Demographics and Entrepreneurship

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General Intuition

• Need creativity and energy to start a business
• Also need some skills, which requires experience
• High level experience more valuable for producing human capital needed for entrepreneurship
• Young countries provide more opportunities for young to acquire skills because they take on more responsibility in firms in which they work
Main Implications and Findings

• Older countries (measured by shrinkage parameter or median age) have lower average entrepreneurship rates
• Older countries (measured by shrinkage parameter or median age) have lower entrepreneurship rates for individuals of any given age
• The smaller the share of the workforce older than a cohort, the higher the rate of entrepreneurship for that cohort (rank effect)
• For any given share of the workforce above a cohort, the lower is age, the higher the rate of entrepreneurship (creativity effect)
• The relation of entrepreneurship to age is inverted u-shaped (combination of the two effects)
• Entrepreneurship rates decline with country aging most for middle-age individuals
Figure 1. Countries with young and old labor forces

Note:
1. Younger countries have higher rates of entrepreneurship at every age
2. Relation of entrepreneurship to age is inverted u
3. Inverted u most pronounced among young countries
Two Parts to the Model

• Demographic structure
• Economics of becoming an entrepreneurship
Demographic Structure

Cohort size (proportion) as function of age, $a$, and shrinkage parameter, $r$

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

Cumulative (proportion younger than age $a$)

$$F(a, r) = \frac{e^{ra} - 1}{e^r - 1}$$
Properties of Demographic Structure

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

and for \( a > a_m \), \( \frac{d^2 F}{drda} > 0 \).

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

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

This states that the proportion of people below age \( a \) decreases in \( r \) for all ages (0 and 1 excepted, of course).
The share below any age falls in $r$, the shrinkage parameter. It falls most for the middle aged.
Economic Model of Entrepreneurship

Value of entrepreneurship, $v$, depends on human capital, $h$, creativity, $q$, and luck, $\xi$

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

The risk-neutral worker will choose to start a business if

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

$P(x)$ is the probability that $x > 1/\xi$
so $P(V(h, a))$ is the proportion of workers who start a business

**Human capital**: Let $s_a$ denote rank so $s_a = F(a, r)$. Then, $h = H(s)$ with $H' > 0$.

**Creativity**: $q = Q(a)$. Creativity is assumed to decrease with age, $Q'(a) < 0$.

Substituting, the proportion of workers of age $a$ who start a business (denoted as $E(a, r)$) is given by

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

or equivalently,

$$G(a, s_a) = P(V(H(s_a), Q(a)))$$
Theoretical Results

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

\[
\frac{\partial E(a, r)}{\partial r} \leq 0
\]

**Corollary 1.** For any given age group, \( a \), the entrepreneurship rate rises in \( s_a \) or

\[
\frac{\partial G(a, s_a)}{\partial s_a} > 0
\]

(This is the rank effect of human capital acquisition.)

**Corollary 2.** For any given rank \( s_a \), the entrepreneurship rate falls in \( a \) or

\[
\frac{\partial G(a, s_a)}{\partial a} < 0
\]

(This is the creativity effect.)
Theoretical Results, Continued

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

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

Proposition 3. There exists an age $a_m$ with $0 < a_m < 1$ such that $E(a_m, r) > E(a, r)$ $\forall a \neq a_m$.

(The relation of entrepreneurship to age has an inverted-u shape.)

Proposition 4. There exists some $a_M$, $0 < a_M < 1$ such that

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

and

$$\frac{\partial E(a_M, r)}{\partial r} < \frac{\partial E(1, r)}{\partial r}$$

(Entrepreneurship rates shift the most with demographic structure for middle-aged workers.)
Summary of Empirical Implications

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

2. Holding age constant, the higher is $s(a)$, the higher is the rate of entrepreneurship.

3. Countries that are aging more quickly, captured by higher levels of $r$, should have lower rates of entrepreneurship at any given age.

4. Categorizing countries by their $r$, those with higher values of $r$ should have lower rates of entrepreneurship overall.

5. It also follows that countries with higher median ages should have lower entrepreneurship rates.

6. Within a country, entrepreneurship rates rise with age and then decline after some point.

7. The entrepreneurship rates of the middle-aged are most sensitive to cross-country changes in $r$. 
Data

Global Entrepreneurship Monitor

- Survey 2000-2010 (not all countries all years)
- 1.3 million individuals 15-60 years old
- 82 countries
- Entrepreneurship defined a number of ways.
  - For most, used “Manages and owns a business that is up to 42 months old and pays wages”
Data

US Census Bureau’s International Data Base

• Population counts for 200 countries
• Ages 0 to 100
• Used by GEM to calculate sampling weights
Data

Country Characteristics

• GDP-per-capita: Penn World Table (PPP in 2005 dollars)
• Tertiary education completion rates: Barro and Lee (2010).
• Start-up costs: World Bank Database
• Property rights index: Property Rights Alliance
Table 1. Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Overall (N=82)</th>
<th>OECD (N=31)</th>
<th>Non-OECD (N=51)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std</td>
<td>Mean</td>
</tr>
<tr>
<td>Entrepreneurship rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative definitions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early-stage, pay wage (esentr)</td>
<td>0.06</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>Early-stage + Shutdown (esentr_shd)</td>
<td>0.11</td>
<td>0.11</td>
<td>0.05</td>
</tr>
<tr>
<td>Nascent, not-pay wage (nascent)</td>
<td>0.07</td>
<td>0.06</td>
<td>0.04</td>
</tr>
<tr>
<td>Total Early Stage (tt_esentr)</td>
<td>0.12</td>
<td>0.11</td>
<td>0.06</td>
</tr>
<tr>
<td>With high aspiration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan to hire 5 in 5 years (esentr_ha5)</td>
<td>0.010</td>
<td>0.009</td>
<td>0.006</td>
</tr>
<tr>
<td>Plan to hire 10 in 5 years (esentr_ha10)</td>
<td>0.005</td>
<td>0.005</td>
<td>0.003</td>
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<tr>
<td>New product/market (esentr_newps)</td>
<td>0.011</td>
<td>0.015</td>
<td>0.007</td>
</tr>
<tr>
<td>Demographic (among age 20-64)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cohort shrink rate (r)</td>
<td>-0.63</td>
<td>0.64</td>
<td>-0.17</td>
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<tr>
<td>Average age</td>
<td>39.55</td>
<td>2.52</td>
<td>41.34</td>
</tr>
<tr>
<td>Median age</td>
<td>38.74</td>
<td>3.50</td>
<td>41.19</td>
</tr>
<tr>
<td>Percentage of young (20-45)</td>
<td>0.52</td>
<td>0.09</td>
<td>0.46</td>
</tr>
<tr>
<td>Other Characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP per capita</td>
<td>$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>College enrollment rate</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start-up cost (% of GNP per capita)</td>
<td>%</td>
<td>17.01</td>
<td>34.51</td>
</tr>
<tr>
<td>Property right index</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Results
Demographic Model

• Fits well
• Estimate $r$ non-linearly for each country (45 age group observations) from
  \[
  \hat{S}_a = \frac{e^{\hat{r}a} - 1}{e^{\hat{r}} - 1}
  \]
• Then get correlation of $s_a$ with $\hat{S}_a$
• 2561 age-country cells in 2010
• R-squared is .998
Aging Countries Have Less Entrepreneurship
### Results: Country Comparisons

#### Table 2: Country-Year Level Entrepreneurship Rate Regression

<table>
<thead>
<tr>
<th>Dep. Var.</th>
<th>Babybuso</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>All</td>
</tr>
<tr>
<td>specifics</td>
<td>(1)</td>
</tr>
<tr>
<td>r</td>
<td>-0.041</td>
</tr>
<tr>
<td></td>
<td>[0.007]***</td>
</tr>
<tr>
<td>Median age</td>
<td>-0.007</td>
</tr>
<tr>
<td>(age 20-64)</td>
<td></td>
</tr>
<tr>
<td>GDPpc</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Tertiary</td>
<td>0.03</td>
</tr>
<tr>
<td>Start-up Cost</td>
<td>0.032</td>
</tr>
<tr>
<td>IPRI</td>
<td>0.002</td>
</tr>
<tr>
<td>GDP growth rate</td>
<td>0.001</td>
</tr>
<tr>
<td>Constant</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>[0.004]**</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y</td>
</tr>
<tr>
<td>Country FE</td>
<td>Y</td>
</tr>
<tr>
<td>Obs</td>
<td>393</td>
</tr>
<tr>
<td>R-square</td>
<td>0.4</td>
</tr>
</tbody>
</table>

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

Standard errors clustered at the country level are in parentheses.

* Significant at 10%; ** significant at 5%; *** significant at 1%.
Summarizing Table 2

• Higher $r$ (older, shrinking population), the lower the rate of entrepreneurship (columns 1 and 2 and Proposition 2)
  – US with $r=-.1$ would have entrepreneurship rate 61% higher than Japan, with $r=.22$.

• Higher median age, the lower the rate of entrepreneurship (columns 3 and 4 and Corollary 3)
  – One s.d. decline in median age results in 2.5 percentage point increase in entrepreneurship, which is over 40% of mean rate of .06

• Including controls (GDP, education, cost of startup, property rights) does not change conclusion

• Conclusion holds, albeit weaker, even within country (country fixed effects included)
### Results: Country Age Relationships

**Table 3**

<table>
<thead>
<tr>
<th>Sample specifics</th>
<th>Dep. Var.</th>
<th>Entrepreneurship rate within country-age cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>OECD</td>
<td>All</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>a</td>
<td>-0.028</td>
<td>-0.023</td>
</tr>
<tr>
<td></td>
<td>[0.003]***</td>
<td>[0.003]***</td>
</tr>
<tr>
<td>r</td>
<td>-0.038</td>
<td>-0.021</td>
</tr>
<tr>
<td></td>
<td>[0.007]***</td>
<td>[0.007]***</td>
</tr>
<tr>
<td>s_a</td>
<td>0.336</td>
<td>0.164</td>
</tr>
<tr>
<td></td>
<td>[0.054]***</td>
<td>[0.048]***</td>
</tr>
<tr>
<td>a^2</td>
<td></td>
<td>-0.085</td>
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<tr>
<td></td>
<td></td>
<td>[0.008]***</td>
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<tr>
<td>Constant</td>
<td>0.025</td>
<td>0.033</td>
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<tr>
<td></td>
<td>[0.004]***</td>
<td>[0.004]***</td>
</tr>
<tr>
<td>Year dummies</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Country FE</td>
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<td>Y</td>
</tr>
<tr>
<td>Obs</td>
<td>17554</td>
<td>10309</td>
</tr>
<tr>
<td>R-square</td>
<td>0.26</td>
<td>0.12</td>
</tr>
</tbody>
</table>

**Note:**

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

Standard errors clustered at the country level are in parentheses.

* Significant at 10%; ** significant at 5%; *** significant at 1%.
Summarizing Table 3

• Age, \( a \), enters negatively (creativity effect), \( r \), population shrinkage parameter, (human capital rank effect) enters negatively (columns 1 and 2, and Proposition 1)
• Also, \( a \) enters negatively, \( s_a \), share younger than age \( a \) (human capital rank effect), enters positively (columns 3 and 4 and Corollaries 1 and 2)
• True even with country fixed effects, reflecting importance of within-country age variation (columns 5 and 6)
• Relation of entrepreneurship to age is inverted u (column 7 and Proposition 3)
More Refined Tests

• Each age group provides a potentially independent test across countries so 45 tests
• Table 4 allows every age group to have its own effect of $r$ and a different constant term
• The effect of $r$ is negative and significant in almost all cases (Proposition 1) which is strong support of the human capital rank effect
• Three versions:
  – just $r$ (one intercept) varies by age group $R^2 = .23$
  – just $a$ (45 intercepts) varies by age group $R^2 = .09$
  – both $r$ and intercepts vary by age group $R^2 = .25$
• Most of the action is in $r$
• Table 5 repeats the analysis but uses $s_a$ instead of $r$. Results are parallel (Corollaries 1 and 2)
• Age dummies become more negative with age, reflecting the creativity effect
Population Aging Affects Middle Age Workers Most

(Proposition 4)

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

Note: This figure plots the magnitude of the age-specific coefficient on \( r \) reported in column 1 of Table 4.
Entrepreneurship Peaks in Middle Age
(Proposition 3)
Using Different Definitions of Entrepreneurship Does not Affect Conclusions

- Early-stage entrepreneur plus those that have died in last twelve months
- Nascent business are less than 42 months old, but do not pay wages
- Nascent plus early stage
- “High aspiration” entrepreneurship
  - expect to hire more than five employees in next ten years
  - expect to hire more than ten employees in next ten years
Causation and Alternatives

- Reverse causation: Entrepreneurship causes age structure
  - Only possible for immigration
  - Implausible: Too small an effect on median age
- Theory is specific with respect to details. All supported.
- Alternatives
  - Older countries are more developed
    - GDP-per-capita and education do not affect results
  - Older countries are poorer prospects for investment
    - GDP growth rates do not affect results
  - These alternatives do not predict the inverted u nor the change in entrepreneurship among middle aged being the most pronounced
Summary

• Human capital framework coupled with demography provides strong theoretical predictions for entrepreneurship and aging

• Seven specific predictions the most important being
  – aging societies have less entrepreneurship
  – entrepreneurship rate is lower in aging societies at every age
  – because the creativity and human capital rank effect work in opposite directions, entrepreneurship rates peak in middle age

• All theoretical predictions are borne out