part Japan's "lost decades" in the 1990s and 2000s. It echoes some existing studies that identify the "sheer pressure of entrepreneurship" as the main driving force of postwar rebirth of Japan's economy (e.g., Stone 1969). Watanabe (1970) documents some interesting features of Japan's entrepreneurship in the 1960s when the GDP growth rate in Japan averaged around 10 percent per year. In 1962, nearly 16 percent of Japan's manufacturing firms were identified as "new enterprises."[6] Self-employed entrepreneurs accounted for nearly 10 percent of the labor force throughout the 1960s (see Watanabe 1970, 534, table I). More than 60 percent of

[6] Based on the Second Survey of Medium and Small-Scale Enterprises conducted by the Median and Small-Scale Enterprise Agency, Ministry of International Trade and Industry, 1962. "New enterprises" are defined as firms established on or after January 1, 1958, and were still in business on December 31, 1962.

the founders established their firms when they were in their 20s or 30s, with the highest concentration between 25 and 35 years of age. This pattern looks similar to that of the United States today. In present-day Japan, entrepreneurship is postponed to later ages and is reduced significantly from the levels reported by Watanabe.[7]

Dore (1996) finds that managers have gotten older over time in Japan at the same time that entrepreneurship has slowed.[8] As Japan has aged, the table reveals, for example, that in 1976, 32 percent of the subsection chief–level workers were younger than 35; in 1994 the ratio dropped to only 16 percent. That pattern of changes over time is found throughout the managerial workforce. This fact, coupled with the decline in Japanese entrepreneurship, is time-series evidence that motivates and is consistent with the theory proposed.

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 percent of its GDP, ahead of all the other OECD countries.[9] 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 the creation of new firms.

B. Determinants of Entrepreneurship over Lifetime

Among all the determinants of the decision to engage in entrepreneurship, age is the most obvious factor to consider.[10] Data from the GEM, figure 1, which divides countries into young, middle, and old, show the changes in entrepreneurial propensities at different ages. One noticeable stylized fact is that all three curves are inverted-U-shaped, with the likelihood of becoming an entrepreneur peaking in young middle age. This observation is consistent with many existing studies (e.g., Evans and

[7] Both of these facts, that the United States today looks like Japan in earlier years and that Japan's entrepreneurship occurs later today than it did a few decades ago, are found in the Global Entrepreneurship Monitor (GEM).

[8] Refer to table 1 of Dore (1996), which is copied as app. table D1.

[9] This also tends to undermine the argument that it is physical capital accumulation that drives results. Additionally, and most important, there is no reason why physical capital at any given age should be directly related to the age structure of the country. The inverted-U-shape pattern that results from this model and the within-age variation across countries by demographic structure do not seem to follow directly from the physical capital accumulation mechanism. There is no doubt that this is a factor, but not the one that drives the main results contained below.

[10] Parker (2004, 106) reports the results of a meta-study, which identifies age as the most important factor in determining entrepreneurship.

Leighton 1989; Blanchflower and Meyer 1994; Blanchflower and Oswald 2009; Mondragon-Velez 2009).[11]

There is much research, primarily outside economics, on age-productivity patterns. Some attributes necessary for successful entrepreneurship clearly decrease over the life cycle. 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 finds that inventor and manager ages are both negatively correlated with the degree of the invention's creativity.

Still, successful entrepreneurship must require more than youth or the entrepreneurship rate would be highest among fresh graduates. Lazear (2004a) found that entrepreneurship requires 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 et al. 2000). Moreover, it is helpful for aspiring entrepreneurs to develop a strong social network, which assists their ability to access resources in different phases of the 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., Wellman 1999; Greve and Salaff 2003).

As a logical matter, the productivity-age pattern for virtually all work activities must be an inverted U. Young children have neither the skills, strength, nor 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.

C. Demographic Structure and Entrepreneurship

Another pattern apparent in figure 1 is that entrepreneurship in countries with a younger workforce 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

[11] Evans and Leighton's table 2 suggests that self-employment increases and then decreases with age. Of course, unincorporated self-employment includes many individual service workers who are not entrepreneurs, so the results are not comparable.

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.

III. Model

A. *Age Structure of the Workforce*

Suppose a country's cohort structure is given by

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

where a is age, and r is the shrinkage parameter that relates the size of one cohort to another.[12] Normalize age a such that $a = 0$ is age 20, which conceptually serves as a typical work starting age, and $a = 1$ is age 65, which serves as a typical retirement age. Then the fraction of the workforce under age a, or the age distribution cumulative distribution function (cdf), is given by the following expression:

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

Figure 2 compares the age distribution of a balanced workforce ($r = 0$) to the age distributions of a shrinking ($r = 0.22$) and a growing workforce ($r = -2.18$). (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.)[13]

Two properties of the population cdf are important for deriving the propositions that follow later. The formal proofs of these properties are in appendix A.

First, there exists an $a_m \in [0, 1]$ such that for all $a < a_m$, $d^2F/drda < 0$, and for $a > a_m$, $d^2F/drda > 0$. 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. The intuition comes from noting that $F(0, r) = 0$ and $F(1, r) = 1$ for all r, which means that shares cannot change at all at the endpoints with r.

Second, for all $0 < a < 1$, $dF/dr < 0$; that is, the proportion of people below age a decreases in r for all ages (0 and 1 excepted, of course). This is shown in panel B of figure 2 as a downward shift in the cdf as r increases.

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

[13] The estimation of r is discussed below in Sec. V.A.

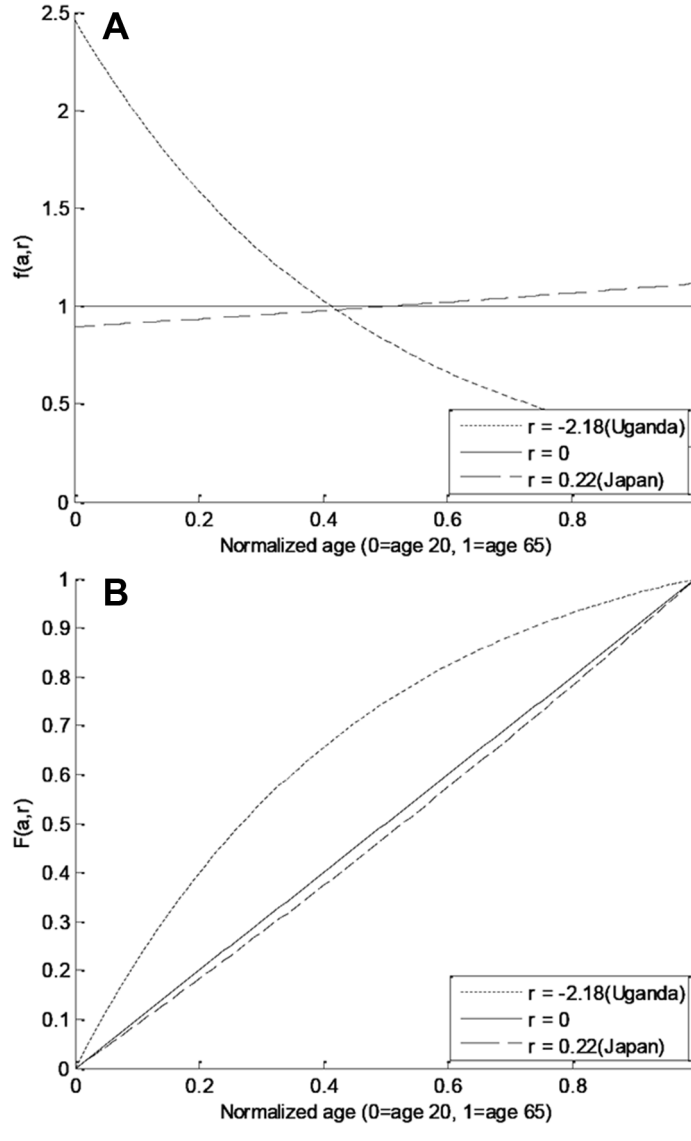

FIG. 2.—Age distribution $F(a, r)$: *A*, probability distribution function; *B*, cumulative distribution function.

B. The Value of Starting a Business

To model business formation, think of each person as 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 suf-

ficient, however, 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 youth affect the ability to come up with a significant innovation.

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

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

where ξ is a random variable that captures luck, h reflects business skills, and q captures the advantages of youth 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 cdf $P(1/\xi)$. The risk-neutral worker will choose to start a business if $v > 1$ or if

$$V(h, q) > 1/\xi. \tag{4}$$

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[14]

$$\xi = A + u, \tag{5}$$

where A is a specific person's ability (like IQ), which remains constant over time, and u is luck that the individual encounters in a given period 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. Prior entrepreneurship would say nothing about the likelihood of starting a new business. At the other extreme, if the variance u were 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 (see LaFontaine and Shaw 2014).

Other than luck, there are two factors that affect the expected value of an idea. The first, q, is the advantages of youth effect and is determined by the function $q = Q(a)$. The advantages of youth effect 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

[14] This transitory and permanent ability structure was used in Lazear (2004b).

of workers younger than he. Let s denote rank. Then $h = H(s)$ with $H' > 0$. In a seniority-based society, 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 rank is simply given by $s \equiv F(a, r)$. 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, because $F(a, r)$ decreases in r, $r_0 < r_1$ implies that $F(a, r_0) > F(a, r_1)$ for all $a \neq 0$ or 1. This implies that workers who have opportunities to gain business skills today also had opportunities to gain those skills in the past because there are fewer senior workers for every age cohort when the shrinkage parameter is r_0 than when it is r_1.

C. *Entrepreneurial Activity*

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

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

with $V_1, V_2 > 0$.[15] So the fraction of the workers at age a who start a business (denoted as $E(a, r)$) is given by

$$E(a, r) = P(V(H(F(a, r)), Q(a))), \tag{6}$$

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 an aging population, entrepreneurship falls. Specifically,

[15] Alternatively, if we assume a constant relative risk aversion, the results in the model are essentially unchanged. Moreover, we can assume that 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.

$$\frac{\partial E(a, r)}{\partial r} \leq 0. \tag{7}$$

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 (2). QED

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 countries 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 we have the following corollary.

COROLLARY 1. For any given age group, a, the entrepreneurship rate rises in s_a.

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

$$G(a, s_a) = P(V(H(s_a), Q(a))). \tag{6'}$$

Then

$$\frac{\partial G(a, s_a)}{\partial s_a} = P' V_1 H' > 0.$$

QED

Proposition 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. For any given s_a, the entrepreneurship rate falls in a.

Proof. $\partial G(a, s_a)/\partial a = P' V_2 Q' < 0$ because $Q' < 0$. QED

Corollary 2 says that older age groups should have lower entrepreneurship rates for any given share of the population that is younger than the group in question. Put simply, 30-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 relate to entrepreneurship at the individual level and by themselves do not 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. As shown below, no additional conditions are needed to prove the results at the level of the country. The demographic structure of equation (2), coupled with proposition 1 and its corollaries, are sufficient to guarantee the result at the country level.

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:

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

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, that is, $d\bar{E}/dr < 0$.

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 through the combination of both 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 tested in the empirical analysis.

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

Proof. See appendix A.

Additionally, the entrepreneurial activity of the middle-aged group is affected the most by a reduction in the population growth rate. The demographic structure is most sensitive to r at the middle age, a_m (as proved in app. A). It is also true that the entrepreneurship rate shifts down the most in the middle, as shown in figure 1 and formalized by proposition 4.

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

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

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 the advantages of youth effect 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:

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

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

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

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 $E(a_m, r) > E(a, r)$ for all $a \neq a_m$.

Proof. It has already been shown that $\partial E(0, r)/\partial a > 0$, which means that there exists some $a_m > 0$ for which $E(a_m, r) > E(0, r)$. Similarly, be-

cause $\partial E(1, r)/\partial a \leq 0$, 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. QED

Proposition 3 implies that there is a peak age of entrepreneurship somewhere in the middle of life.[16] 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 those at the peak age because they have lost the advantages of youth. 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 V below.

The effect of demographics on entrepreneurship rates is greater for middle-aged individuals than it is for the very old or very young. 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 age 0 or 1. This is formalized in the following proposition.

PROPOSITION 4. There exists some a_M with $0 < a_M < 1$ such that

$$\frac{\partial E(a_M, r)}{\partial a} < \frac{\partial E(a, r)}{\partial a} \leq 0,$$

for all $a \in [0, 1]$ and $a \neq a_M$, under the conditions that the first and second derivatives of V, H, and 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.[17] 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 V, other theories that link entrepreneurship to demographics do not provide that implication without additional ad hoc assumptions. The intuition is that $F(0, r) = 0$ and $F(1, r) = 1$ for all r, which means that shares cannot change at all at the endpoints with r. Consequently, entrepreneurship rates cannot be affected at 0 or 1 by r because r operates only through the rank effect and rank does not change with r at either extreme.[18]

[16] Without additional assumptions, it cannot be guaranteed that there is only one local maximum age a^* such that $\partial E(a^*, r)/\partial a^* = 0$. It is certain, however, that one of these a^* is a_m, i.e., $E(a_m, r) \geq E(a, r)$ for all $a \neq a_m$.

[17] Note that entrepreneurship declines in r, so proposition 4 says that the effect gets closer to zero at the two extreme ages of 0 and 1.

[18] Empirically, because

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

D. *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. Furthermore, 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 $Q(a)$. Younger workers enjoy the advantages of youth. 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 youth 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 members of society.

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

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. At any given age, 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 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 rates of entrepreneurship overall. This is corollary 3.
6. Within a country, entrepreneurship rates rise with age and then decline after some point. This is the result of proposition 3.

---

because β_{s_a} is found to be positive in the empirical analysis (see col. 3 of table 3), and because the demographic structure is most sensitive to r at middle age a_m, it follows that the entrepreneurship rate shifts down more with increasing r at middle ages than at older and younger ages. This is also what was observed in the raw data shown in fig. 1.

7. The entrepreneurship rates of the middle-aged are most sensitive to cross-country changes in r. This is proposition 4.

IV. Data

A. *Measures of Entrepreneurship*

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

First, the GEM data set captures entrepreneurial choices and decisions at the individual level. This is important for the purposes here because the age of the founder is a key variable of interest. Second, the GEM has a wide range of coverage, including both developed countries and developing ones.[19] The 2001–10 GEM data set used contains more than 1.3 million individuals between 15 and 60 years of age at the time of sampling and does this for 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, the GEM questionnaires are designed under a uniform framework with the goal of producing data that are comparable across countries.

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 V.E reports results based on three alternative definitions of entrepreneurship. The first alternative definition, "all new businesses," includes businesses that have died in the last 12 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 businesses are much more likely to fail than old ones, so the deaths are probably dominated by newly formed firms. The second definition focuses exclusively on start-ups, defined as having an owner actively involved in a start-up effort in which wages are not currently paid. The final definition, "total early-stage entrepreneurship," includes start-ups that do not yet pay wages as well as those that do pay wages

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

and 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.

The 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 5 years. Two variables are used, corresponding to those entrepreneurs who intend to hire five or more and then 10 or more employees, respectively. Second, the GEM also reports whether the newly created business introduces new products in an attempt to capture innovative ambition.

The survey was carried out in 82 countries in various years from 2001 to 2010. Many countries were surveyed multiple times, but the panel is an unbalanced one. (Refer to table B1 in app. B for detailed information on countries, timing of the survey, and sample size in the GEM data.) The total number of observations is 1.3 million, the number of country-year cells is 393, and the number of country-age-year cells is 17,554. The entrepreneurship rate can be constructed at each cell level.

Prior studies have confirmed the reliability of earlier waves of the GEM data (Reynolds et al. 2005; Ardagna and Lusardi 2010) after some have questioned some aspects of their design.[20] Ardagna and Lusardi compare the entrepreneurship rate in the GEM with rates reported in studies using various data sources and conclude that "the descriptive statistics on entrepreneurship in many of the countries covered by the GEM are consistent with the results reported in other studies on entrepreneurship" (28).

In the same vein, the analysis below on the GEM data is checked against those obtained using another data set, namely, the Flash Eurobarometer Survey on Entrepreneurship (FESE).[21] The FESE is collected by the European Commission. It is an individual-level, cross-national survey on attitudes, values, and beliefs covering a wide range of topics in the sociocultural and sociopolitical domain. European and other large countries are surveyed. Table C1 reports the sample size by country-year.

The FESE provides a reliable check on the GEM results for a number of reasons. First, both the GEM and the FESE are individual-level surveys with the same design across countries. As a result, difficulties that might arise were the data collected by each country individually and entered into a global data set do not arise. Second, the FESE samples EU and other large countries specifically, most of which are covered in the GEM. These countries are more homogeneous in level of development, which allows for better comparisons. For this reason, we exclude China, the only

[20] See Lerner and Shoar (2010). Also, Gentry and Hubbard (2004) suggest that households with more wealth (which may be more likely to be surveyed) are more involved in entrepreneurship.

[21] The FESE data are available at https://dbk.gesis.org.

developing country in the FESE sample, when we conduct our analysis.[22] Third, starting in 2002, the FESE includes information that permits construction of an entrepreneurship variable that is similar to that used from the GEM. Appendix C gives the details. The entrepreneurship rates reported by the GEM and the FESE are similar for the countries that are sampled in both data sets.

B. Demographics

The population statistics come from the US Census Bureau's International Data Base (IDB).[23] 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 in calculating its sampling weights (Bosma et al. 2012, 56). Every country in the GEM sample from 2001–10 can be matched with information from the IDB to construct the share of the population below any age in each country in a given year.

C. Other Country Characteristics

A variety of country-level attributes serve as controls in some of the analyses. First, year- and country-specific GDP per capita and GDP growth rates are used to control for stage of development. These data come from the Penn World Table, version 7.1 (Heston, Summers, and Aten 2012). These variables are measured in purchasing power parity 2005 constant dollars. To further control for level of development, the share of the agricultural sector in GDP, obtained from the World Bank database, is used.[24]

The education variable, identified as "college enrollment rate" in the tables, is the country- and year-specific rates of completed tertiary education among the adult population. These are taken from an education attainment data set constructed by Barro and Lee (2010).

"Start-up costs," defined as the cost of registering a business (as a percentage of per capita gross national income in 2010), is available from the World Bank database. This variable is used to control for institutional constraints on business formation that may vary across countries and over time.

Similarly, an international property rights index from the Property Rights Alliance (Strokova and Mitra 2010) is used. It reflects the legal

[22] We also try to use (1) the full sample of FESE with China and (2) the EU sample excluding China, Japan, and Korea. Our conclusions are not affected.

[23] Available at http://www.census.gov/population/international/data/idb/index.php.

[24] Available at https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS.

and political environment, physical property rights, and intellectual property rights for each country. The index ranges between 0 and 10. This variable is available for all countries in the sample only for 2010. That value is assumed to hold in that country for all years in which the country is sampled. The bulk of the data come from years near 2010, so this assumption is likely to be innocuous.

Finally, because experience in the military could also provide young individuals with the kind of high-responsibility jobs that parallel those of managers in business, information on the length of compulsory military service is used.[25]

Table 1 presents the summary statistics (in 2010) of the main variables used in this paper.

V. Empirical Implementation

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. The advantages of youth effect 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 operates through $H(s_a)$ or, equivalently, through $H(F(a, r))$. As described in the data section, both a and s_a are observable in the GEM and population census data, respectively. Recall that a is the normalized age, a number between zero and one, and s_a is 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 purposes, the unit of analysis is the country-age group because there is no variation in the independent variables at levels of aggregation finer than that. Because 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.[26]

[25] Available at http://en.wikipedia.org/wiki/Military_service.

[26] All estimates of standard errors are based on clustering at the country level, which is the level of treatment because the key variable is r and r is estimated for each country. Additionally, standard errors are derived after weighting for cell size.

TABLE 1
SUMMARY STATISTICS

	OVERALL ($N = 57$)		OECD ($N = 26$)		NON-OECD ($N = 31$)	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Entrepreneurship rate:						
Alternative definitions:						
Early-stage, pays wage	.061	.063	.030	.012	.087	.075
Early-stage, pays wage + shut down firms	.106	.107	.055	.019	.150	.130
Early-stage, does not pay wage	.061	.055	.035	.022	.083	.064
Early-stage, irrespective of whether or not wages are paid	.121	.108	.064	.029	.170	.126
High aspiration:						
Plans to hire 5 employees in 5 years	.010	.009	.006	.004	.013	.011
Plans to hire 10 employees in 5 years	.005	.005	.003	.002	.006	.006
New product/service	.011	.015	.007	.006	.015	.020
Demographics (among ages 20–64):						
Cohort shrink rate (r)	−.63	.64	−.17	.35	−1.01	.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)	.52	.09	.46	.05	.57	.08
Other characteristics:						
GDP per capita ($)	19,032	13,230	30,036	9,819	9,802	7,306
GDP growth rate in the past 5 years (%)	2.54	2.96	.70	1.57	4.08	2.99
Percentage of agriculture in GDP (%)	6.68	6.57	2.45	1.97	10.24	6.98
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 rights index	6.02	1.34	7.10	1.00	5.11	.79
Military service of more than a year	.09	.29	.08	.27	.10	.30

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

A. *Summarizing the Demographic Structure*

The demographic structure of a country is captured by a single parameter, namely, r; see equations (1) and (2). However, since the actual ranks, s_a, from the population data can be used to create the explanatory variables, there is no need to rely on a single population statistic.

Still, it is useful for two reasons to see whether the demographic model postulated in (1) and (2) 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, 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 cdf form of equation (2), r is fitted for each country and each year taken separately, using nonlinear least squares, 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.

For the purposes of testing goodness of fit, only the data from 2010 are used because most countries are included in that year. Nonlinear 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

$$\hat{s}_a = \frac{e^{\hat{r}a} - 1}{e^{\hat{r}} - 1}. \tag{10}$$

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.[27] The regression generates an R^2 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 a and the estimated r. Thus, the model of equations (1) and (2) fits the actual demographic data very well.[28]

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 .98. As a consequence, representing the country's age structure by the more commonly used median age instead of r is likely to be accurate for most purposes.

B. Country-Level Analysis

It is first instructive to examine the raw data at the country level. Panel A of figure 3 plots a country's entrepreneurship rate against the median age (among those 20–64) of a country in 2010. Panel B of figure 3 is the same as panel A but replaces median age with the country estimated r. The figures show 57 points, one for each country.

The raw data appear to support proposition 2, which states that higher-r (older) countries should have lower entrepreneurship rates. The various

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

[28] Even if cross-country variation is omitted by using the mean value of r rather than the estimated value of r to predict $\hat{s}_a$, the R^2 is .96. Much of this is because s_a is highly correlated with a. Despite the correlation, s_a and a have independent and important effects on entrepreneurship rates, as shown below.

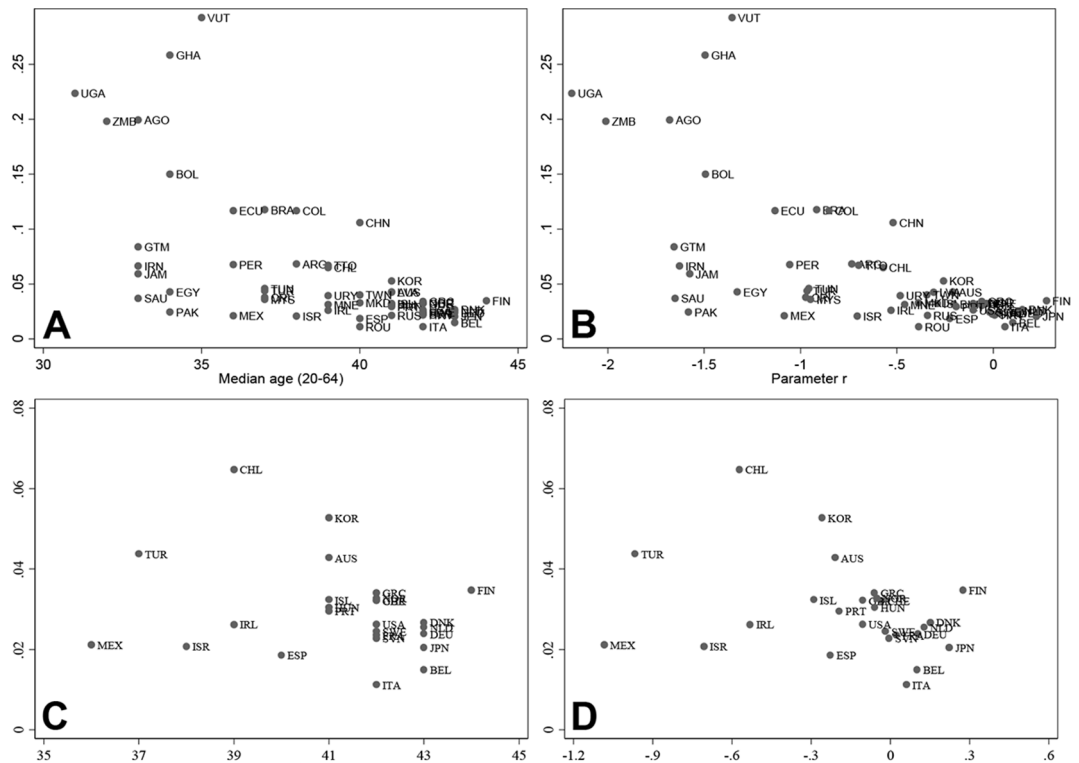

FIG. 3.—Entrepreneurship rates and demographics (2010): *A*, overall sample; *B*, overall sample; *C*, OECD sample; *D*, OECD sample

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 C and D, although the statistical relation for OECD countries in the single year of 2010 alone, which is what is shown, is not statistically significant.

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. The unit of analysis is a country-year. 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.[29]

Columns 1 and 2 regress the country's entrepreneurship rate on *r*. 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 in the country.[30] The results are similar.

Columns 5 and 6 add other explanatory variables. They are the log of per capita GDP, the 5-year per capita average growth rate, the share of agriculture sector in GDP, 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 1 year of compulsory military service.[31] 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.

One interesting result is that compulsory military service is positively related to entrepreneurship, both alone and interacted with *r*. This is

[29] Country-year clustering was also done when relevant. None of the results on the demographic variables was affected in any substantive way.

[30] The median age is calculated only for those 20–64 years old.

[31] We also try to use share of agricultural population, obtained from the World Bank database, as a control for degree of urbanization. The conclusion does not change. The logic of requiring more than 1 year of service is that soldiers cannot be expected to rise to a leadership position where they are given significant responsibility in less than 1 year.

TABLE 2
COUNTRY-YEAR-LEVEL ENTREPRENEURSHIP RATE REGRESSION

	DEPENDENT VARIABLE: Entrepreneurship Rate (Early Stage, Pays Wages)								
	All (1)	OECD (2)	All (3)	OECD (4)	All (5)	OECD (6)	All (7)	OECD (8)	All (9)
r	−.041	−.023			−.026	−.027	−.047	−.050	
	[.007]***	[.007]***			[.008]***	[.006]***	[.024]*	[.023]**	
Median age (ages 20–64)			−.007	−.004					−.002
			[.001]***	[.001]***					[.002]
Log(GDPpc)					−.006	−.003			
					[.009]	[.009]			
GDP growth rate (average of the past 5 years)					.001	.001			
					[.001]	[.001]			
Percentage of agriculture in GDP					.003	.002			
					[.002]*	[.001]**			
College enrollment rate					.048	.029			
					[.036]	[.030]			
Start-up cost (% of GNP per capita)					.020	.005			
					[.016]	[.018]			
Property rights index					.004	.007			
					[.003]	[.002]***			
Military service > 1 year					.043	.044			
					[.020]**	[.010]***			
(Military service > 1 year) × r					.052	.062			
					[.015]***	[.031]*			
Constant	.010	.022	.318	.17	.023	−.014	−.024	.027	.128
	[.004]**	[.004]***	[.051]***	[.043]***	[.086]	[.082]	[.040]	[.010]**	[.071]*
Country fixed effects							Yes	Yes	Yes
Observations	393	230	393	230	393	230	393	230	393
R^2	.40	.24	.37	.19	.57	.41	.91	.72	.90

NOTE.—Observations are weighted by the number of individuals who make up each country-year cell. Year dummies are included in all regressions. Standard errors clustered at the country level are in brackets.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

consistent with the view of human capital acquisition posited by the theory. The military is one institution in which 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 living in an older country. Although it may be tough for young workers to acquire the skills necessary to start a business in an older country, one way in which this is accomplished is to have the young in positions of responsibility in the military.

Finally, columns 7, 8, and 9 repeat the analysis of columns 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. However, the demographic structure changes sufficiently over the period in some countries, especially among the OECD countries, to pick up the demographic effect. On average, OECD countries are surveyed 7.4 years in the GEM, while non-OECD countries are surveyed 3.2 years. Therefore, most of the within-country variations are generated by the OECD sample. This also explains why the coefficient on r for the overall sample (col. 7 in table 2) is very similar to that for the OECD sample (col. 8 in table 2).

The magnitudes obtained in table 2 are substantial and suggest an important quantitative relation of entrepreneurship to demographic structure. On the basis of 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 percent higher.

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 in 2010) 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 0.061 in 2010). On the basis of 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 about 50 percent more than the 2010 mean rate.

C. Country-Age Relationships

The cross-country relation of entrepreneurship to the demographic structure is a 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.

Now, the country-year-age cell is 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 percent 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.[32] 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.

As in table 2, all specifications include 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.[33]

Column 1 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, 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.[34] 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.

[32] 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.

[33] Clustering at the country-year level reduced the standard errors.

[34] As before, r is country-year-specific.

TABLE 3
Country-Age Regressions

	Dependent Variable: Entrepreneurship Rate (Early Stage, Pays Wages) within Country-Age Cell						
	All (1)	OECD (2)	All (3)	OECD (4)	All (5)	OECD (6)	All (7)
a	−.028	−.023	−.376	−.191	−.189	−.104	.045
	[.003]***	[.003]***	[.057]***	[.049]***	[.025]***	[.036]***	[.009]***
r	−.038	−.021					
	[.007]***	[.007]***					
s_a			.336	.164	.156	.079	
			[.054]***	[.048]***	[.024]***	[.036]**	
a^2							−.085
							[.008]***
Constant	.025	.033	.038	.04	.046	.04	.035
	[.004]***	[.004]***	[.003]***	[.003]***	[.003]***	[.002]***	[.004]***
Country fixed effects					Yes	Yes	
Observations	17,554	10,309	17,554	10,309	17,554	10,309	17,554
R^2	.26	.12	.25	.12	.56	.24	.11

Note.—Observations are weighted by the number of individuals who make up each country-age-year cell. Year dummies are included in all regressions. Standard errors clustered at the country level are in brackets.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

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 but only one r value in any given survey 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.[35] This is a direct implication of corollary 1 and reflects the rank effect. In younger countries, young individuals get more opportunities to acquire the human capital necessary to start a business. As a result, in a 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 youth effect that is the focus of corollary 2. Were it not for the necessity of acquiring business skills, younger individuals would have higher rates of entrepreneurship than older individuals.[36] 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 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 overcontrols for country differences because the demographic structure, insofar as it affects all ages similarly, is picked up by the fixed effect. As before, the fixed-effect regressions pick up within-country variation over time. 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 nonlinearities. 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.

[35] This is true despite the fact that in the entire sample, a and s_a have a correlation over .9.

[36] 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 are unlikely to vary much for young individuals because the length of life effect cuts many years out, when the present value of the differences is small.

D. Age-Specific Estimation

There are 45 different age groups per country per year, which means that for each age group, the relation of entrepreneurship to either r or s_a can be estimated. Also, because the country-year-age-specific entrepreneurship rate at one age is potentially independent of the country-year-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.

The unit of analysis in table 4 is the country-year-age group and the dependent variable is the entrepreneurship rate for that cell. In the regressions, 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.

There are three columns. In column 1, 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. 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 that was displayed in figure 1. (The omitted age is 20.) The highest levels of entrepreneurship are experienced in the late 20s through the mid-30s.

Column 3 includes both age dummies and the age-specific r effects. Both columns 1 and 3 in table 4 provides strong support for proposition 1, which states that within–age group rates of entrepreneurship vary inversely with r. The effect of r on the age-specific entrepreneurship rates is negative and significant in virtually all cases. Each of these coefficients is based on cross-country variation and provides strong evidence that the demographic structure is closely related to the entrepreneurship rates. This prediction comes directly from the rank, or business skills effect, and is not related to the simple idea that young people are more creative. Young people in older societies form fewer businesses than young 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.

Columns 1 and 3 of table 4 also 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. A country's demographic structure has a greater effect on entrepreneurship of the middle-aged than it does for the young or old. This is shown in figure 4. Addition-

TABLE 4
AGE-SPECIFIC COEFFICIENT ON r

	DEPENDENT VARIABLE: Entrepreneurship Rate (Early Stage, Pays Wages)		
	(1)	(2)	(3)
	Coefficient on r for Age Shown on Left		
21	−.030***		−.039***
22	−.030***		−.035***
23	−.039***		−.043***
24	−.046***		−.048***
25	−.043***		−.040***
26	−.052***		−.045***
27	−.051***		−.046***
28	−.059***		−.051***
29	−.059***		−.047***
30	−.053***		−.042***
31	−.060***		−.051***
32	−.059***		−.047***
33	−.059***		−.045***
34	−.060***		−.049***
35	−.052***		−.040***
36	−.053***		−.045***
37	−.049***		−.041***
38	−.050***		−.041***
39	−.048***		−.040***
40	−.042***		−.036***
41	−.043***		−.036***
42	−.042***		−.035***
43	−.041***		−.038***
44	−.045***		−.042***
45	−.039***		−.038***
46	−.037***		−.033***
47	−.035***		−.037***
48	−.033***		−.037***
49	−.031***		−.033***
50	−.028***		−.037***
51	−.029***		−.034***
52	−.023***		−.029***
53	−.021***		−.025***
54	−.025***		−.035***
55	−.020***		−.029***
56	−.017***		−.029***
57	−.013**		−.023***
58	−.015**		−.031***
59	−.016***		−.033***
60	−.007		−.025***
61	.000		−.018***
62	−.005		−.026***
63	−.002		−.025***
64	.001		−.023***
	Coefficient on Age Group Dummies		
21		.007***	−.016***
22		.009***	−.012*
23		.015***	−.011

TABLE 4 (*Continued*)

	Dependent Variable: Entrepreneurship Rate (Early Stage, Pays Wages)		
	(1)	(2)	(3)
	Coefficient on Age Group Dummies		
24		.019***	−.009
25		.021***	−.003
26		.027***	.002
27		.026***	−.000
28		.032***	.004
29		.032***	.008
30		.030***	.006
31		.027***	.003
32		.031***	.007
33		.029***	.008*
34		.028***	.005
35		.027***	.006
36		.023***	.002
37		.020***	.002
38		.021***	.002
39		.018***	.002
40		.017***	−.000
41		.014***	−.000
42		.015***	−.000
43		.012***	−.003
44		.013***	−.003
45		.012***	−.005
46		.010***	−.003
47		.007**	−.008
48		.005*	−.009*
49		.004	−.008*
50		.002	−.014**
51		.002	−.010*
52		−.000	−.011**
53		−.000	−.009*
54		−.002	−.014***
55		−.002	−.013**
56		−.005	−.015***
57		−.006*	−.014***
58		−.008**	−.018***
59		−.009**	−.019***
60		−.012***	−.021***
61		−.015***	−.020***
62		−.014***	−.023***
63		−.016***	−.024***
64		−.016***	−.024***
Observations	17,554	17,554	17,554
R^2	.277	.129	.300

Note.—Observations are weighted by the number of individuals who make up each country-age-year cell. Standard errors are clustered at the country level but are not reported to save space. Year dummies are included in all regressions.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

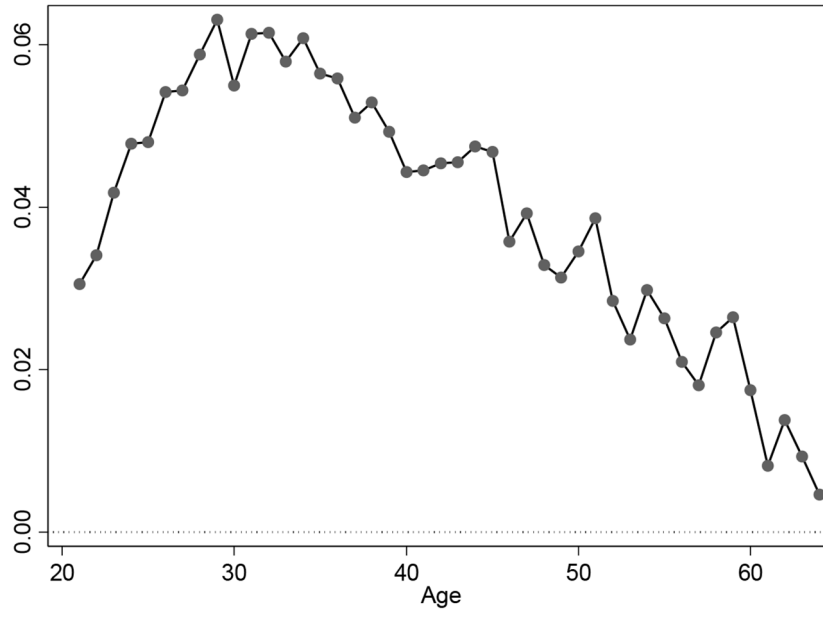

FIG. 4.—Absolute value of the coefficients on r by age in the age-specific entrepreneurship rate regression. This figure plots the magnitude of the age-specific coefficient on r reported in column 1 of table 4. The effect of a country's demographic structure on entrepreneurship rates is greatest for those in the middle-aged groups, as proposition 4 predicts.

ally, the youth 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).

As is clear, the age dummies alone do not explain much of the variation, whereas the age-specific r effects capture most of it. 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^2 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. The average effect across countries of age, ignoring the demographic structure of each country, is captured by the regression in column 2, which has a much lower R^2 (.13 vs. .28 in col. 1). Finally, the R^2 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 improves R^2 to only .30 from the .28 of column 1. This is an important result. It implies that cross-country differences in entrepreneurship rates observed in ta-

ble 2 are not so much a reflection of the young being inherently more entrepreneurial, but instead of the fact that every age group is less entrepreneurial in countries that have an old population.

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 result only from variations in the demographic structure across countries because s_a is defined specific to each age.[37] 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 unit of observation is the county-year-age cell and the dependent variable is the entrepreneurship rate for that group.

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 support the importance of the rank effect, given that each s_a coefficient is a potentially independent test of that effect. The estimates in column 1 reflect the effect on entrepreneurship of cross-country differences in demographic structure. 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 youth effect because population structure is held constant by the inclusion of s_a.

Note that as in table 4, the R^2 for the s_a-only regression is .23. Allowing only within-country age effects to matter yields an R^2 of .13. When both effects are permitted, the R^2 rises to .29. Also noteworthy is that r, used in table 4, does better at explaining variations in entrepreneurship than does s_a directly, used in table 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.

Figure 1 showed that a country's entrepreneurship rate rises and then falls with age, as predicted by proposition 3. The implication is also borne out by column 7 of table 3, where a enters positively and a^2 enters negatively, resulting in an inverted U that peaks at age 32.[38] It is also supported

[37] 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.

[38] $20 + 0.045/(2 \times 0.085) \times (64 - 20) = 32$.

TABLE 5
AGE-SPECIFIC COEFFICIENT ON s_a

	Dependent Variable: Entrepreneurship Rate (Early Stage, Pays Wages)		
	(1)	(2)	(3)
	Coefficient on s_a for Age Shown on Left		
21	2.012***		2.575***
22	1.023***		1.171***
23	.773***		1.000***
24	.630***		.845***
25	.510***		.600***
26	.468***		.552***
27	.396***		.494***
28	.380***		.505***
29	.341***		.427***
30	.293***		.361***
31	.270***		.405***
32	.254***		.358***
33	.232***		.328***
34	.214***		.345***
35	.192***		.278***
36	.174***		.313***
37	.158***		.287***
38	.150***		.289***
39	.138***		.278***
40	.126***		.253***
41	.116***		.258***
42	.112***		.257***
43	.103***		.289***
44	.100***		.308***
45	.094***		.285***
46	.088***		.263***
47	.080***		.312***
48	.075***		.310***
49	.071***		.306***
50	.065***		.327***
51	.064***		.321***
52	.059***		.274***
53	.058***		.252***
54	.054***		.359***
55	.052***		.352***
56	.048***		.361***
57	.046***		.297***
58	.043***		.408***
59	.041***		.525***
60	.037***		.498***
61	.033***		.418***
62	.033***		.746***
63	.030***		1.118***
64	.029***		2.168***
	Coefficient on Age Group Dummies		
21		.007***	−.062***
22		.009***	−.054***
23		.015***	−.065***

TABLE 5 (*Continued*)

	Dependent Variable: Entrepreneurship Rate (Early Stage, Pays Wages)		
	(1)	(2)	(3)
	Coefficient on Age Group Dummies		
24		.019***	−.070***
25		.021***	−.058***
26		.027***	−.059***
27		.026***	−.064**
28		.032***	−.073***
29		.032***	−.066***
30		.030***	−.064***
31		.027***	−.084***
32		.031***	−.079**
33		.029***	−.078***
34		.028***	−.092***
35		.027***	−.079***
36		.023***	−.102***
37		.020***	−.101***
38		.021***	−.109***
39		.018***	−.112***
40		.017***	−.110***
41		.014***	−.119***
42		.015***	−.125***
43		.012***	−.152***
44		.013***	−.168***
45		.012***	−.165***
46		.010***	−.157***
47		.007**	−.199***
48		.005*	−.207***
49		.004	−.210***
50		.002	−.237***
51		.002	−.237***
52		−.000	−.210***
53		−.000	−.198***
54		−.002	−.291***
55		−.002	−.294***
56		−.005	−.310***
57		−.006*	−.262***
58		−.008**	−.367***
59		−.009**	−.481***
60		−.012***	−.470***
61		−.015***	−.405***
62		−.014***	−.725***
63		−.016***	−1.099***
64		−.016***	−2.152***
Observations	17,554	17,554	17,554
R^2	.232	.129	.292

Note.—Observations are weighted by the number of individuals who make up each country-age-year cell. Standard errors are clustered at the country level but are not reported to save space. Year dummies are included in all regressions.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

by the results in column 2 of tables 4 and 5, where age dummies first rise and then fall, also peaking at age 32.

E. Robustness Checks

Recall that entrepreneurship is defined as owning a business that is less than 42 months old and 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 of the robustness checks 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, including all controls at the country level. Only the coefficients of interest are reported. The alternative definitions

TABLE 6
ROBUSTNESS CHECKS: ALTERNATIVE ENTREPRENEURSHIP DEFINITIONS

	Dependent Variable					
	Early-Stage-Plus Businesses That Have Died within Last 42 Months		New Businesses That Do Not Pay Wages		Early-Stage Businesses Irrespective of Whether or Not Wages Are Paid	
	All (1)	OECD (2)	All (3)	OECD (4)	All (5)	OECD (6)
	A. Country-Level Regressions					
r	−.046	−.05	−.028	−.027	−.054	−.054
	[.013]***	[.011]***	[.008]***	[.013]**	[.014]***	[.013]***
Country characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Observations	393	230	393	230	393	230
R^2	.67	.56	.47	.43	.59	.47
	B. Country-Age-Level Regressions					
s_a	.666	.336	.363	.222	.667	.381
	[.102]***	[.107]***	[.059]***	[.103]**	[.094]***	[.130]***
a	−.715	−.361	−.408	−.253	−.748	−.437
	[.107]***	[.107]***	[.061]***	[.105]**	[.098]***	[.131]***
Observations	17,554	10,309	17,554	10,309	17,554	10,309
R^2	.33	.14	.23	.13	.33	.18

NOTE.—In panel A, observations are weighted by the number of individuals who make up each country-year cell. In panel B, observations are weighted by the number of individuals who make up each country-age-year cell. Year dummies are included in all regressions. Standard errors clustered at the country level are in brackets.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

include (1) early-stage entrepreneur (the definition used in the analysis thus far) plus those businesses that have died in the last 12 months (in cols. 1 and 2), (2) early-stage businesses that are less than 42 months old but do not pay wages (in cols. 3 and 4), and (3) early-stage entrepreneur regardless of whether wages are paid or not (in cols. 5 and 6).

Altering the definition of entrepreneurship has no substantive effect on the conclusions. The coefficient on r remains negative and significant irrespective of the definition of entrepreneurship, although the magnitudes change somewhat.[39] 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. The definitions include entrepreneurial events in which the founder plans to hire more than five or more than 10 employees during the next 10 years. This approach is useful to distinguish entrepreneurial events from self-employment, where an individual works alone or with a very small number of others.[40] 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.

F. GEM versus FESE Results

In this section, the GEM results are compared with those from the FESE. Recall that the FESE provides information on entrepreneurship for Euro-

[39] 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.

[40] 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.

TABLE 7
ROBUSTNESS CHECK: ENTREPRENEURSHIP WITH HIGH ASPIRATION

	Types of Early-Stage Entrepreneur					
	Plan to Hire More than 5 Employees in 10 Years		Plan to Hire More than 10 Employees in 10 Years		Involve New Products/Services	
	All (1)	OECD (2)	All (3)	OECD (4)	All (5)	OECD (6)
	A. Country-Level Regressions					
r	−.005	−.008	−.003	−.004	−.006	−.008
	[.002]***	[.001]***	[.001]**	[.001]***	[.002]***	[.003]**
Country characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Observations	393	230	393	230	393	230
R^2	.33	.48	.26	.44	.31	.43
	B. Country-Age-Level Regressions					
s_a	.058	.046	.031	.024	.054	.051
	[.011]***	[.017]**	[.007]***	[.012]**	[.010]***	[.028]*
a	−.068	−.054	−.036	−.029	−.062	−.058
	[.012]***	[.017]***	[.007]***	[.012]**	[.011]***	[.029]*
Observations	17,554	10,309	17,554	10,309	17,554	10,309
R^2	.08	.06	.05	.04	.09	.07

NOTE.—In panel A, observations are weighted by the number of individuals who make up each country-year cell. In panel B, 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 brackets. Year dummies are included in all regressions.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

pean and other large countries, so comparisons can be done for the samples of countries that overlap.

Although the FESE provides information that is similar to that in the GEM, it is not identical. In particular, the dependent variable in the GEM requires that to be deemed an entrepreneur, the business in question must be paying wages. The FESE does not provide information on whether or not wages are being paid. Entrepreneurship is defined in the FESE as having started a new business within the past 42 months, regardless of whether or not wages are paid.

As a result, the definition used for the GEM is the final one in table 6, which is the most encompassing and includes businesses, like those in the FESE, that do not pay wages. It parallels the definition of entrepreneurship reported in the FESE.

Table 8 reports the results. Each observation is a country-year combination. The time period is restricted to 2002–9, the only time during which the relevant entrepreneurship variable is available in FESE data. The same countries are used in the analysis across the two data sets, but the num-

TABLE 8
COUNTRY-LEVEL ENTREPRENEURSHIP RATE REGRESSION

	DEPENDENT VARIABLE: Early-Stage Businesses Irrespective of Whether or Not Wages Are Paid					
	GEM Sample (2002–9)			FESE Sample (2002–9)		
	(1)	(2)	(3)	(4)	(5)	(6)
r	−.037		−.027	−.03		−.033
	[.013]***		[.012]**	[.015]*		[.019]*
Median age (ages 20–64)		−.005			−.004	
		[.002]**			[.003]	
Country characteristics			Yes			Yes
Observations	171	171	171	103	103	103
R^2	.19	.13	.48	.12	.09	.32

NOTE.—Observations are weighted by the number of individuals who make up each country-year cell. The numbers of observations differ between the two data sets because the number of years surveyed is not the same in both for all countries. Columns 3 and 6 include the same set of country-level characteristics and those in table 2. Year dummies are included in all regressions. Standard errors clustered at the country level are in brackets.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

ber of years covered is not necessarily the same in each. Year dummies are included.[41]

Columns 1–3 contain the results based on the GEM sample, whereas columns 4–6 are results based on the FESE sample.[42] The coefficients on r and median age are virtually identical across the two data sets in all three specifications.

Table 9 replicates the key analyses of table 3, where the unit of analysis is the country-year-age cell. The structure of table 9 mimics that of table 8. Once again, coefficients from the FESE analysis are qualitatively similar to those from the GEM analysis. Because the sample size is smaller in the FESE, some precision of estimation is lost. Still, five of the six coefficients remain statistically significant.

G. 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 pa-

[41] The numbers of observations differ across data sets because the FESE does not survey the same number of years as does the GEM. Year dummies are included to correct for year effects.

[42] Since only 7 years of data are included, not many countries are surveyed in multiple years. As a result, country fixed-effect regressions were not run.

TABLE 9
COUNTRY-AGE-LEVEL ENTREPRENEURSHIP RATE REGRESSION

	DEPENDENT VARIABLE: Early-Stage Businesses Irrespective of Whether or Not Wages Are Paid					
	GEM Sample (2002–9)			FESE Sample (2002–9)		
	(1)	(2)	(3)	(4)	(5)	(6)
a	−.048	−.289	.091	−.087	−.316	.047
	[.004]***	[.088]***	[.013]***	[.004]***	[.099]***	[.018]**
r	−.034			−.022		
	[.013]**			[.014]		
s_a		.235			.224	
		[.088]**			[.097]**	
a^2			−.138			−.131
			[.010]***			[.016]***
Observations	7,695	7,695	7,695	4,618	4,618	4,618
R^2	.17	.17	.21	.09	.09	.10

NOTE.—Observations are weighted by the number of individuals who make up each country-age-year cell. The numbers of observations differ between the two data sets because the number of years surveyed is not the same in both for all countries. Year dummies are included in all regressions. Standard errors clustered at the country level are in brackets.

* Significant at 10 percent.
** Significant at 5 percent.
*** Significant at 1 percent.

rameter 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, entrepreneurship rates are negatively related to r. The same is 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 3–6, 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 3–6, supports this claim, as does column 3 of table 5, which shows age dummies tending to become more negative with age, given s_a.
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, supports this prediction.
5. Corollary 3 is a restatement of proposition 2 but is cast in terms of median age instead of r. Table 2, columns 3 and 4, bears 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 column 2 of both tables 4 and 5, which do not hold r or s_a constant. The age dummies first rise and then fall with age. Additionally, the raw data shown in figure 1 provide additional support for this prediction.

7. Proposition 4 predicts that entrepreneurship rates decline most for middle-aged workers as a population ages. This is borne out by figure 1 and by the analytic result that is based on the fact that $dF/dr < 0$ for interior a coupled with the positive coefficient on β_{s_a} in column 3 of table 3.

H. Identification

The approach used is one that assumes the demographic structure is given and predetermined. 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 reflects 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 predetermined 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, the flow of immigrants is almost always too small relative to the size of the native popula-

tion to make much of a difference. Second, even if there were a large flow of immigrants, 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 5 years lower than that of the native-born population. Green card holders are those who have immigrated to the United States but have not obtained citizenship status (Office of Immigration Statistics 2012; Lazear 2013). Although 5 years is significant, green card holders account for only about one-thirtieth of all those living in the United States, which means that the 5-year difference would lower the median by about one-sixth of a year. Indeed, among the 2010 sampled countries, median ages (among population ages between 20 and 64) range from 31 to 44 years old, with a standard deviation of almost 4 years. As a consequence, immigration, even on a large scale, is unlikely to cause much bias in the estimates.

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 these effects are pervasive. The next section considers some possible alternative theories.

Alternative mechanisms.—The most novel and compelling support of the theory 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 countrywide entrepreneurship rate. The coefficients on r remain significant and statistically precise, although the one for all countries taken together does decline in absolute magnitude (compare col. 5 to col. 1). Per capita GDP would seem to be a good proxy for stage of development, but it does not have a significant or quantitatively meaningful effect on the results.

A second and related possibility is that 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 5-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. 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 theory presented here implies an inverted-U-shape relation of entrepreneurship to age, which comes about because two effects work in opposite directions. 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 in which 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.

I. 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. Data of this kind could prove relevant and might permit 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 because the country r captures the industry-relevant r with error.

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 demo-

graphic variables. The rank and youth effects can be separated from overall industry effects by doing within-age across-industry analysis.

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 (2004a, 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 businesses. An appropriate test would examine the subsequent entrepreneurial experiences of people who were randomly thrust into supervisory positions.

VI. 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, energy, and risk tolerance, 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 older 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 provides more opportunities 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 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 data set called the Global Entrepreneurship Monitor and verified using a second data set, the Flash Eurobarometer Survey on Entrepreneurship.

Most basic of the predictions is that the older the population, the lower is the overall rate of entrepreneurship. The model predicts that this holds, both with respect to the population shrinkage parameter, which measures the speed with which a population ages, and with respect to 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 finds no support.

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, energy, or willingness 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 than do countries with older populations. The reason is 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. The evidence supports this view and 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 simply 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 50 years after the work was done, new implications of his profound theories continue to be discovered and borne out.

Appendix A

Proofs

Properties of the Demographic Structure Discussed in Section III.A: Proofs

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

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), it must be true that for all $a < a_m$, $d^2F/drda < 0$ and for $a > a_m$, $d^2F/drda > 0$.[43] QED

PROPERTY 2. For $F = (e^{ra} - 1)/(e^r - 1)$ and $0 < a < 1$, $dF/dr < 0$.

Proof. Note that

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

Therefore,

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

and

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

Given (A6), (A7), and $d^2F/drda < 0$ and for $a > a_m$, $d^2F/drda > 0$ and $dF/dr < 0$ for $a \in [0, 1]$. QED

Proof of Proposition 2

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

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

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

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

$$G_2 \equiv \frac{\partial G}{\partial r} = -G_1 F_2 > 0. \tag{A9}$$

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

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

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

Given (A9) and $q' < 0$, we know $d\bar{E}/dr < 0$. QED

Proof of Corollary 3

The median age, a_{med}, is defined by $F(a_{\text{med}}, r) = 0.5$ or by solving $(e^{ra} - 1)/(e^r - 1) = 0.5$. The solution is

$$a = \frac{1}{r}\ln\left(\frac{e^r - 1}{2}\right),$$

which increases monotonically in r (the function resembles the standard logistic shape). Since, by proposition 2, $d\bar{E}/dr < 0$, it follows that $d\bar{E}/da_{\text{med}} < 0$. QED

Proof of Proposition 4

Notice that

$$\frac{\partial^2 E}{\partial a \partial r} = P' V_1 H' \cdot F_{12} + \frac{\partial P' V_1 H'}{\partial a} F_2. \tag{A11}$$

Since $F_2(0, r) = 0$ and $F_2(1, r) = 0$, the value of $\partial^2 E/\partial a \partial r$ is dominated by $P' V_1 H' \cdot F_{12}$ when a is close to 0 or 1. Moreover, as shown above, $F_{12}(0, r) < 0$ 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 exists one $a_M \in (0, 1)$ such that

$$\frac{\partial^2 E(a_M, r)}{\partial a \partial r} = 0$$

and

$$\frac{\partial E(a_M, r)}{\partial a} < \frac{\partial E(a, r)}{\partial a} \leq 0$$

for all $a \in [0, 1]$ and $a \neq a_M$.[44] QED

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

Appendix B

Global Entrepreneurship Monitor Data Coverage

TABLE B1
GEM Sample Sizes by Country and Year

	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 & Herzegovina								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 Republic							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

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
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	1,996	2,049	2,029	2,002
Pakistan										2,007
Panama									2,000	
Peru				2,007		1,997	2,000	2,052	2,021	2,108
Philippines						2,000				
Poland	2,000	2,000		2,001						
Portugal	2,000			1,000			2,023			2,002
Puerto Rico							1,998			

TABLE B1 (*Continued*)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Romania							2,046	2,206	2,093	2,235
Russia	2,012	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	2,004	2,005	2,008	3,852	4,004	4,011				
Slovenia		2,030	2,012	2,003	3,016	3,008	3,020	3,019	3,030	3,012
South Africa	1,827	6,993	3,262	3,252	3,268	3,248		3,270	3,135	3,279
Spain	2,016	2,000	2,000	16,980	19,384	28,306	27,880	30,879	28,888	26,388
Sweden	2,056	2,000	2,025	26,700	2,002	2,003	2,001			2,492
Switzerland		2,001	2,003		5,456		2,148		2,024	2,002
Syria									2,002	
Taiwan		2,236								2,001
Thailand		1,043			2,000	2,000	2,000			
Tonga									1,184	
Trinidad & Tobago										2,016
Tunisia									2,000	2,001
Turkey						2,417	2,400	2,400		2,401
Uganda			1,035	2,005					2,095	2,267
United Arab Emirates						2,001	2,180		2,056	
United Kingdom	4,899	16,002	22,010	24,006	11,203	43,033	41,829	8,000	30,003	3,000
United States	1,983	7,059	9,197	2,007	2,021	3,093	2,166	5,249	5,002	4,000
Uruguay						1,997	2,000	2,027	2,001	2,034
Vanuatu										1,182
Venezuela			2,000		2,000		1,794		1,693	
West Bank & Gaza Strip									2,080	1,992
Yemen									2,065	
Zambia										2,039
Total	66,602	115,770	96,712	145,189	117,833	171,631	155,183	134,990	183,074	176,699

SOURCE.—Bosma et al. (2012).

Appendix C

Comparison between GEM and FESE Data

Table C1 reports the sample size of FESE data by country and year during the survey period.

TABLE C1
FESE Sample Size by Country and Year

Country	2002	2003	2004	2007	2009
Austria	500	500	500	504	501
Belgium	510	519	1,000	1,005	1,007
China					1,002
Croatia					500
Czech Republic			1,008	1,003	1,001
Denmark	501	500	503	511	500
Finland	500	500	501	505	500
France	503	1,002	1,007	1,000	1,005
Germany	503	1,000	1,000	1,006	1,005
Greece				1,016	1,006
Hungary			1,000	1,021	1,002
Iceland	502	501	501	500	504
Ireland	500	500	500	500	500
Italy	502	1,001	1,004	1,006	1,017
Japan					1,000
Korea					1,000
Latvia			510	501	504
Netherlands	500	500	1,000	1,000	1,003
Norway	500	503	500	500	503
Poland			1,000	1,011	1,005
Portugal	500	500	1,000	1,010	1,006
Romania					504
Slovenia			500	502	503
Spain	502	1,001	1,001	1,005	1,009
Sweden	500	500	500	502	501
Switzerland					510
Turkey					504
United Kingdom	500	1001	1,006	1,029	1,000
United States	500	1,011	1,003	1,009	1,010

Table C2 reports the summary statistics of entrepreneurship variables for the two data sets. The entrepreneurship variables in both data sets are defined as early-stage businesses irrespective of whether or not wages are paid. For comparability, the same countries are used in both the GEM and FESE analyses.[45] It is evident that the entrepreneurship rates are comparable. The correlation of this variable across the two data sets is .50, where the unit of analysis is the country-year.

[45] All of them are OECD countries.

TABLE C2
COMPARISON OF ENTREPRENEURSHIP RATE BETWEEN GEM AND FESE

Year	Data	Number of Countries	Mean	Standard Deviation	Minimum	Maximum
2002	GEM	21	.061	.032	.018	.150
	FESE	16	.055	.026	.018	.136
2003	GEM	19	.056	.029	.014	.119
	FESE	16	.057	.022	.032	.109
2004	GEM	20	.057	.028	.016	.133
	FESE	21	.053	.023	.024	.120
2007	GEM	24	.058	.025	.023	.128
	FESE	22	.066	.022	.028	.126
2009	GEM	21	.062	.024	.031	.118
	FESE	28	.065	.027	.028	.139

Appendix D

Table 1 of Dore (1996)

TABLE D1
OCCUPANTS OF SELECTED RANKS BY AGE GROUP

	Subsection Chief (Kakari-cho)			Division Chief (Bucho)		
	Under 35	35–39	40 or over	Under 45	45–49	50 or over
1976	31.80%	31.90%	36.30%	24.50%	31.10%	41.40%
1984	18.30%	33.10%	48.60%	12.50%	37.30%	50.20%
1994	16.40%	23.50%	60.10%	7.60%	27.80%	64.60%

SOURCE.—Basic Survey of Wage Structure, various years.

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