Firm Age and the Evolution of Borrowing Costs: Evidence from Japanese Small Firms

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Focus of the paper

- **Look at the relationship between firm age and its borrowing costs**

  Many studies on the evolution of real activity variables

  Evans (1987), Cabral and Mata (2003), Davis et al. (1996)

  But almost nothing on financial variables

- **Two channels in the evolution**

  Selection – process through which nonviable firms are separated from healthy firms and forced to exit from market

  Adaptation – process through which surviving firms (or surrounding agents) change their behavior as they age

Three empirical questions

1. **Selection vs. Adaptation?**
   - Alchian (1950), Jovanovic (1982), Hopenhayn (1992), Cabral and Mata (2003), Okazaki (2004)
2. **Natural vs. Unnatural Selection?**
   - Caballero et al. (2004), Peek and Rosengren (2005), Hoshi (2005), Nishimura et al. (2003)
     - "Unnatural selection"; "Zombie lending"; "Misallocation of bank credit"
     - Inefficient zombie firms continue to stay in markets, creating "congestion", thereby preventing new entrance
3. **Track Record vs. Size?**
   - Does firm age directly (Diamond (1989)), or indirectly (through size) affect borrowing costs?

Empirical approach (1): Data

- Credit Risk Database collected by the CRD Association
- A data set of more than 200,000 small firms
- Able to identify default events: failure; de facto failure; delinquent payment for more than three months; repayment by a loan guarantee corporation

Number of Observations

Year	All Firms	Surviving Firms	Defaulting Firms	Default Ratio (%)
1997	240,384	232,811	7,573	3.150
1998	232,811	224,005	8,806	3.782
1999	224,005	215,404	8,601	3.840
2000	215,404	208,644	6,760	3.138
2001	208,644	203,337	5,307	2.544
2002	203,337	203,337		
Total	1,324,585	1,287,538	37,047	2.797

Empirical approach (2): Identification of age effects

Borrowing cost as a confluence of the year, cohort, and age effect

$$R_i(t,\tau) = \alpha(t) + \beta(\tau) + \gamma(t-\tau) + \varepsilon_i(t,\tau)$$

Remove the year effect by subtracting a weighted prime lending rate from *R*.

The slope of age profile of borrowing cost is identified as

$$\hat{R}_i(t+1,\tau) - \hat{R}_i(t,\tau)$$
$$= \gamma(t-\tau+1) - \gamma(t-\tau) + \varepsilon_i(t+1,\tau) - \varepsilon_i(t,\tau)$$

Empirical approach (3): Decomposition into selection and adaptation

- Total evolution of borrowing costs from year *t* to *t+1* can be decomposed into a "selection" effect and an "adaptation" effect

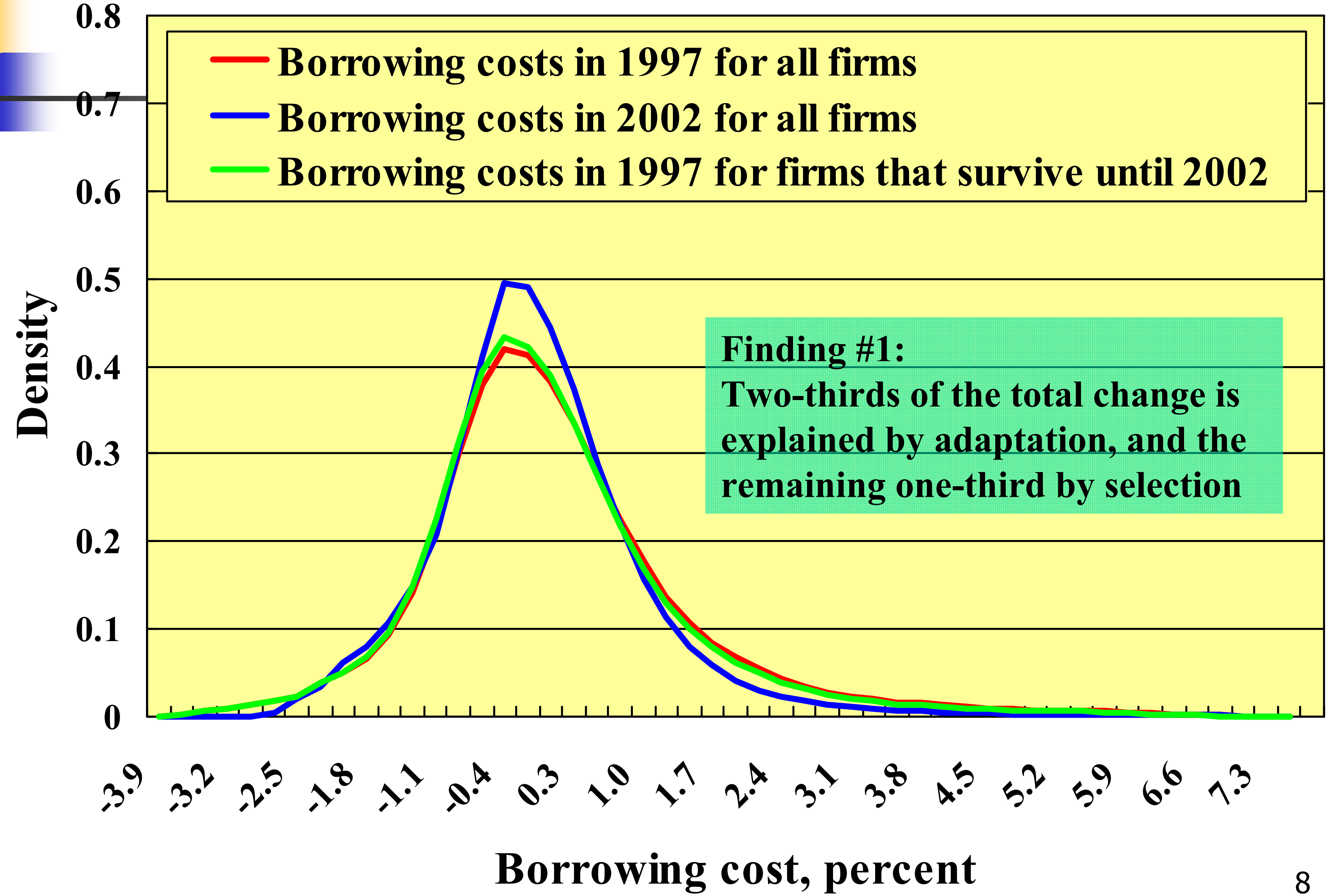
$$E_{i\in A(t+1,\tau)}R_i(t+1,\tau)-E_{i\in A(t,\tau)}R_i(t,\tau)$$

$$=\underbrace{\theta(t,\tau)\left[E_{i\in S(t,\tau)}R_i(t,\tau)-E_{i\in D(t,\tau)}R_i(t,\tau)\right]}_{\textbf{Selection Effect}}+\underbrace{E_{i\in A(t+1,\tau)}R_i(t+1,\tau)-E_{i\in S(t,\tau)}R_i(t,\tau)}_{\textbf{Adaptation Effect}}$$

Selection Effect **Adaptation Effect**

Q1: Selection vs. adaptation

Total evolution, selection, and adaptation



Q2: Natural vs. unnatural selection

Unnatural selection hypothesis

- **Unnatural selection implies**

$$\theta(t,\tau)\left(E_{i\in S(t,\tau)}R_i(t,\tau)-E_{i\in D(t,\tau)}R_i(t,\tau)\right)>0 \quad \text{and}$$

$$\theta(t,\tau)\left(E_{i\in S(t,\tau)}Q_i(t,\tau)-E_{i\in D(t,\tau)}Q_i(t,\tau)\right)<0$$

where *R* is the borrowing cost and *Q* is firm's quality

Finding #2:
We reject the unnatural selection hypothesis for the entire sample, and for almost all sub-samples (by industry, by cohort, et al)

Results for borrowing cost

One-tailed t-Test for the Borrowing Cost

	Cohort									
	1950—1955	1956—1960	1961—1965	1966—1970	1971—1975	1976—1980	1981—1985	1986—1990	1991—1995	All
All	−0.410 a (0.032)	−0.529 a (0.038)	−0.521 a (0.032)	−0.614 a (0.029)	−0.562 a (0.027)	−0.600 a (0.027)	−0.614 a (0.027)	−0.689 a (0.023)	−0.729 a (0.027)	−0.613 (0.008)
Construction	−0.348 a (0.097)	−0.674 a (0.104)	−0.510 a (0.071)	−0.646 a (0.059)	−0.626 a (0.050)	−0.802 a (0.048)	−0.770 a (0.050)	−0.879 a (0.041)	−0.847 a (0.048)	−0.726 (0.017)
Manufacturing	−0.529 a (0.054)	−0.521 a (0.058)	−0.568 a (0.052)	−0.748 a (0.052)	−0.618 a (0.050)	−0.614 a (0.055)	−0.531 a (0.058)	−0.649 a (0.051)	−0.706 a (0.069)	−0.612 (0.015)
Wholesale	−0.401 a (0.058)	−0.598 a (0.076)	−0.418 a (0.071)	−0.587 a (0.065)	−0.616 a (0.067)	−0.535 a (0.066)	−0.689 a (0.068)	−0.559 a (0.064)	−0.623 a (0.076)	−0.570 (0.020)
Retail	−0.386 a (0.082)	−0.594 a (0.112)	−0.598 a (0.097)	−0.574 a (0.084)	−0.488 a (0.079)	−0.549 a (0.077)	−0.477 a (0.072)	−0.651 a (0.063)	−0.578 a (0.068)	−0.523 (0.024)
Real Estate	0.404 (0.247)	0.185 (0.201)	0.607 (0.178)	−0.009 (0.126)	0.179 (0.119)	0.279 (0.126)	0.033 (0.124)	−0.511 a (0.106)	−0.865 a (0.175)	−0.050 (0.044)
Service	0.222 (0.151)	−0.318 b (0.167)	−0.227 b (0.134)	−0.464 a (0.113)	−0.406 a (0.098)	−0.278 a (0.092)	−0.516 a (0.080)	−0.437 a (0.064)	−0.521 a (0.072)	−0.405 (0.029)

1) Standard errors are in parentheses
2) a: Significant at the 1 percent level. b: Significant at the 5 percent level. c: Significant at the 10 percent level.

Results for operating profit

One-tailed t-Test for the Operating Profit

	Cohort									
	1950—1955	1956—1960	1961—1965	1966—1970	1971—1975	1976—1980	1981—1985	1986—1990	1991—1995	All
All	2.113 a	1.897 a	1.973 a	1.264 a	1.596 a	1.879 a	2.170 a	1.993 a	2.291 a	2.320
	(0.219)	(0.257)	(0.222)	(0.190)	(0.169)	(0.175)	(0.182)	(0.162)	(0.202)	(0.057)
Construction	0.952 c	0.942 c	1.911 a	0.195	1.249 a	1.193 a	1.457 a	0.927 a	1.322 a	1.448
	(0.590)	(0.656)	(0.473)	(0.377)	(0.316)	(0.308)	(0.332)	(0.295)	(0.353)	(0.116)
Manufacturing	2.951 a	3.060 a	2.524 a	1.519 a	1.782 a	1.981 a	3.069 a	2.336 a	2.892 a	2.934
	(0.408)	(0.451)	(0.407)	(0.378)	(0.347)	(0.386)	(0.410)	(0.373)	(0.527)	(0.112)
Wholesale	2.084 a	1.144 a	2.068 a	2.132 a	1.413 a	2.637 a	2.267 a	1.831 a	2.089 a	2.171
	(0.339)	(0.442)	(0.439)	(0.381)	(0.386)	(0.392)	(0.415)	(0.394)	(0.515)	(0.121)
Retail	1.132 b	1.127 c	1.889 a	0.595	2.454 a	1.908 a	1.811 a	3.131 a	3.172 a	2.388
	(0.579)	(0.749)	(0.672)	(0.580)	(0.525)	(0.522)	(0.527)	(0.461)	(0.546)	(0.170)
Real Estate	5.301 a	2.168 b	0.944	3.998 a	2.491 a	2.150 a	1.240 b	0.850 c	4.317 a	2.464
	(1.378)	(1.023)	(0.855)	(0.642)	(0.577)	(0.652)	(0.635)	(0.585)	(0.889)	(0.226)
Service	2.645 a	1.793 c	1.715 b	2.021 a	1.351 b	3.447 a	2.338 a	2.976 a	2.974 a	2.797
	(1.072)	(1.208)	(0.963)	(0.744)	(0.671)	(0.657)	(0.596)	(0.495)	(0.595)	(0.215)

Standard errors are in parentheses
a: Significant at the 1 percent level. b: Significant at the 5 percent level. c: Significant at the 10 percent level.

Q3: Track record vs. firm size

Which "state variable" is more important?

- Adaptation effect among surviving firms

  Diamond (1989):

  Firms with a good **track record** (i.e., high reputation) wants to keep it by choosing less risky projects as it ages

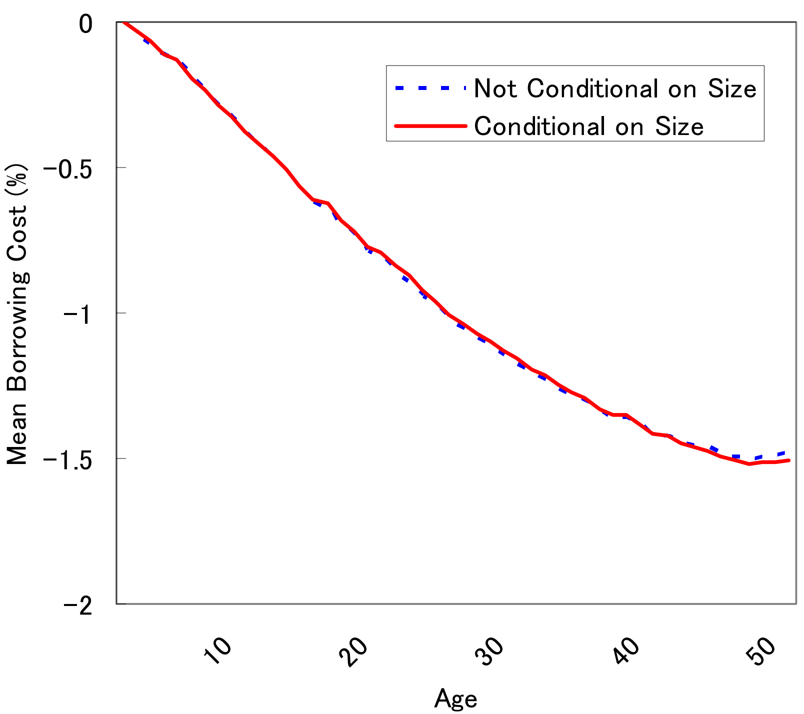
  Cooley and Quadrini (2001):

  Firms with larger **size** borrow less because of decreasing returns to scale, thereby reducing default probability

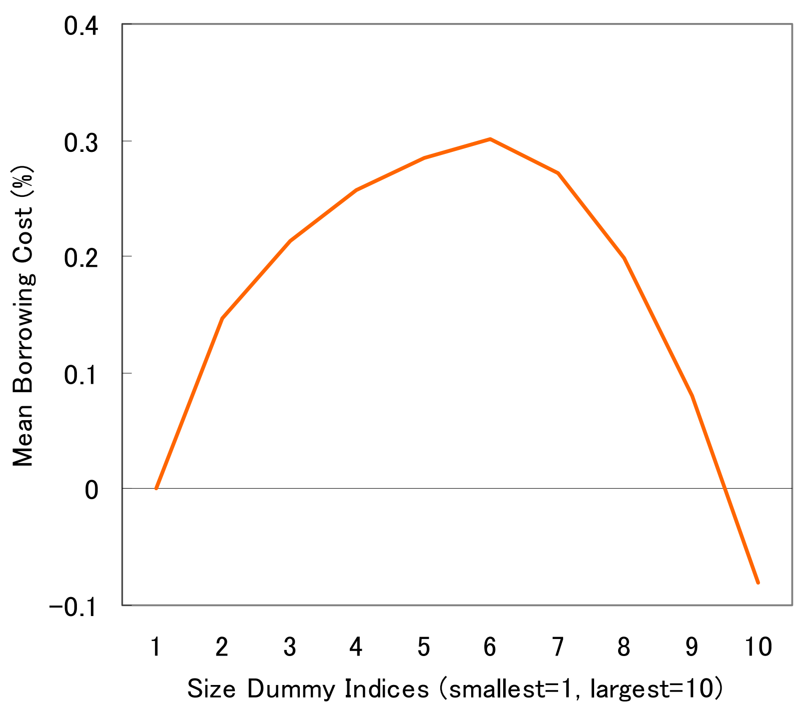
- If track record story is correct, **age profile conditional on firm size** should be downward sloping

Estimated age and size profiles

Age profile conditional on size



Size profile conditional on age



Conclusion

- **Selection vs. adaptation?**

  Adaptation dominates in the evolution of borrowing costs
- **Natural vs. unnatural selection?**

  Natural selection prevails among small firms
- **Track record vs. firm size?**

  Track record is more important than firm size