

# Persistent heterogeneity of R&D intensities within sectors: Evidence and policy implications

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# Motivation

- “Sectors matter!”
- Sectoral systems of innovation
- EU’s R&D gap explained in terms of sector specialization
  - Large innovative firms in the ‘wrong’ sectors
- *"In order to achieve its 3 % target for R&D intensity and boost its competitiveness and job creation, the EU needs to adapt its industrial structure and increase economic activity in the high-R&D-intensive sectors."*
  - Moncada-Paternò-Castello et al., (2016, p1).

- “You have a product. The product is selling. That gives you a certain stream of revenue. You can take that stream of revenue and put some of it into R&D for the next round. Some of it has to be reserved for manufacturing, some of it for profits. Now, if you are on an upward swing and your product is succeeding, you have a flow back of money to invest in R&D; and if it isn’t, you don’t. And in my experience, and the experience of many other people, oddly enough, R&D is determined, more or less, as a percent of sales. It is not an independent variable. Let me say once more. **R&D is often a fixed percent of sales.** Now I exaggerate to make my point. Ten percent is a very reasonable sort of number in a high-tech industry... It may be that, in the correlation, which has often been remarked on, between R&D spending and industrial success, it is the industrial success which causes the R&D spending, not the other way around.”
- Ralph Gomory, former senior vice-president of IBM and former member of the US President’s Council of Advisers on Science and Technology. Gomory (1992, p392), cited in Thompson (1999 p323), emphasis added.)

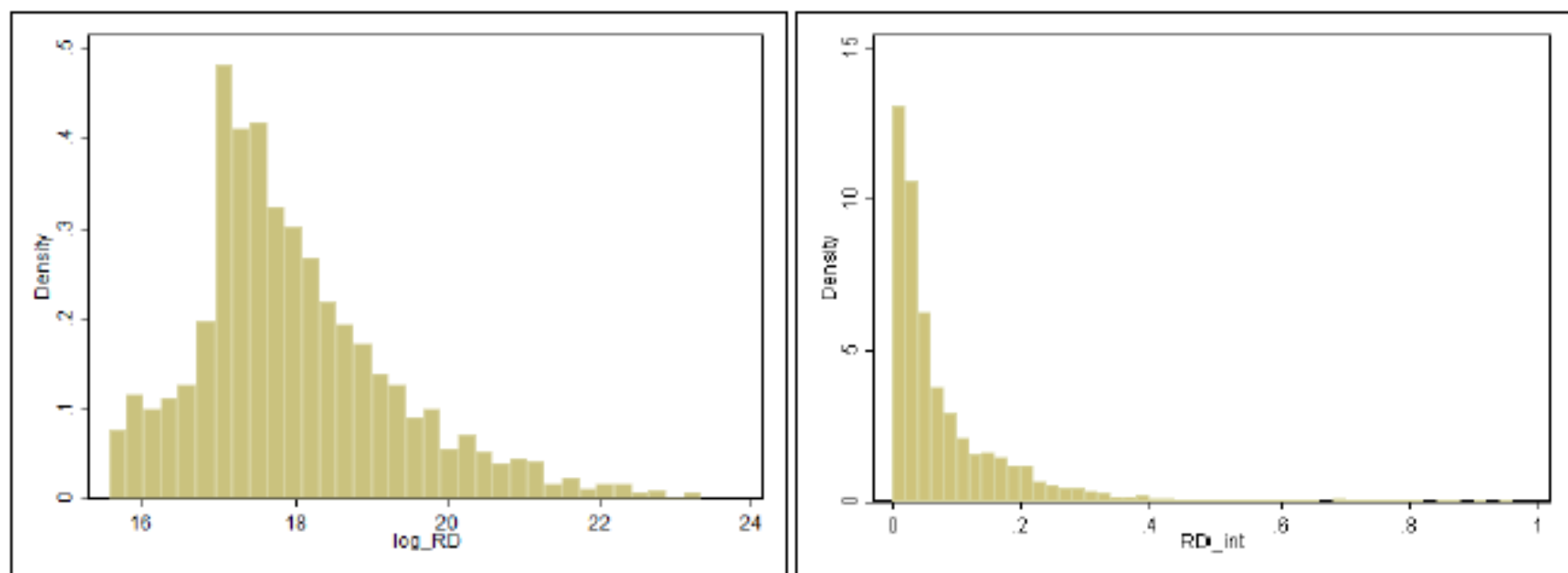
- "R&D budget are driven by sector specificities. **R&D budgets are largely driven by sector specific needs and are broadly set as a percentage of sales.** According to Phillips, this is one of the ratios to which financial analysts pay attention for R&D intensive companies. Profits do not seem to be an indicator to fix R&D budgets as most times profits are not reinvested in R&D."
- Hervas, Dosso and Vezzani (2015, p5, emphasis added)

- Hypothesis 1: firms in the same industry will have the same R&D intensity
- Hypothesis 2a: firms whose R&D intensity is below the industry average will 'catch up' and increase their R&D intensity faster than firms whose R&D intensity is above the industry average ( $\beta$ -convergence).
- Hypothesis 2b: the variation in R&D intensities among firms in the same sector will decrease over time ( $\sigma$ -convergence)

# Data

- EU Industrial R&D Investment Scoreboard
- firms included in the Scoreboard account for about 90% of the total expenditure on R&D by business firms worldwide
  - Not just 1 country
- ICB 3-digit & 4-digit sectors

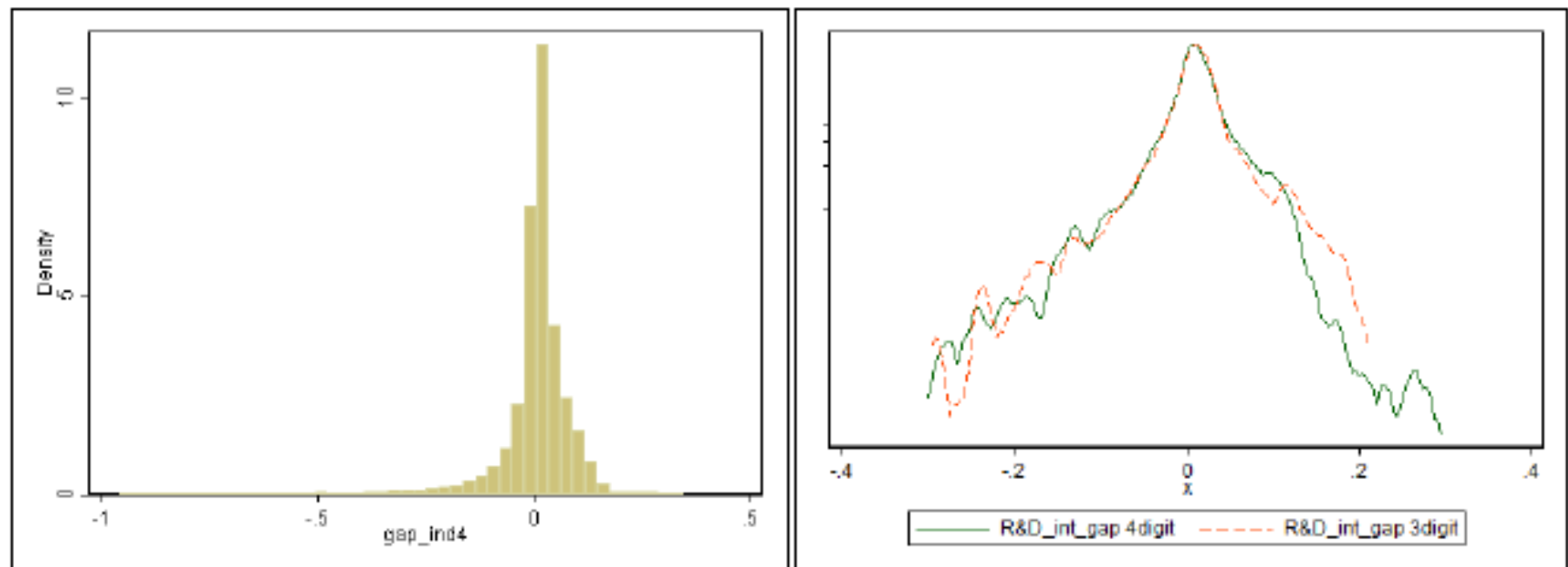
**Figure 1 - Distribution of R&D investments (left) and R&D intensity (right) across firms**



**Note:** Left: histogram of log R&D investment amounts of firms in 2015 (bin width = 0.228). Right: histogram of the distribution of R&D intensities of firms in 2015 (bin width = 0.02). Lower bound at 0.00.

$$RD\_intensity\_gap_{it} = \overline{RD\_intensity}_{jt} - RD\_intensity_{it}$$

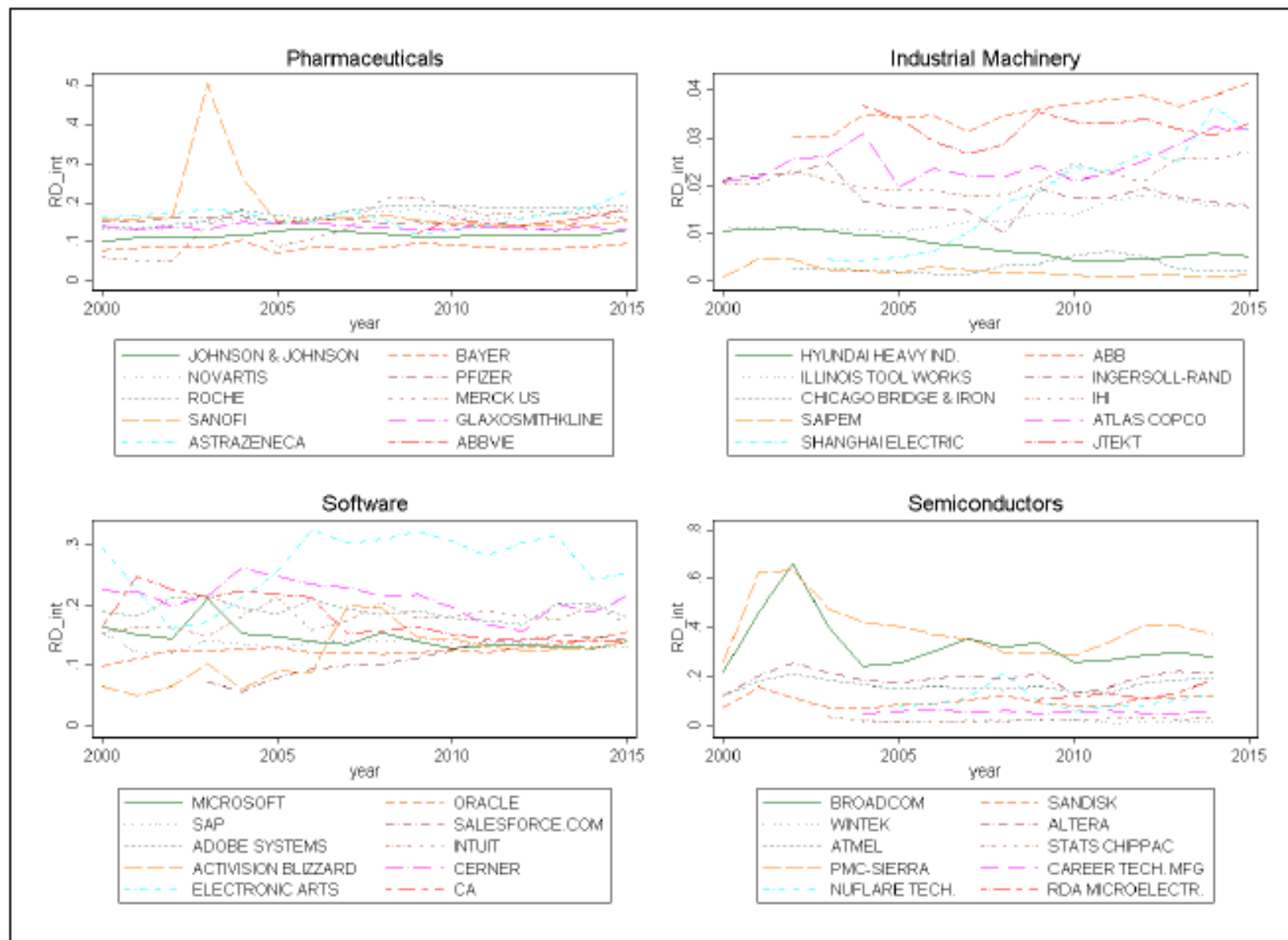
Figure 2 - R&D investment gap (left) and its kernel density (right)



Note: Left: histogram of the variable  $R\&D\_intensity\_gap$  (i.e. the gap between a company's R&D intensity and the average R&D intensity of its ICB 4 digit sector). Right: kernel density of the variable  $R\&D\_intensity\_gap$ , where sector is defined at the 3-digit or 4-digit sector. Note the log scale on the y-axis.



**Figure 3: Evolution of R&D intensities of the 10 largest firms (in terms of sales in 2015) in four sectors.**



**Note:** For the Semiconductors sector, there are few observations for 2015, so firms are instead ranked in terms of sales in 2014.

Figure 4: evolution of the standard deviation of "R&D\_intensity\_gap" for panels that are unbalanced or balanced, at the 4-digit and 3-digit levels.



Table 3: R2 statistics from different OLS regressions of R&amp;D intensity

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	RD_int	RD_int	RD_int	RD_int	RD_int	RD_int	RD_int
ICB 3-digit codes <i>82 dummies</i>	yes						
ICB 4-digit codes <i>119 dummies</i>		yes					
Country codes <i>53 dummies</i>			yes				
log_NS				-0.0339*** (0.00107)			
log_EMP					-0.0352*** (0.00101)		
log_OP						-0.0144*** (0.000709)	
log_labprod							-0.0141*** (0.00200)
Constant	0.0391	0.131	0.0332	0.790*** (0.0227)	0.382*** (0.00918)	0.329*** (0.0134)	0.262*** (0.0250)
Observations	43.000	43.778	43,778	43.778	39.371	35,506	39,371
R-squared	0.261	0.318	0.088	0.271	0.254	0.122	0.009
ll	33746	35965	29607	34527	31241	40190	25658
ll_0	27246	27598	27598	27598	25485	37885	25485

Note: Robust standard errors in parentheses. Key to significance levels: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

# Formal tests

- $\beta$ -convergence: Regressions show R&D intensity gap is positively associated with R&D growth
  - Robustness: 3- or 4-digit sectors, R&D-growth as DV, low- vs high-R&D, subperiods, OLS/FE/BE, outliers removed...
- $\sigma$ -convergence: variance increases over years

# Conclusions

- Heterogeneity of R&D intensities even within the same sector
- No evidence of convergence
- Sectoral systems of innovation?
- Should countries pursue R&D intensity targets (e.g. 3% of GDP) by adjusting the sector mix?