



# ***Sector dynamics and firms demographics of top EU R&D investors in the global economy***

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Analysis (IRIMA) workshop:  
"R&D Investment and Firm Dynamics"***

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# ***WHY THIS WORK ?***

## **Motivations:**

- Analyse the dynamics of corporate R&D investment in the main world economies (2005-2013)
- Investigate the relation between sectoral dynamics and firms' age
- Identify possible implication for policies.

## **Aim:**

- ➔ *To understand better the reasons for EU corporate R&D intensity gap considering firms' demographics and sector dynamics*
- ➔ *To contribute to the literature of innovation, industrial dynamics and firms' heterogeneity*

# ***RESEARCH QUESTIONS***

- 1. How do countries perform in corporate R&D?***
- 2. Are there country specificities in the change of R&D investment across sectors ?***
- 3. How (if) does sector composition determine firms' age ?***
- 4. How does EU firms' demographics compare with respect to US in key R&D intensive sectors ?***

## ***DATASET***

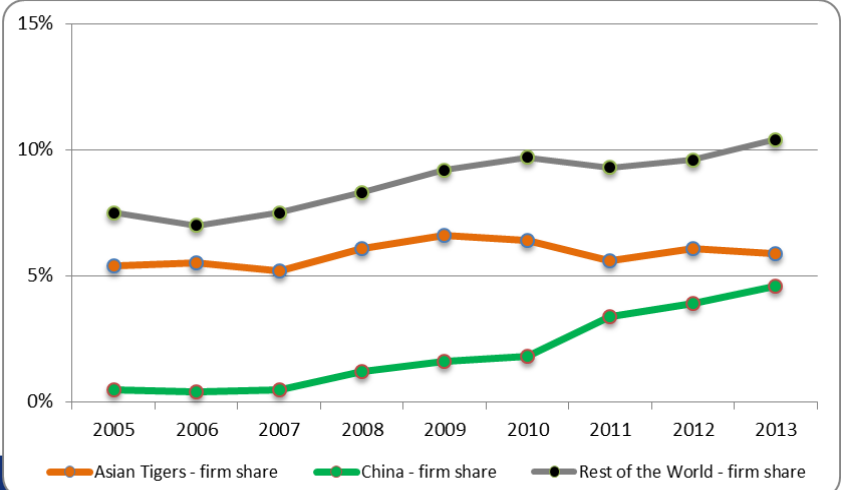
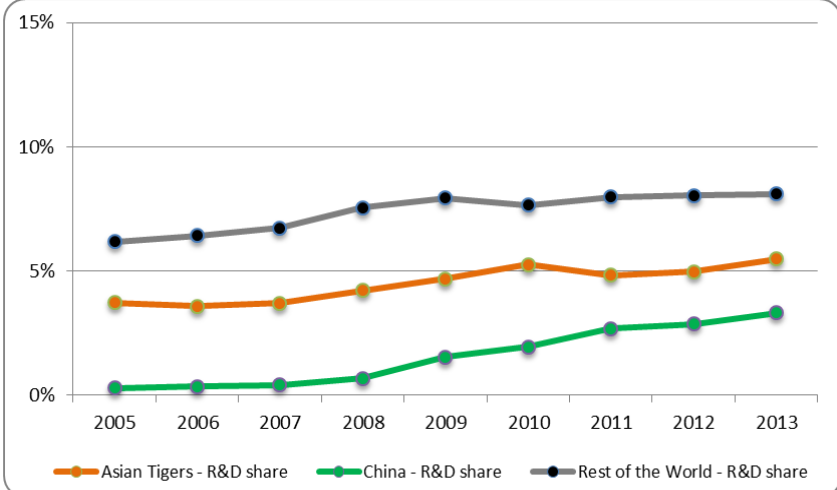
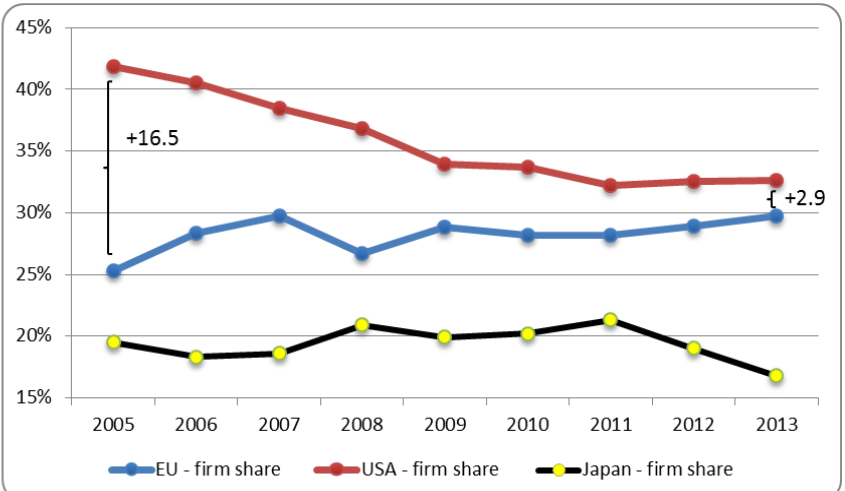
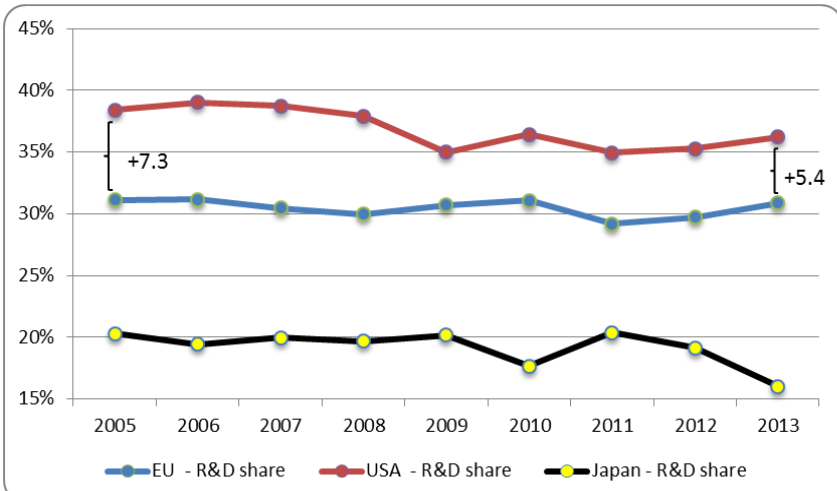
- **Sources:** EU Industrial R&D Investment Scoreboard: economic & financial micro-data of top world R&D investors.
- Data from **9 R&D Scoreboard editions:** 2006 to 2014;  
**top 1,000 R&D firms in each edition**
- **Limitations:** low representativeness of companies in Asian Tigers and China in the earliest EU R&D Scoreboards

## ***METHODOLOGICAL APPROACH***

- **Manhattan distance metrics** (in "sectors shift" computation);
- **OLS linear regression model with sector and country dummies** (for the effects of sectors to firms' age);
- **Descriptive statistical analysis** (in the rest of analyses)

# Main results (1)

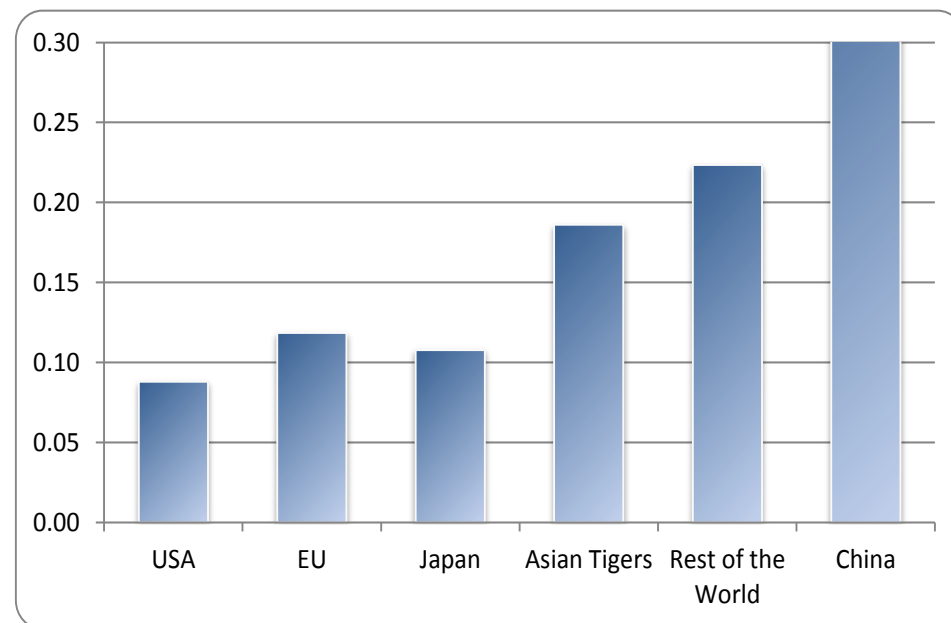
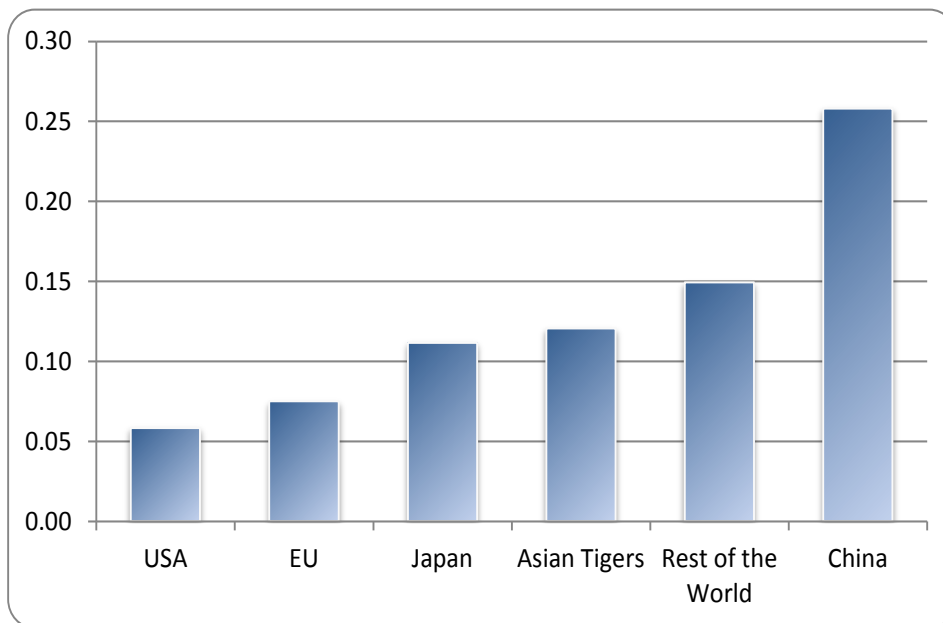
## Shares of R&D investment (left) and firms (right)



# Main results (2.1)

## Average shift across sectors, 2005-2013































R&D investment (left), number of companies (right)



Note: Based on the top 1000 R&D investors worldwide for each of the years

# Main results (2.2)

## Sectors with the highest changes in R&D shares for the economies considered (ICB-3 digits; 2005 -2013)

The 5 sectors with the highest increases in R&D shares					The 5 sectors with the highest decreases in R&D shares					
Region	ICB Sector	Tech. Group	R&D Delta	R&D Int.	ICB Sector	Tech. Group	R&D Delta	R&D Int.		
EU	Banks	Low		3.0%	2.1%	Chemicals	Medium/High	-2.8%		2.1%
	Automobiles & parts	Medium/High		1.8%	5.5%	Technology & Hardware	High	-2.7%		14.6%
	General industrials	Medium/High		1.6%	5.5%	Leisure goods	High	-2.3%		2.6%
	Industrial engineering	Medium/High		1.6%	4.3%	Electronic	Medium/High	-1.9%		5.0%
	Software & computer	High		1.0%	13.4%	Aerospace & defence	Medium/High	-1.6%		5.8%
USA	Software & computer	High		6.3%	12.4%	Automobiles & parts	Medium/High	-4.9%		3.8%
	Industrial engineering	Medium/High		1.1%	3.2%	Pharma & biotech	High	-2.2%		15.8%
	General retailers	Medium/Low		0.7%	3.2%	Leisure goods	High	-1.2%		5.3%
	Electronic	Medium/High		0.6%	4.2%	General industrials	Medium/High	-0.6%		3.3%
	Fixed line telecom	Medium/Low		0.6%	1.2%	Aerospace & defence	Medium/High	-0.4%		3.4%
Japan	Pharma & biotech	High		5.6%	20.4%	Technology & Hardware	High	-12.0%		5.3%
	General industrials	Medium/High		4.1%	3.7%	Leisure goods	High	-4.8%		8.8%
	Software & computer	High		2.5%	4.7%	Fixed line telecom	Medium/Low	-1.3%		2.3%
	Automobiles & parts	Medium/High		2.3%	4.2%	Electricity	Low	-0.9%		4.8%
	Electronic	Medium/High		1.7%	4.8%	Construction & materials	Low	-0.4%		1.6%

# Main results (3.1)

## Age of top corporate R&D investors, differences among regions and sectors; 2005-2013

### What "explains" age variance?

Sector = 41.4%

Region = 29.8%

Other factors = 28.8%

### Regions:

- US companies are younger than EU and Japanese
- Chinese companies are the youngest

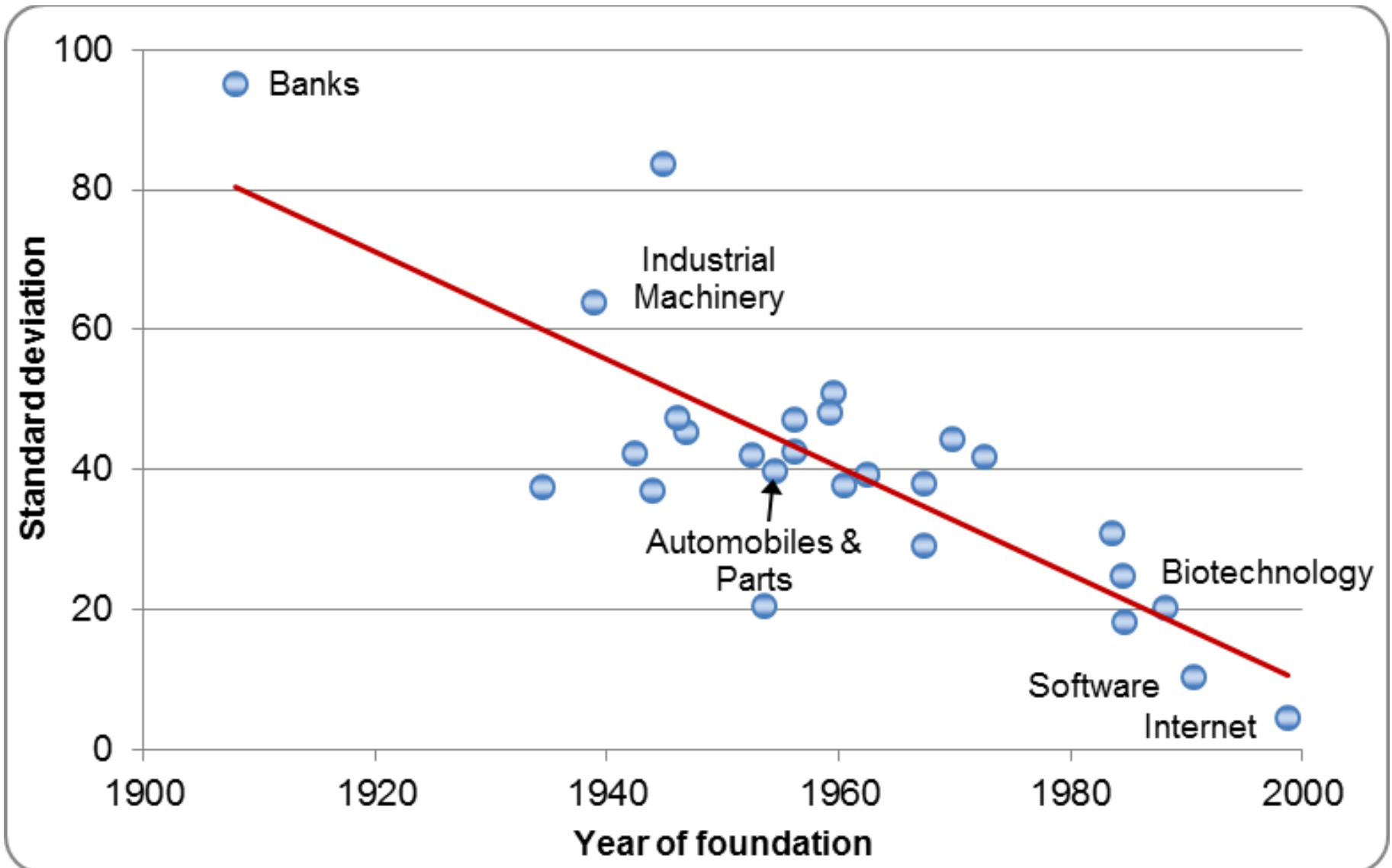
	All sectors	
	Age (dummy region)	Age (dummy region and sector)
<i>Regions</i>		
<i>EU = baseline</i>		
Asian Tigers	-34.91*** (4.44)	-31.21*** (3.27)
China	-53.34*** (5.99)	-66.13*** (4.32)
Japan	2.94 (2.42)	-1.48 (1.77)
Rest of the World	-13.91*** (2.72)	-14.22*** (1.99)
USA	-23.68*** (2.32)	-26.20*** (1.73)
Sector Dummies		Included
Constant	65.79*** (1.48)	61.71*** (4.76)
Observations	578	578
R-squared	0.298	0.712

➔ The substantial **difference in the average age of firms** is due to sectors specificities



# Main results (3.2)

Average year of foundation of top R&D firms and their years' variation by sectors (ICB-4 digits, 2013)



# Main results (4)

## Number and size of top R&D firms, EU and US in *Software and Computer Services* sector; 2005-13

<i>Software &amp; Computer Services</i>	2005	2006	2007	2008	2009	2010	2011	2012	2013
Companies - No.	14	19	17	16	17	16	13	13	14
<b>EU</b>									
R&D average - € million	167	165	199	225	229	259	310	359	360
Employees - average No.	7939	9479	9538	12917	12287	12840	13447	14848	16852
Companies - No.	50	52	44	43	45	45	46	47	53
<b>US</b>									
R&D average - € million	330	361	469	521	483	526	615	678	656
Employees - average No.	13889	14584	18297	19460	18912	19864	23051	21215	20178

→ Higher number of larger **US** firms in this young, growing and high R&D-intensive sector compared to the **EU** *since the beginning of the period of observation*

# **SUMMARY & CONCLUSIONS**

- (i) EU maintained its **R&D investment share** vis-à-vis other world regions, and somewhat improved its position vs. US and Japan
  
- (ii) Slightly higher **EU R&D shift over sectors** compared to the US  
However, both economies show a slower pace of change compared to the emerging economies.
  - Contrary to previous studies comparing EU vs US, based on data from 80ies and 90ies (e.g. Gambardella et al., 2007; Foray and Lhuillery, 2010)
  
- (iii) The **typology of sectors determines the average age** of top R&D investing firms
  - Can be coupled with Cincera & Veugelers (2013) study, where most of the EU R&D investment gap vs US is due to a different sectoral composition of "yollies"
  
- (iv) EU's "follower behaviour" **in new high-tech growing sectors** ('software & computer s.'): **less & smaller firms than the US**
  - Key role of the presence of young and growing innovative firms when new high-tech markets emerge (Ackermann, 2012; Czarnitzki & Delanote, 2012).

## ***IMPLICATIONS FOR R&I POLICY***

Aiming at a sectors mix with more knowledge-intensive sectors in the EU - to reduce the R&D intensity gap -:

- (a) Target new (more risky), strategic R&D-intensive sectors – i.e. "young innovative emerging sectors" (YiES)**
  - (b) Favour entrepreneurship to create innovative EU firms in these new sectors and make them growing.**
- ➔ This would increase the probability that the new champions of tomorrow will be European companies, ensuring in turn a better sectors mix and dynamics.

# *Thank you*

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## **More information can be found here:**

Industrial Research and Innovation website: <http://iri.jrc.ec.europa.eu/>

IPTS - Institute for Prospective Technological Studies: <http://ipts.jrc.ec.europa.eu/>

JRC - Joint Research Centre: <http://ec.europa.eu/dgs/jrc/index.cfm>

## Technological sector groups

**High R&D intensity** sectors (R&D intensity above 5%) include e.g. Pharmaceuticals & biotechnology; Health care equipment & services; Technology hardware & equipment; Software & computer services; Aerospace & defence.

**Medium-high R&D intensity** sectors (between 2% and 5%) include e.g. Electronics & electrical equipment; Automobiles & parts; Industrial engineering & machinery; Chemicals; Personal goods; Household goods; General industrials; Support services.

**Medium-low R&D intensity** sectors (between 1% and 2%) include e.g. Food producers; Beverages; Travel & leisure; Media; Oil equipment; Electricity; Fixed line telecommunications.

**Low R&D intensity** sectors (less than 1%) include e.g. Oil & gas producers; Industrial metals; Construction & materials; Food & drug retailers; Transportation; Mining; Tobacco; Multi-utilities; Banks.

Source: European Commission (2014) following OECD (1997) approach

Industry classification: ICB (Industry Classification Benchmark), 3-digit level



## Year of foundation - ICB-4 digits – Top R&D companies (2013)

ICB4digit Sector	Year of foundation			Firms
	Average	St.dev.	Median	
Internet	1999	4.6	1999	13
Software	1991	10.3	1992	52
Biotechnology	1988	20.4	1993	30
Semiconductors	1985	18.3	1989	72
Computer Hardware	1985	24.8	1988	32
Computer Services	1984	31.0	1997	21
Fixed Line Telecommunications	1973	41.9	1994	15
Telecommunications Equipment	1970	44.3	1991	39
Electronic Equipment	1967	29.3	1974	53
Health Care Equipment & Services	1967	38.1	1977	43
Oil & Gas Producers	1962	39.2	1972	19
Leisure Goods	1960	37.9	1968	19
Industrial Metals & Mining	1959	51.1	1985	15
Commercial Vehicles & Trucks	1959	48.2	1982	23
Food Producers	1956	47.2	1961	20
Pharmaceuticals	1956	42.7	1964	70
Aerospace & Defence	1955	39.8	1960	33
Electricity	1954	20.7	1951	10
Automobiles & Parts	1953	42.0	1948	75
Chemicals	1947	45.4	1949	56
Electrical Components & Equipment	1946	47.5	1950	23
Construction & Materials	1945	83.6	1956	19
General Industrials	1944	37.1	1939	29
Household Goods & Home Construction	1942	42.3	1953	11
Industrial Machinery	1939	63.9	1958	52
Personal Goods	1934	37.5	1930	14
Banks	1908	95.1	1955	20





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	Average age		Median age	
	Base	Including sector fixed effects	Base	Including sector fixed effects
<i>EU = baseline</i>				
Asian Tigers	-34.91*** █ (4.44)	-31.21*** █ (3.27)	-25.23*** █ (4.89)	-23.72*** █ (3.79)
China	-53.34*** █ (5.99)	-66.13*** █ (4.32)	-44.08*** █ (6.60)	-54.50*** █ (5.01)
Japan	2.94 █ (2.42)	-1.48 █ (1.77)	12.25*** █ (2.67)	8.06*** █ (2.05)
Rest of the World	-13.91*** █ (2.72)	-14.22*** █ (1.99)	-17.17*** █ (3.00)	-21.04*** █ (2.31)
USA	-23.68*** █ (2.32)	-26.20*** █ (1.73)	-20.82*** █ (2.56)	-26.61*** █ (2.01)
Sector fixed effects (a)		0.000***		0.000***
Constant	65.79*** █ (1.48)	61.71*** █ (4.76)	55.43*** █ (1.63)	67.41*** █ (5.52)
Observations	578	578	578	578
R-squared	0.298	0.712	0.274	0.670
F-test	48.67	23.92	43.21	19.69
RMSE	20.94	14.04	23.07	16.26

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

(a) Reported is the p-value of an F-test of joint significance for the sector fixed effects (ICB3digit)