Employment effects of innovation and R&D private and public collaboration: the role of knowledge spillovers in Europe

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Aims

- We analyze the connections between the public and private investments in R&D in Europe. (Still in progress)
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- We develop a theoretical analysis
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- We develop a theoretical analysis
- We build an empirical analysis
- We use the specification similar to Faggio and Overman (2014) and introduce an instrumental variable based on the shift-share approach (Bartik, 1991)
- We explore the role of knowledge spillovers on leading firms employment in Europe. (started and in progress)
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We develop a theoretical analysis

We build an empirical analysis

We use the specification similar to Faggio and Overman (2014) and introduce an instrumental variable based on the shift-share approach (Bartik, 1991)

We explore the role of knowledge spillovers on leading firms employment in Europe. (started and in progress)

We provide some useful implications for European innovation policy strategy (started and in progress)
As mentioned in Piva and Vivarelli (2018a, 2018b) there are two different effects of innovation on employment: product innovations produce the emergence of new markets and induce positive job-creation effects, while process innovations lead to technological unemployment due to increased labour productivity or higher cost.
Innovation: Employment or Unemployment?

- As mentioned in Piva and Vivarelli (2018a, 2018b) there are two different effects of innovation on employment: product innovations produce the emergence of new markets and induce positive job-creation effects, while process innovations lead to technological unemployment due to increased labour productivity or higher cost.
- Indirect compensation and substitution effects could counterbalance the potential increase or reduction in employment deriving from product and process innovations.
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Product Innovations: earlier research has identified a positive impact on employment (Marx 1961; Say 1964) and recently Dachs et al. (2017), defined as Welfare Effect.
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Innovation: Employment or Unemployment?

- Bianchini and Pellegrino (2019) examine the effect of persistence in process and product innovations on the employment dynamics in Spain. They illustrate how the firm might react in terms of employment growth under the influence of the degree of persistence in their process and product innovations.
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Guarascio and Tamagni (2019) observe the relationship between the long-run contribution of innovation persistence to sales growth and market share dynamics in Spain. They consider employment and sales as interchangeable measures of firm size and want to show the link between innovation persistence and market success.
David et al. (2000) determine the relationship between public and private R&D in order to build tangible and effective economic policies to stimulate the employment dynamics. The aim is to understand if the public and private R&D spending are complementary or additively related and to clearly identify if they are substitute or if the public R&D crowds out the private one.
The role of Public and Private R&D

- Lopez-Rodriguez and Martinez-Lopez (2017) use an augmented macro-theoretical growth model to demonstrate that besides R&D the non-R&D innovation activities play a key role as main drivers of total factor productivities in Europe. They don’t separate public from private R&D but show that R&D and non-R&D are statistically significant and economically relevant in technological catch-up. In addition they find that the impact of R&D on total factor productivity growth is twice as big as that of non-R&D in Europe.
Bianchini et al. (2019) measure the impact of public R&D subsidies on business R&D investment in heterogeneous institutional frameworks within the Europe. Public support for research and innovation activities may leverage private sources when firms are constrained by lower quality public institutions, reducing uncertainty and favouring private risky investments. The results of their analysis reject full crowding-out supporting the idea that the beneficiary firms invest more in R&D than non-beneficiaries in all regions, including those with lower institutional quality.
The role of Public and Private R&D

Bianchini et al. (2019) develop an institutional index based on existing indicators and group regional economies on the basis of the quality of their public institutions. Analysing a comprehensive sample of Spanish firms observed over more than 20 years and a larger dataset of 13 European economies drawn from the Community Innovation Survey 2014 they check the policy impact in terms of private R&D expenditure for companies operating in different institutional frameworks.
Theoretical Framework 1
The production function of the representative entrepreneur


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- \( cu/p \) = real user cost of capital
- \( C \) = Capital
Theoretical Framework 2
F.O.C. for Profit Maximization

\[ \log L = \log Y + (\sigma - 1) \log T(K, K^R, K^G) - \sigma \log \frac{w}{p} + (\sigma - 1) \log A(K, K^R, K^G) \]

with

\[ \sigma = \frac{1}{1 + \rho} \]

captures the labor and physical capital substitution elasticity

\[ \log L = \log C - \sigma \log \frac{w}{p} + \sigma \log \frac{cu}{p} + (\sigma - 1) \log \left[ \frac{A(K, K^R, K^G)}{B(K, K^R, K^G)} \right] \]
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- \( \lg C = \lg Y + (\sigma - 1) \lg T(K, K^R, K^G) - \sigma \lg \frac{cu}{p} + (\sigma - 1) \log B(K, K^R, K^G) \)

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- \( \lg L = \lg C - \sigma \lg \frac{w}{p} + \sigma \lg \frac{cu}{p} + (\sigma - 1) \log \frac{A(K, K^R, K^G)}{B(K, K^R, K^G)} \)

R&D stock \((K)\), knowledge spillovers \((K^R)\) and public R&D \((K^G)\) are utilised as proxies of technological progress.
Theoretical Framework 3
Proxies and First-difference version to remove the unobserved term $u_i$

$$ \frac{A_{i,t}(K, K^R, K^G)}{B_{i,t}(K, K^R, K^G)} $$

- Technological Progress

$$ \Delta \ln L_{i,t} = \beta_0 \Delta \ln C_{i,t} + \beta_1 \Delta \ln w_{i,t} + \beta_2 \Delta \ln K_{i,t} + \beta_3 \Delta \ln K_{i,t}^R \beta_4 \Delta \ln K_{i,t}^G + \beta_5 \Delta K \ast K_{i,t}^G + \Delta \nu_i + \Delta \mu_{i,t} $$
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- Because of unavailability of wages data in our dataset, we use the physical capital stock as proxy, as in Bogliacino (2014)

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- Technological Progress

- Because of unavailability of wages data in our dataset, we use the physical capital stock as proxy, as in Bogliacino (2014)

- to identify the crowding effect, we introduce also the interaction variable between private R&D \((K)\) and public R&D \((K^G)\)

\[
\Delta \ln L_{i,t} = \beta_0 \Delta \ln C_{i,t} + \beta_1 \Delta \ln w_{i,t} + \beta_2 \Delta \ln K_{i,t} + \beta_3 \Delta \ln K_{i,t}^R + \beta_4 \Delta \ln K_{i,t}^G + \beta_5 \Delta K \ast K_{i,t}^G + \Delta v_i + \Delta \mu_{i,t}
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Data Description and Methodology

- EU R&D investment scoreboards that have been issued by the JRC-IPTS between 2002 and 2010 (European Commission, 2011)
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- The second database is REGPAT (January 2012) which is issued by the OECD. REGPAT collects data on patents and allocates them to each country according to the addresses of the applicant and inventors

Data have been deflated by using national GDP price deflators where 2007 appears as the reference year.

The R&D and physical capital stocks are constructed by using a perpetual inventory method (Griliches, 1979) with a depreciation rate of 0.15 for the R&D capital stock and 0.08 for the physical capital stock.
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For each firm the scoreboard reports data on:

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- Number of employees (L)
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- We use the measure of spillovers based on patent data (Jaffe proximity measure) as a proxy of knowledge spillovers
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To alleviate the critique that the initial share can be correlated with other factors, we use many control variables relative to demographic and labor composition that affect employment at regional level.
We consider structural equation linking employment growth to private and public R&D:

\[ \text{lc} = \tau + \beta_0 \text{PrR&D}_c + \beta_1 \text{PubR&D}_c + \epsilon_c \]

- \( \text{lc} \) is employment growth in country \( c \)
- \( \text{PrR&D}_c \) is private R&D in country \( c \)
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- \( \epsilon_c \) is a structural error term correlated with \( \text{PrR&D}_c \) and \( \text{PubR&D}_c \)

Our estimands of interest are \( \beta_0 \) and \( \beta_1 \).

We use the Bartik instruments to estimate them.
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  - Our estimands of interest are \( \beta_0 \) and \( \beta_1 \)
    We use the Bartik instruments to estimate them
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- The Bartik instrument combines two accounting identities: it is the product of industry shares and local industry growth rates
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  - \( PrR&D_c = \sum_k z_{ck}g_{ck} \)
  - \( Pub&D_c = \sum_k z_{ck}g_{ck} \)
  - \( z_{ck} \) is the share of country c’s private (or public) R&D in industry \( k \), and \( g_{ck} \) is the growth rate of industry \( k \) in country c.
Empirical Framework 2
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- The Bartik instrument is the product of the industry country shares and the industry component of the growth rates:
  \[ B_c = \sum_k z_{ck} g_k \]
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We compute the TSLS estimation where \( B_c \) is explanatory variable of the first stage with private and public R&D as the dependent variables.
Results

Table 1 presents the summary statistics for our sample.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnS</td>
<td>8.14</td>
<td>1.803</td>
</tr>
<tr>
<td>LnL</td>
<td>9.60</td>
<td>1.693</td>
</tr>
<tr>
<td>LnC</td>
<td>7.19</td>
<td>2.065</td>
</tr>
<tr>
<td>LnK</td>
<td>6.46</td>
<td>1.721</td>
</tr>
<tr>
<td>LnK^G</td>
<td>0.71</td>
<td>0.134</td>
</tr>
<tr>
<td>z</td>
<td>0.15</td>
<td>0.108</td>
</tr>
<tr>
<td>g</td>
<td>0.06</td>
<td>0.166</td>
</tr>
</tbody>
</table>

*Number of observations: 2099
Results

Table 2 presents the results related to crowding out effect

<table>
<thead>
<tr>
<th></th>
<th>TSLS</th>
<th>Est.</th>
<th>S. E(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\ln S)</td>
<td>0.55</td>
<td>***</td>
<td>(0.044)</td>
</tr>
<tr>
<td>(\ln C)</td>
<td>0.21</td>
<td>***</td>
<td>(0.024)</td>
</tr>
<tr>
<td>(\ln K)</td>
<td>0.47</td>
<td>***</td>
<td>(0.153)</td>
</tr>
<tr>
<td>(\ln K^G)</td>
<td>-0.21</td>
<td></td>
<td>(0.364)</td>
</tr>
<tr>
<td>(\ln K \times \ln K^G)</td>
<td>-0.47</td>
<td>***</td>
<td>(0.148)</td>
</tr>
</tbody>
</table>

\(R^2\) \([0.472]\)

\(a\): heteroskedastic-consistent standard errors, which are clustered around the firm and the year. **\(p\)-values significant at the 1\%, 5\%, 10\%. Country, Sector and Time dummies are included.
Results and Preliminary Policy Implications

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- We evidence a statistically significant role of employment effects of innovation for European firms.
- We identify a positive impact of private R&D on employment growth.
- We find a crowding effect between private and public R&D with respect to employment growth.

In all the European geographical area considered globally rises up a crowding out effect. It is fundamental to begin a process in order to coordinate public and private R&D investment in this area that exhibited a high propensity to innovate during the last twenty years.
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The collaboration between firms and public institute to develop new researches it is crucial to become their investments in R&D complement.
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- A mechanism that creates a continental innovation system involving firms and public research institutes in different geographical areas can support strongly the innovation processes avoiding crowding out effect and collecting in more efficient way the resources employed from the different actors in the innovative activities
THE END

THANK YOU FOR YOUR ATTENTION...WE ARE STILL WORKING ON IT BY NOW