University-Industry interaction and firms' innovative performance: evidence from the biopharmaceutical industry

by ANNA GIUNTA | Davide Vurchio | Eleonora Pierucci | Università degli Studi Roma Tre | Università degli Studi di Bari | Università degli Studi Roma Tre

Abstract ID: 53
Inviato: 06/05/2021
Evento: XIX Workshop Annuale SIEPI
Argomento: XIX Workshop Annuale SIEPI
Parole chiave: University-Industry interaction, biopharmaceutical industry, co-publishing, innovative activity

Objectives

The present work investigates the role of University-Industry (U-I) interaction on the innovative performance of firms in the biopharmaceutical industry.[1] Notably, we investigate whether collaborative research in the form of co-publishing between scholars from private companies and public research institutions (Universities and National Research Council) affects the probability to innovate as well as the intensity of firms' innovative activity.[2]

Industry–science links benefit firms' R&D productivity (Henderson et al., 1998). Public research (particularly University research) and its interaction with the private sector produces relevant knowledge spillovers that play an important role as innovation drivers (Owen-Smith and Powell, 2004; Audia et al., 2006; Mueller, 2006). As a science-based industry, whose growth and profitability are strictly dependent on successful research, biopharmaceutical industry is the testing ground of our work because of its vital need to acquire external knowledge and exploit public spillovers. Indeed, given the increasing amount of human and financial resources needed to develop new drugs, biotech and pharmaceutical firms extensively engage with university and public research centers (Calvert and Patel, 2003; Gittelman and Kogut, 2003). Further, the pharmaceutical sector has matured the peculiar capability to quickly capture new ideas developed originally within university labs (Cohen et al., 2002). Against this backdrop, in light of the expected positive spillovers, policy-makers have been attempting to promote innovation and growth also through the higher education sector (Acs et al., 2009).

The processes of discovery and development of new drugs in life sciences requires a notable and increasing amount of resources (human and physical capital, financial resources and knowledge) along with an intense interaction between basic and applied research. Therefore, more than other industries, biopharma industry has to be analyzed as a system of linkages among different actors (big pharmaceutical firms, small biotech firms, universities, public research centers, national health systems, policy makers and financial institutions).

We can identify two main very wide fields of investigation. The first deals with internal and external determinants of innovation at firm, regional and national level and it is mainly concerned with agglomeration economies and national innovation systems (Furman et al., 2002). The second focuses on the determinants (geographical, organizational, institutional, managerial) of U-I interaction (Perkman et al., 2013 and references therein). The economic literature highlights as science provides beneficial effects to industry as it supplies guidance for industrial research by pointing out promising avenues for technology development (Fleming and Sorenson, 2004; Dasgupta and David, 1994; Henderson et al., 1998; Hall et al., 2003; Crespi et al., 2010). Innovative collaborations can strengthen partners' innovative activities and increase the probability of product innovation (Vonortas, 1997). However, there is still very limited evidence on the role of U-I interaction on firms' innovative activity. So far, most of research is mainly based on very small samples or case studies (e.g., Cockburn and Henderson, 1998)[3], and/or on survey data such as those from the Community Innovation Survey (Lee and Wong, 2009; Protogerou, 2017; Apa et al., 2020) where networking with universities and technology collaborations are subjective measures. Rarely, contributions identify U–I collaborations through non-subjective measures. Baba et al. (2009), by focusing on a sample of firms operating in the specific field of advanced materials field in Japan, exploit data on co-inventions with scientists (more precisely, "Pasteur scientists"),[4]finding a positive effect of this collaboration mode on firms' innovative performance.

Our work aims at contributing to the literature by investigating whether firms are able to reap the benefit of positive knowledge spillovers deriving from the collaboration with academia. We test if those firms interacting with public research (University and National Research Council) in the co-publication mode: *i*) experience a higher probability to own a patent; *ii*) increase the intensity of their innovative activity. We use a large sample of Italian firms over a long-time horizon (2000 – 2010) based on the dataset by Lotti and Marin (2013), merged with data on co-publishing from Giunta et al. (2016).

Co-publishing is an objective (informal/tacit) technology transfer variable representing a particularly appropriate proxy for U-I interaction when considering the biopharma sector. Unlikely other industries, in the pharmaceutical industry companies extensively publish (Koenig, 1983; Hicks, 1995; EU Commission, 2003; Leten et al., 2010) because their papers serve as tickets to scientific networks (Hicks, 1995; Cockburn and Henderson, 1998). Indeed, for such industry the share of collaborative publication is more than two third of total scientific publications (Calvert and Patel, 2003, Gittelman and Kogut, 2003).

We argue that those firms coming in touch with academic research through collaborations, formalized in a joint scientific publication, are more exposed to a cross-fertilization of ideas and knowledge that allows to better perform in terms of innovative activity. We also account for the fact that the presence of patents in firm's portfolio can precede the occurrence of a joint publications. Therefore, by adopting probit and negative binomial models, besides co-

publication activity, we also take into account the leads of such collaboration proxy to capture the effect of partnerships not yet signaled by a joint paper. We find that spillovers coming from academic knowledge are beneficial to firms by increasing their probability to own a patent as well as the intensity of their innovative activity. Frequency of the collaboration as well as a high stock of prior partnerships also play a role.

Methodology

Our investigation strategy adopts a parametric approach using both probit estimators and negative binomial to investigate whether firms involved in co-publications with universities tend to patent more. By adopting co-publishing as proxy for U-I collaborations, our research design aims to investigate whether being involved in such collaboration increases the probability of being innovative– as well as the number of patents.

Our baseline model is:

pat_it= beta_cp * CP_it+ beta_hc*highcoll_i+beta_x*X_it +epsilon_it

where pat_it is a dummy variable equal to 1 when firm has at least one patent at time – or, alternatively, the number of patents of firm i at time t – while CP_it represents a dummy variable equal to 1 when firm co-published at least once at time – or, alternatively, the (logarithm of) the number of publications that firms' employees have co-authored with academic staff. We include a group of control variables such as firms' research and development expenditure, labor cost, total assets, capital stock and value added as well as macroregional and year fixed effects. We also include – a dummy variable equal to 1 when a firm shows a total number of co-publications higher than the average during the period 2000-2010, capturing the propensity of a firm to entail in collaborations with universities.

We include a group of control variables X_it such as firms' research and development expenditure, labor cost, total assets, capital stock and value added as well as macroregional and year fixed effects. Since the ability to collaborate could be linked to firms' co-publishing activity as well as to knowledge and networking capabilities accumulated through time, we include Highcoll_i – a dummy variable equal to 1 when a firm shows a total number of co-publications higher than the average during the period 2000-2010, capturing the propensity of a firm to entail in collaborations with universities. This variable can capture the general trend in collaborations and the objective of its inclusion is twofold. First, it allows us to isolate the effect of current collaboration activity () from the propensity to be involved in collaborations deriving from years – or decades – of U-I partnerships. Second, being a proxy of the average knowledge stock deriving from prior partnerships, it provide us with the

chance to test if it plays a role on firm's innovative performance (Hp.3).

An important aspect, already introduced in Section 2, is the need to consider the role of time in the process of knowledge generation. We are interested in understanding how the collaboration between companies and universities influence the innovative performance of the former and, in order to do so, we proxy U-I collaborations with information on co-publishing activity. However, such proxy captures collaborations that have taken place months or years before and the publication of a co-authored article and represents a step downstream the interaction process. In such circumstances, identifying a clear order between patenting and publishing activities is not a trivial task. To consider such aspect, in our estimates we also include a set of forwarded variables that allow us to capture the effect of collaborations just before the observation of a co-publication.[5]

To further corroborate our results , we replicate our analysis in two ways. First, we replicate probit and negative binomial estimates by adopting, this time, co-publications lags instead of time-forward variables in order to check whether such 'placebo' variables, despite being specular to time leads, lead to similar results. Second, we investigate the presence of pre- and post-treatment effects of the binary time-varying treatment *co-publication*dummy on the number of patent applications, by following the Dynamic Difference-in-Difference approach by Cerulli and Ventura (2019) and Cerulli et al. (2021).

Results

In all our estimated specifications we find that including the forwards of the collaboration proxy, *i.e.*, considering the periods in which a collaboration has started but has not yet led to a co-publication, adds information to our analysis with respect to the temporal relationship between innovative activity and the manifestation of collaborative research (as proxied by co-authored papers).

In the three-year period before the publication of at least one paper co-authored with academic researchers, the probability of patenting is, according to the specification adopted, between 16.9 and 25.1 percent higher. Also the intensity of co-publishing is positively associated to the probability of being innovative. Such relationship is particularly significant for the forwarded variables which capture the anticipatory effect of co-publications. The coefficient associated to *high_coll* is positive and significant as well and confirms that firms with a cumulated number of co-publications higher than the average have a probability of patenting 6.2 to 10 higher with respect to other firms.

When we move to analyze the effect on innovative intensity, we find that our proxy of U-I collaboration is positively associated to the number of patent applications, in particular when the leads of the variable are included. Such evidence shows that the positive effect of

collaboration might starts a couple of years before the publication of a co-authored article, confirming the existence of a knowledge spillover that – most of the times – is *ex-post* delatentized. Looking at the role of prior partnership (measured by the *high_coll*) we find that firms with a cumulated number of collaborations higher than the average are more innovative and tend to patent more (on average, 29 to 57 percent more). Size seems to matter since firms with a higher total asset value tend to patent more while value added is faintly associated to the number of patent applications.

Summing up, collaborations – and co-publications – play a double role in the innovation process of firms: they are crucial in boosting both the innovation capability of firms (Hp.1) as well as the innovative intensity (Hp.2) thanks to the spillover effect generated by current partnerships (Hp.1 and Hp.2) and knowledge capabilities accumulated in previous years of collaborations (Hp.3). Indeed, firms that in the period under scrutiny had a cumulated number of collaborations with universities higher than the average (highly collaborative firms) exhibit a higher level of innovativeness. This results is stable in all specifications, confirming that having experiences of co-publishing – and thus of collaborations in the past – positively influences the ability to be innovative (Hp.3).

The adoption of lagged variables as robustness check (that might capture a delayed effect of U-I collaboration in the following years) does not seem to provide convincing results and, on the contrary, gives support to the results we have reported in the previous section. Also our robustness analysis, based on the adoption of Dynamic DiD estimator, confirms our results and shows that firms' innovation activity is increased since the third year before the recording of co-publications. Moreover, the impact on the number of patents is even higher 2 to 3 years before the co-publication with respect to the year of co-publication, confirming the validity of our results and our setting according to which co-publication is a proxy – although delayed – of collaboration and a key predictor of the innovative performance.

Implications

Our findings rise some policy implications concerning two main issues.

First, the role of public policy in fostering U-I formal and informal collaborations. It follows from our findings the relevance of public policies addressing U-I links as they are crucial to promote the innovative performance of science-based industries, such as the biopharma. Research and innovation in biopharmaceutical industry are highly risky, require significantly long processes and remarkably high costs (Sternitzke, 2010). Therefore, firms' private investments can be suboptimal, while economic and societal returns of new drugs discovery is potentially very large. This aspect already gained attention by European policy makers in the Horizon 2020 objectives. Nevertheless, the recent events connected to the Covid-19 pandemic and the vaccine race shed a new light on the need of public intervention to foster public-private partnerships since they may reduce uncertainty and speed-up

research and innovation processes by pooling resources and gathering critical mass. Indeed, the European Commission recognizes that diverse sources of funding are essential for innovation: “Horizon Europe, Cohesion Policy, the European Defence Fund, public-private and public-public such as the Innovative Health Initiative and national schemes are important enablers for R&D, including for small and medium-sized enterprises (SMEs) and academia” (EU Commission, 2020a, pag. 11). Further, the European Partnership for Innovative Health (Initiative) among its main objectives establish to “integrate fragmented health R&I efforts across sectors and technologies, academia and industry/public and private stakeholders” (EU Commission, 2020b, pag. 15). To this end, cooperation between health systems and private companies can also be pursued through public procurement: public buyers can set up partnerships for the development, manufacturing and subsequent purchase of medicines with limited demand (EU Commission, 2020a). Within this framework, our results show how also tacit knowledge transfer through co-authorship of scientific articles increases the probability of firms to own a patent as well as the intensity of their innovative activity. As firms can take advantage of knowledge spillovers stemming from academia and given the potential large positive effects on public health, policy makers should incentivize such type of collaboration.

Second, the role of collective and private incentive to collaborate. Scholars from the public sector do not have institutional incentives to engage in co-publishing with colleagues from private firms. Individual academics might have only private incentives to engage with industry. Given that academic career and departments’ evaluation for accessing public funding are mainly based on publication records, academic scholars might be willing to co-author papers with scientists from private companies only if it increases the publishability of their research in highly ranked journals. On the contrary, policy makers have taken a number of actions to rise attention on other (more formal) technology transfer modes such as spinoffs creation (in line with the European trend, periodical research quality assessments have been given increasing importance to the evaluation of the so called “University third mission”). Therefore, in this peculiar research field, to align private and collective interests and encourage academic scholars to engage in joint publications with private company researchers, policy makers should pursue a performance evaluation strategy, at individual and institutional level, that might rate more those publications that include as co-authors scientists from the private sector.

Finally, co-publishing as a knowledge cross-fertilization tool that can produce positive effects also on the academic research side. For this reason, universities might find fruitful to promote collaborations between academics and researchers from the private sector to increase both their research output and the number of highly ranked publications in their portfolios.

[1] On the same line of previous literature (Brusoni et al., 2005; Battelle, 2013; Giunta et al., 2016), we refer to biopharmaceutical industry as the chemical, biotech and pharmaceutical industry.

[2] In our work we consider the presence of a patent in the firm's portfolio as evidence of innovative activity. According to the Oslo Manual (OECD,1992), innovative activities can include patenting activity within the firm as well as acquisition of external technology, such as in the form of patents. Indeed, as defined by the Oslo Manual (OECD/Eurostat, 2018), "[a]n innovation-active firm is engaged at some time during the observation period in one or more activities to develop or implement new or improved products or business processes for an intended use" (pag. 81).

[3] Cockburn and Henderson (1998) find an effect of the fraction of co-authorships with universities on the log number of patents (they rely only on 82 observations relative to a sample of 10 firms).

[4] "Scientists who never lose sight of the desire to advance scientific understanding, but whose research has potential real-world utility" (Baba et al. 2009, pag. 757).

[5] Including leads (or lags) of the main covariate is not a new approach as it has been adopted since Autor (2003) to detect pre- and post-treatment effects in a parametric setting.