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R&D, Firm and Industry Performance: Where are we?

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R&D and Economic Performance

- The main conclusion of the literature is the beneficial effect that R&D has on economic performance, because of:
  - *Learning by doing effects.*
  - Greater benefits when complemented with other *types of investments:* infrastructures, ICT, human capital or physical capital.
  - Role of *spillovers* and *externalities.*

At the industry level

- Possibility to analyse other aspects: different effect of specific policies on **industry performance** and **disparities** in the effect of R&D on productivity under different levels of:
  - technological requirements,
  - knowledge intensive or
  - production and communication services.
- Differences in growth patterns at the industry level may capture industrial differences in capturing economic changes benefits offered **by using new technologies.**

Comparability among industries

› Two main groups of literature:

I. **Aggregate trends** of productivity growth of sectors (Verspagen, 1995; Timmer et al., 2010; Uppenberg, 2011; Mas and Stehrer, 2012).

II. Analyses of **micro-data** to draw conclusions on industry comparisons (Cuneo and Mairesse, 1983; Los and Verspagen, 2000; Ortega-Argilés et al., 2010, 2011)

I. Industrial aggregate trends

- Technological change has enabled **rapid productivity growth** in the **IT producing** and, most recently, **IT-using** industries (O'Mahony and van Ark, 2003; Timmer et al., 2010; Mas and Stehrer, 2012)
- Existent variations in the degree to which industries and firms can **benefit** from **technological opportunities**
- **Elasticities** lie around 10-30% range and **rates of returns** around 20-30%.

- OECD STAN or EUROSTAT
- KLEMS – US data
- EUKLEMS - European KLEMS project
- INDICSER, COINVEST – with a focus on services
- WIOD – World Input Output Dataset

II. Micro-data analyses

- R&D contributes to explaining potential **cross-sectional differences** in productivity levels.

  - Hall (1996) reports a range levels of elasticity of output/R&D capital between 0.10 -0.15, while Griliches (1995) reports 0.06-0.10.
  - Minasian (1969) reports 0.26 for Chemicals
  - Cuneo and Mairesse (1985) report 0.21 for the scientific sectors

II. Micro-data analyses

- High-tech, Science-based, Knowledge-intensive sector studies show higher R&D elasticities than studies with a mixture of sectors.

- When focusing in particular industries the R&D elasticities vary in the cross-sectional and time-series analyses depending as well on data quality issues.

- Literature shows the importance for firm performance of developing **R&D** in a **continuous manner**, because of the hysteresis of developing complex investments and the diminishing risk and costs associated to them (e.g. Hall and Mairesse, 1995).
- Mairesse and Sassenou (1991) after a survey conclude that the quality of **data** with **historical records** is **crucial** in these types of studies.

Micro-data: industrial disparities

- Manufacturing studies (cross-section, time series)
- R&D and non-R&D manufacturing performing firms (control group, surveys and annual accounts)
- High-tech, Medium-tech and Low-tech manufacturing industries
- Pavitt taxonomy and extended applications
- Manufacturing and Services
  - IT users, IT producers vs. Non-IT
  - Knowledge Intensive Services vs. Traditional services

Greater R&D impacts in productivity

- **Scientific firms** appear to have higher impact of R&D in productivity than other firms - Griliches and Mairesse, 1982 (FR); Cuneo and Mairesse, 1983 (US)
- Positive and significant effects of the R&D in **high-tech manufacturing firms** than in other firms:
  - European industry level (Verspagen, 1995)
  - German firm level (Harhoff, 1998)
  - US firm level (Los and Verspagen, 2000)
  - European and US firm level (Ortega-Argilés, 2011a, b)
  - Japanese firms (Kwon and Inui, 2003)
  - Taiwanese firms (Tsai and Wang, 2004)
  - UK firms (Rogers, 2010)
- **"Net users of innovations"** than others (Wakelin, 2001)

Manufacturing vs. Services

- "Solow disease"
- O'Mahony and Vecchi (2009) - UK, US, Japanese, French and German firms – found a higher R&D elasticity in non-manufacturing industries (0.251) than in manufacturing (0.170).
- Ortega-Argilés et al. (2011c) – EU, US firms - also found a higher R&D elasticity in services than high-tech manuf.

- Potential explanation:
  - Sample composition: Majority of service firms belong to R&D intensive service sectors such as business, financial and personal services.
  - Potential failling to capture innovation process in service industries, such as financial services (Gallouj, 2010)

Industry vs Firm analyses' comparison

- Examining industry data allows the inclusion of spillovers between different firms within an industry.
- Studies suggest that the social returns to R&D are greater than private returns because of the slower depreciation.

Sectoral disparities

- Ortega-Argilés, R., Piva, M.C., Vivarelli, M. (2011) Productivity Gains from R&D Investment: Are High-tech Sectors Still Ahead?, IZA Discussion Paper 5975, Institute for the Study of Labor (IZA).
  - Compustat subsample
  - What do we have? High-tech/Low-tech manufacturing and services.
  - What have we found? High-tech manufacturing and service sectors appear to obtain more returns of R&D investments in productivity
  - Further analyses: IT producing vs. IT using; High/Low-tech manufacturing vs. KIS/traditional services.
  - Further analyses: Methodological improvements endogeneity solutions apart from the use of stocks.

Micro-data: geographical comparisons

Examples: - Transatlantic Productivity Gap studies between Europe and the US and European regional disparities

1. The importance of the **economic structure/ specialisation patterns** of the economies vs. the importance of the **players** (companies, institutions, entrepreneurs). Is the different structure of the economies or are the individuals located in these economies how explain the productivity disparities?

2. The importance of the **factor**s: Labour conditions, physical capital and knowledge capital.

3. The importance of the **measurement**

Policy debates

- Increasing R&D investment is an issue of major concern for the European long term growth policy strategy. **"Lisbon agenda 2000"**, with the commitment of R&D/GDP level of 3%, 2/3 of them devoted to private R&D. And the new Europe 2020 growth strategy, with the flagship initiative "Innovation Union" (European Council, 2002; European Commission 2002, 2008, 2010).

- Place-based policies and the importance of the specialisation patterns of locations has raised some concerns in the need to move to bottom-up policy approaches that can capture the high heterogeneity of places in Europe, this ideas are in the core of the ***New Cohesion policy***. The reality that "not all the regions can do everything in R&D" and the need to pursue **"smart specialisation"** strategies are the focus of recent innovation, industrial and cohesion policies.

Structural and intrinsic problem

›Divide in the explanation of the gaps between EU and US in terms of innovation, R&D investments and business R&D in particular.

›R&D investment delay is due to a **sectoral composition effect**, since ICT sectors, R&D intensive manufacturing and knowledge intensive sectors are under-represented in the European economy in comparison with the US one (Jorgenson et al., 2005; European Commission, 2008; Mathieu and van Pottelberghe de la Potterie, 2008; Moncada-Paternò-Castello et al., 2010)

›**Less effort** experienced by **the EU** in R&D intensity within each sector a lower transaction of inputs into gains in productivity gains (Erken and van Es, 2007; Ortega-Argilés *et al.,* 2010 and 2011)

What have we learned?

- US and EU have shown a **persistent divide** in terms of labour productivity growth
- Causes:
  - R&D investment delay, due to a sectoral composition effect- **structural problem** (van Ark et al., 2008; Draca *et al.,* 2006)
  - EU firms get **less returns from their investments in R&D** in comparison with US. Less effort experienced by the EU in R&D within each sector. (Ortega-Argilés et al, 2011c; Cozza et al., 2011)
  - **"Two Europes"** are often mentioned by economists: Nordic and British world where R&D and ICT are strongly linked with labour productivity; the so-called "olive-belt" countries, with lower R&D investments and more specialised in traditional sectors (Cozza et al., 2011)

- **Does Geography matter?:** One of the main issues in the literature focuses in analyzing if the returns on productivity of different production inputs can differ among firms located in different environments, and the potential benefit of agglomeration in capturing better returns from R&D.
- This idea can be illustrated by some concepts:
  - *Economic Geography Theories*
    - *Location economies*
    - *Input-output linkages*
  - *Evolutionary Economic Theories*
    - Industrial relatedness (Frenken et al., 2007)
    - Industrial heritage (Klepper, 2007; Boshma and Frenken, 2009)
    - Organisational ecology (Hannan et al., 1995)
  - *Technological spillovers*
  - *Role of agents* (Cantwell and Iammarino, 2001)

- Cozza et al. (2012) found clear evidence of the better ability of firms located in higher R&D-intensive European regions not only invest more in R&D, but also achieve more in terms of productivity gains from their own investments. Among them firms from high-tech industries also have higher returns.
- However, we cannot conclude if the returns of productivity are higher in these firms by being located there (ec. agglomeration) or by their internal characteristics.
- The way forward:
- - using formal Regional innovation classifications (OECD, 2011)
- - analysing more the US regional disparities
- - increasing the European country data samples

Common problems:

- Avoiding **endogeneity** in the R&D productivity link:
  - Crépon, Duguet and Mairesse a la Verspagen
  - Olley and Pakes
- Avoiding endogeneity in the sectoral or regional classes:
  - New IT users/ producers (Mas and Stehrer, 2012)
  - New regional innovation classifications: *Regions and Innovation Policy* (OECD, 2011)
- **Spillovers'** capture / Social returns account:
  - Intra-sectoral and regional spillovers – do not seem to report much
  - Inter-sectoral and inter-regional spillovers
  - Controlling for multinational presence

R&D and Firm performance

- Hernández, H., Moncada-Paternò-Castello, P., Tuebke, A., Ciupagea, C., Ortega-Argilés, R. and L. Potters (2007) *Analysis of the 2006 EU Industrial R&D Investment Scoreboard*, European Commission, Institute for Prospective Technological Studies Technical Report, EU-22694-EN.
  - Chapter 6: "The role of R&D for business performance" (by Ciupagea and Ortega-Argilés)
  - Scoreboard sample of European top R&D investors, special analysis of certain industries such as pharmaceuticals, with special focus on sales, size effects of R&D intensities
- Hernández, H., Moncada-Paternò-Castello, P., Tuebke, A., Ortega-Argilés, R. and L. Potters (2008) *Analysis of the 2007 EU Industrial R&D Investment Scoreboard*, European Commission, Institute for Prospective Technological Studies Technical Report, EU-22694-EN.
  - Chapter 4: "R&D and Firm Performance" (by Ortega-Argilés, Potters and Vivarelli)
  - Scoreboard/DTI sample of European top R&D investors manufacturing

R&D and firm productivity

- Ortega-Argilés, R.; M. Piva; L. Potters and M. Vivarelli (2009) Is corporate R&D investment in high-tech sectors more effective? Some guidelines for European Research Policy, IPTS Working Papers on Corporate R&D and Innovation, num. 09/2009, European Commission, Institute for Prospective Technological Studies Technical Report.
- Ortega-Argilés, R.; L. Potters; M. Vivarelli (2009) The Productivity Impact of R&D Investment: Evidence from European Microdata, IPTS Working Papers on Corporate R&D and Innovation, num. 03/2009, European Commission, Institute for Prospective Technological Studies Technical Report.
- **Publications:**
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  - Ortega-Argilés, R.; L. Potters; M. Vivarelli (2011) R&D and Productivity: Testing Sectoral Peculiarities Using Micro Data, *Empirical Economics*, 41(3), 817-839.

R&D and Firm efficiency

- Kumbhakar, S. C.; Ortega-Argilés, R.; Potters, L.; Vivarelli, M.; Voigt, P. (2009) Corporate R&D and Firm Efficiency: Evidence from Europe's Top R&D Investors, IZA Discussion Papers 4657, Institute for the Study of Labor (IZA)

- **Publications:**
  - Kumbhakar, S.; R. Ortega-Argilés; L. Potters; M. Vivarelli and P. Voigt (2012) Corporate R&D and firm's distance to the frontier: Evidence from Europe's top-R&D investors, *Journal of Productivity Analysis*, 37(2), 125-140, April.

R&D and Stock market performance

- Cincera, M.; Ortega-Argilés, R.; Moncada-Paternò-Castello, P. (2009) "The Performance of Top R&D Investing Companies in the Stock Market," *IPTS Working Papers on Corporate R&D and Innovation*, num. 14/2009, European Commission, Institute for Prospective Technological Studies Technical Report.

Transatlantic productivity gap

- Ortega-Argilés, R.; M. Piva and M. Vivarelli (2011) The transatlantic productivity gap: is the R&D the main culprit?, IZA Discussion Paper 5586, Institute for the Study of Labor (IZA)
  - Compustat subsample EU/US disparities in the R&D-Productivity link / manufacturing and services

- Cozza, C.; R. Ortega-Argilés and M. Piva "Can European heterogeneity tell us more about the transatlantic productivity gap?"
  - Compustat subsample EU Macro-regions/US disparities in the R&D-productivity link

European regional disparities

- Cozza, C.; R. Ortega-Argilés; M. Piva and R. Baptista (forthcoming 2012) Productivity gaps among EU regions, In: Audretsch, Lehmann, Link, and Starnecker (eds.), *Technology Transfer in a Global Economy,* Springer.