

# Demographics and Entrepreneurship

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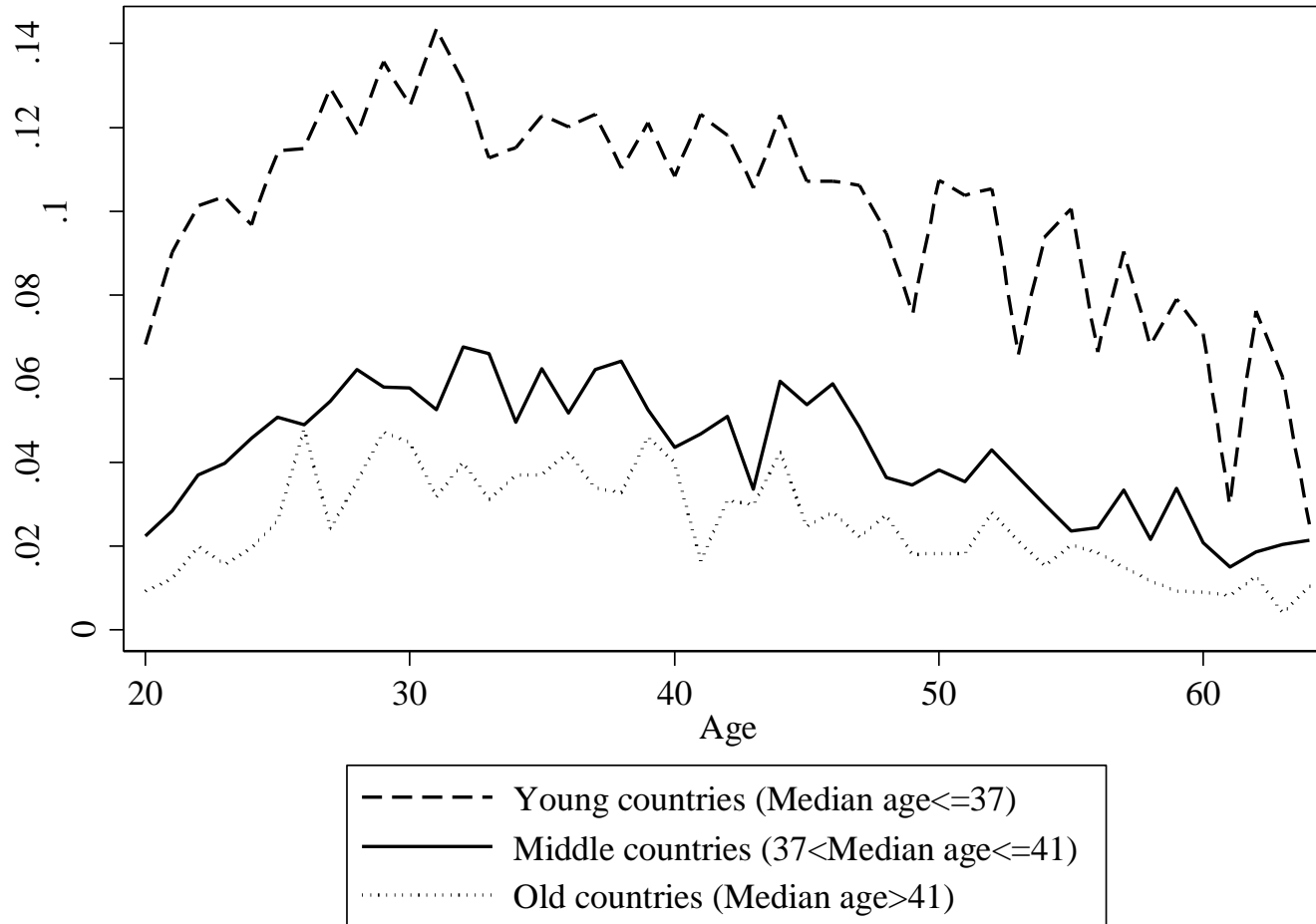
# General Intuition

- 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 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 entrepreneur

# Demographic Structure

Cohort 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  $a < a_m$ ,  $\frac{d^2F}{drda} < 0$ ,

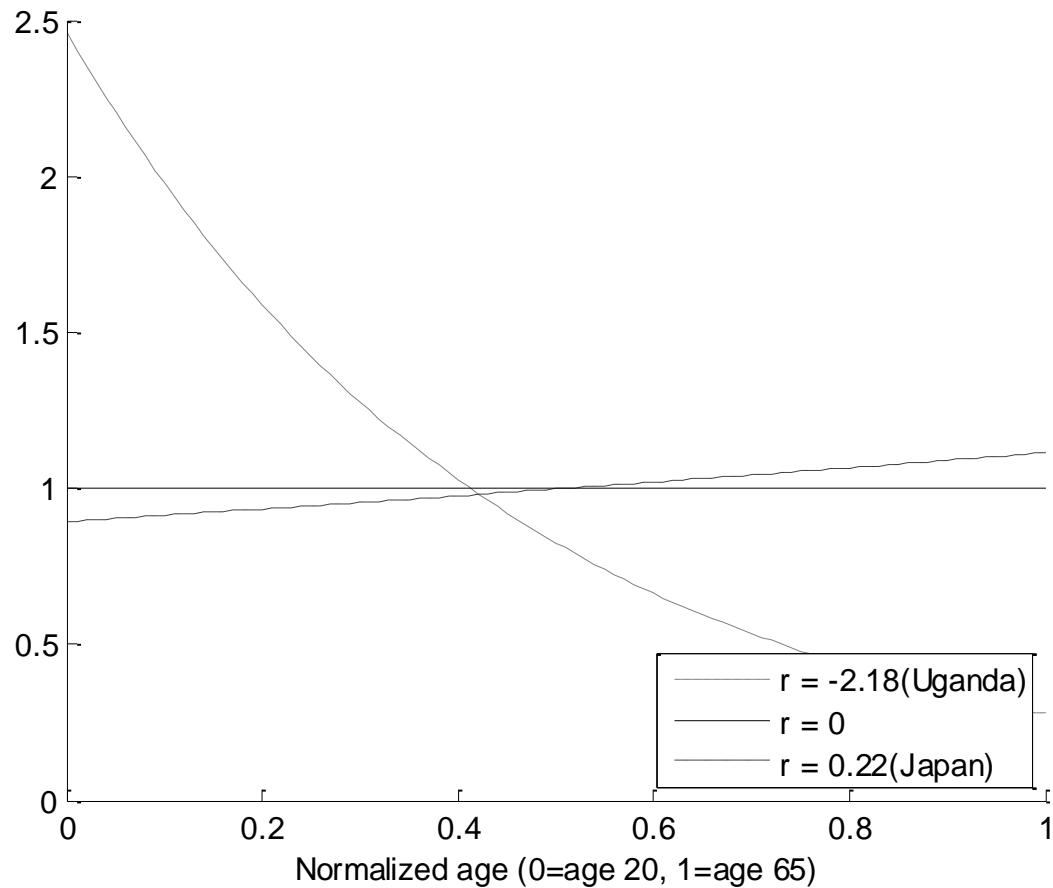
and for  $a > a_m$ ,  $\frac{d^2F}{drda} > 0$ .

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

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

$P(x)$  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,

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

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

**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

$$\frac{\partial E(a_M, r)}{\partial r} < \frac{\partial E(0, r)}{\partial r} \quad \text{and} \quad \frac{\partial E(a_M, r)}{\partial r} < \frac{\partial E(1, r)}{\partial r}$$

(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 2001-2010 (not all countries all years)
- 1.3 million individuals 15-64 years old (20-64 are used here)
- 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**

		Overall (N=82)		OECD (N=31)		Non-OECD (N=51)		
		Mean	Std	Mean	Std	Mean	Std	
<b>Entrepreneurship rate</b>								
<b>Alternative definitions</b>		0.06	0.06	0.03	0.01	0.09	0.08	
	<b>Early-stage, pay wage (esentr)</b>	<b>0.06</b>	0.06	0.03	0.01	0.09	0.08	
	Early-stage + Shutdown (esentr_shd)	0.11	0.11	0.05	0.02	0.15	0.13	
	Nascent, not-pay wage (nascent)	0.07	0.06	0.04	0.02	0.09	0.08	
	Total Early Stage (tt_esentr)	0.12	0.11	0.06	0.03	0.17	0.13	
<b>With high aspiration</b>								
	Plan to hire 5 in 5 years (esentr_ha5)	<b>0.010</b>	0.009	0.006	0.004	0.013	0.011	
	Plan to hire 10 in 5 years (esentr_ha10)	<b>0.005</b>	0.005	0.003	0.002	0.006	0.006	
	New product/market (esentr_newps)	0.011	0.015	0.007	0.006	0.015	0.020	
<b>Demographic (among age 20-64)</b>								
	Cohort shrink rate ( r )	-0.63	0.64	-0.17	0.35	-1.01	0.58	
	Average age	39.55	2.52	41.34	1.40	38.04	2.25	
	Median age	38.74	3.50	41.19	1.96	36.68	3.18	
	Percentage of young (20-45)	0.52	0.09	0.46	0.05	0.57	0.08	
<b>Other Characteristics</b>								
	GDP per capita	\$	19032	13230	30036	9819	9802	7306
	College enrollment rate	%	11.23	6.73	15.59	6.28	7.58	4.64
	Start-up cost (% of GNP per capita)	%	17.01	34.51	6.47	6.90	25.86	44.80
	Property right index		6.02	1.34	7.10	1.00	5.11	0.79



# Results

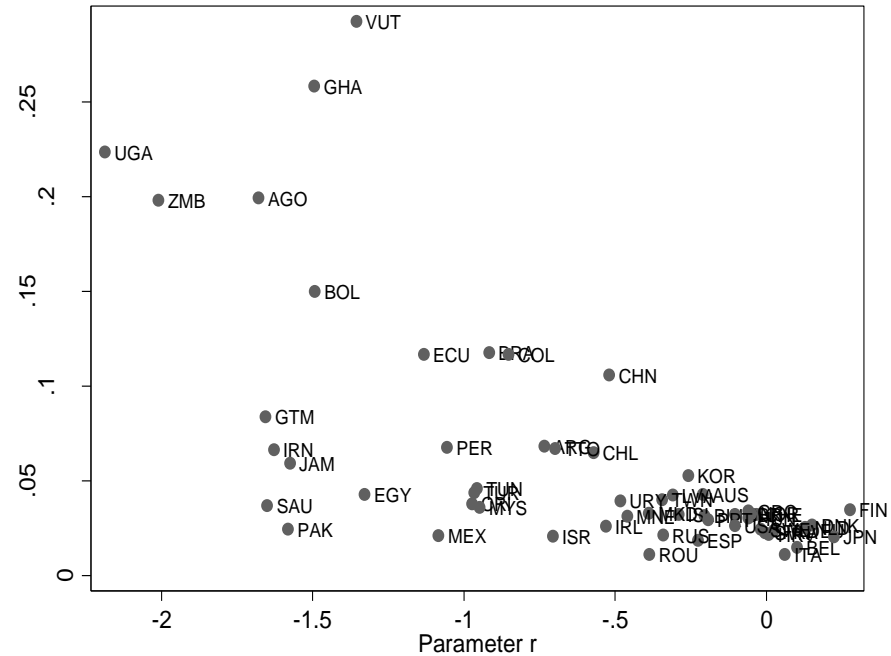
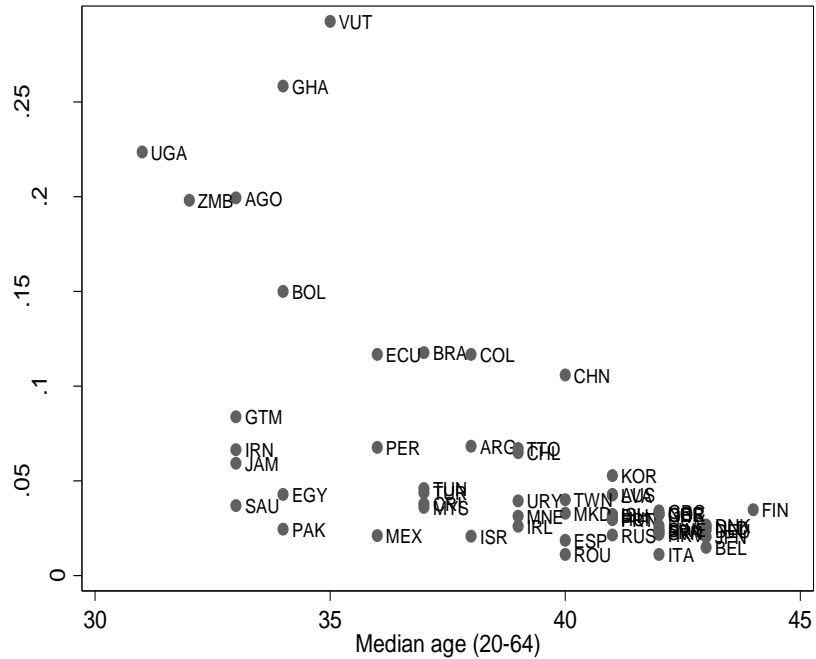
## Demographic Model

- 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





**Table 2. Country-Year Level Entrepreneurship Rate Regression**

Dep. Var.	Entrepreneurship Rate								
Sample	All	OECD	All	OECD	All	OECD	All	OECD	All
specifics	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
r	-0.041	-0.023			-0.025	-0.030	-0.047	-0.050	
	[0.007]***	[0.007]***			[0.009]**	[0.008]***	[0.024]*	[0.023]**	
Median age			-0.007	-0.004					-0.002
(age 20-64)			[0.001]***	[0.001]***					[0.002]
log(GDPpc)					-0.020	-0.006			
					[0.007]***	[0.009]			
Tertiary					0.062	0.032			
					[0.041]	[0.029]			
Start-up Cost					0.024	0.016			
					[0.015]	[0.018]			
IPRI					0.004	0.008			
					[0.004]	[0.002]***			
GDP growth rate					0.002	0.001			
(Average of the past 5 years)					[0.001]	[0.001]			
Military service > 1 year					0.038	0.042			
					[0.022]*	[0.010]***			
(Military service > 1 years) x r					0.047	0.064			
					[0.016]***	[0.032]*			
Constant	0.010	0.022	0.318	0.17	0.169	0.016	-0.024	0.027	0.128
	[0.004]**	[0.004]***	[0.051]***	[0.043]***	[0.063]***	[0.080]	[0.040]	[0.010]**	[0.071]*
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country FE							Y	Y	Y
Obs	393	230	393	230	393	230	393	230	393
R-square	0.40	0.24	0.37	0.19	0.53	0.38	0.91	0.72	0.90
Note:	Observations are weighted by the number of individuals who make up each country-year cell.								
	Standard errors clustered at the country level are in parentheses.								
	* significant at 10%; ** significant at 5%; *** significant at 1%								

# 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

Dep. Var.	Entrepreneurship rate within country-age cell						
Sample specifics	All	OECD	All	OECD	All	OECD	All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>a</b>	<b>-0.028</b>	<b>-0.023</b>	<b>-0.376</b>	<b>-0.191</b>	-0.189	-0.104	<b>0.045</b>
	[0.003]***	[0.003]***	[0.057]***	[0.049]***	[0.025]***	[0.036]***	[0.009]***
<b>r</b>	<b>-0.038</b>	<b>-0.021</b>					
	[0.007]***	[0.007]***					
<b>s<sub>a</sub></b>			<b>0.336</b>	<b>0.164</b>	0.156	0.079	
			[0.054]***	[0.048]***	[0.024]***	[0.036]**	
<b>a<sup>2</sup></b>							<b>-0.085</b>
							[0.008]***
<b>Constant</b>	0.025	0.033	0.038	0.04	0.046	0.04	0.035
	[0.004]***	[0.004]***	[0.003]***	[0.003]***	[0.003]***	[0.002]***	[0.004]***
<b>Year dummies</b>	Y	Y	Y	Y	Y	Y	Y
<b>Country FE</b>					Y	Y	
<b>Obs</b>	17554	10309	17554	10309	17554	10309	17554
<b>R-square</b>	0.26	0.12	0.25	0.12	0.56	0.24	0.11
<b>Note:</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 parentheses.							
* Significant at 10%; ** significant at 5%; *** significant at 1%.							

# Summarizing Table 3

- Population shrinkage parameter,  $r$ , 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

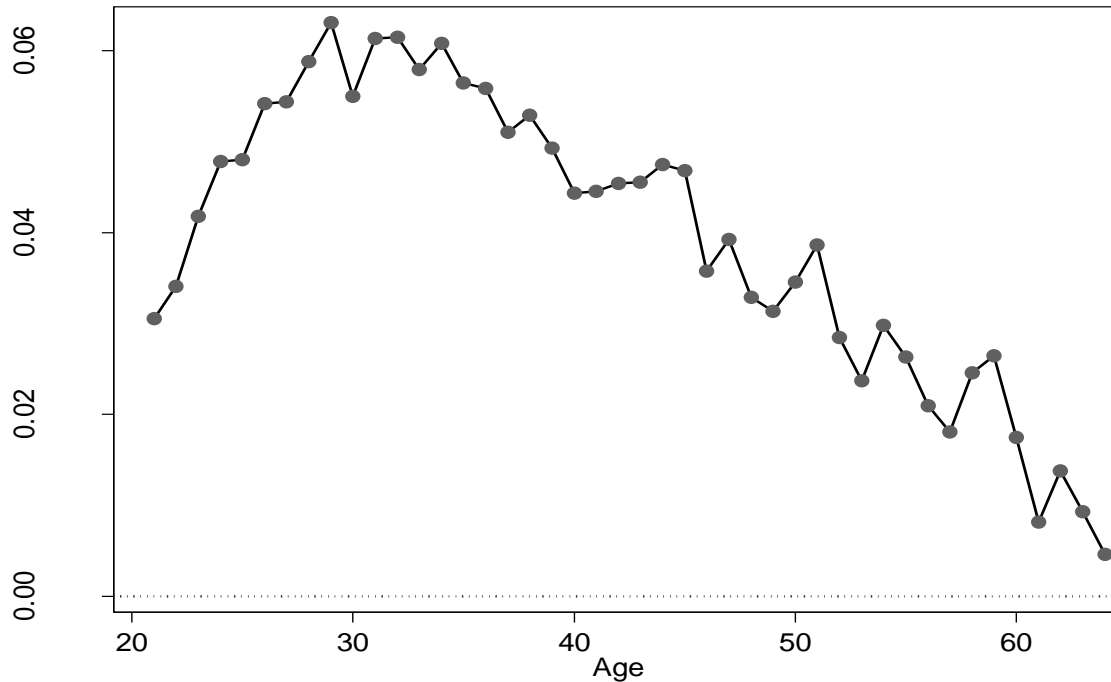
- Each age group provides a potentially independent test across countries so 45 tests
- Table 4 allows every age group to have its own effect of  $r$  and a different constant term
- **The effect of  $r$  is negative and significant in almost all cases (Proposition 1) which is strong support of the human 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.

# Using Different Definitions of Entrepreneurship Does not Affect Conclusions

- Early-stage entrepreneur plus those firms 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
- China one child policy
- Japan low growth