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EXTENDED ABSTRACT

Title: Cooperation between companies and technology centres to motivate the innovation process. Comparing the scenario before and after the financial crisis.

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Abstract:

Improving areas characterised by innovation requires a complex system, with its different parts interacting with each other (Frenken, 2006). Innovation ecosystems are seen as open and non-linear entities, with their actors adapting to new changes, but above all collaborating in different types of networks (Russell and Smorodinskaya, 2018). According to Cantarelli (2019) these interactions become more complex as projects require, and cross-connections and secondary innovations can be found depending on the magnitude of the risk or organisational needs. Aware of this complexity and the needs to promote technological advances and competitiveness, the majority of the countries in the European Union are implementing programmes to foster cooperation in innovation between the different agents of the innovation system. Indeed, the European Commission itself is promoting the adoption of policies to encourage business research in collaboration with universities and research centres (Recommendation C(2008)1329, of 10 April 2008). However, despite the common commitment, there are notable differences in collaboration strategies between regions, with the more innovative European areas fostering international relations more frequently (Srholec, 2015).

One of the most encouraged forms of innovation cooperation has been the creation of research centres. According to Boardman and Gray (2010), cooperative research centers (CRCs) are key mechanisms for national and regional governments and private industry to achieve social and economic outcomes with innovation, science and technology, and their inclusion in innovation ecosystems seems to be working: different authors such Más-Verdú (2007), Sofka and Grimpe (2010), Cruz and others (2012), Gallego and

others (2013), Dolan and others (2019) or Núñez-Romero and Serrano-Estrada (2020) among many others have indicated the importance of knowledge generated by research centres and universities within innovation systems.

To contribute to this issue, we study whether collaboration between firms and technology centres changes managers' perceptions of the usefulness and barriers to innovation. Hypothetically, one might expect that collaboration serves to reduce the brakes on innovation, as well as to convey to companies the need for technological differentiation. Our results will therefore contrast the public utility of research centres.

Cooperation in innovation is defined as the agreement between two or more agents of the innovation system pursuing a common goal. This definition expresses cooperation as a strategy to reach objectives and to solve difficulties in the innovation process (Arranz and De Arroyabe, 2008). These collaborations often occur most successfully in innovation ecosystems, where complementary actors are brought together to drive complex developments (Adner and Kapoor, 2010).

One of the most repeated solutions in previous literature has been to promote collaboration between actors in ecosystems. To cite just a few studies, in Hernández-Trasobares and Murillo-Luna (2020), based on the theoretical approach of the Triple Helix model developed by Etzkowitz and Leydesdorff (1995), it is shown how cooperation generates a positive effect on business innovation in Spain. This article advises firms to cooperate with the three helixes of the model (universities, public sector and private sector), as the effects are incremental. Barge-Gil and Modrego (2008) compared the results of the technological institutes (TI) located in three Spanish regions (Euskadi, Region of Valencia and Galicia), and although the Basque institutes are the best performers, the authors consider the role played by all of them to be very positive. In Díez-Vial and Fernández-Olmos (2015) and in Vásquez-Urriago and others (2016), technology parks are shown to be a source of boosting innovation in Spain, thanks to the synergies that occur in their nearby ecosystem. As a more recent example, Mendi and others (2020) shows how in-house innovation, combined with cooperation with universities and other research centres, generates a positive effect on the R&D performance of Spanish companies.

Away from Europe, Fukugawa's (2008) study, without considering its effect to be negative, does criticise the development strategies of technology centres in Japan as inefficient, given that they had not adapted their activities to the environment in which they are located. And in the case of Mexico, the research conducted by Stezano (2018) on four technology centres shows how not all of them manage to carry out the proposed activities with equal efficiency, with clear asymmetries in results between areas of action and centres.

This difference in observable results depending on the multiple characteristics of the technology centres or the ecosystem itself is also mentioned in Cruz and others (2012), and the aforementioned paper by Sternberg (2004) also highlights the differences between the technology centres promoted in Germany and those in the USA and the UK. In addition, Carta (2020) has criticised the excessive bureaucracy that often accompanies certain types of collaboration, which limits the participation of some stakeholders in the process.

Therefore, even assuming that the lack of innovation in Spain could be partly corrected by the role of technology centres, the criticisms shown make it necessary to study whether over the years Spanish policies have led to significant improvements. To this end, the response of Spanish companies to collaboration with technology centres in their

environment will be analysed in three different stages: one during an economic prosperity, one during an economic crisis, and one during a phase of recovery.

In order to estimate whether the innovation infrastructures and collaborative strategies promoted are being effective in Spain, official sources from its national statistics institute have been used. Specifically, we have used the INE Survey of Innovation, which is constructed annually to provide information on the R&D activities of companies, being 2016 the last year available. This includes terms of the nature and sources of innovation and the fields of action of the innovative processes.

The Survey of Innovation has been widely used in previous literature. Some research that have referred to it include Hervas-Oliver and others (2021), Gimenez-Fernández and others (2020), D'Este and others (2014), De Marchi (2012), Fernández Gual and Segarra-Blasco (2013), Barge-Gil (2010), Segarra-Blasco and Arauzo-Carod (2008) among others. Due to its official nature and the volume of data it handles, it is undoubtedly a reliable source of information, which perfectly reflects the state of the art of innovation in Spanish companies.

In developing our hypotheses, a broad time frame has been chosen, reflecting the effect of innovation collaboration over different time periods. This is why this research proceeds with three analyses: the first between 2004 and 2007, the second between 2008 and 2010, and the third between 2011 and 2014. This fragmentation covers three economic periods in Spain during a whole decade: a stage of economic growth, the effects of the financial crisis, and finally the stage of recovery.

Choosing this period will also allow us to draw conclusions for the post-Covid-19 period. Spain is one of the European countries that suffers most from economic crises, both in terms of job and wealth losses. It happened during the financial crisis, and it is happening again with the coronavirus crisis. Previous authors such as Royo (2009), Crescimanno and others (2014), Sinn (2014) or Perles Ribes and others (2016) among many others, have shown that with the previous economic crisis the Spanish economy and some of its key sectors lost more competitiveness than most EU countries.

We are going to study if boosting innovation may be the answer to prevent the same story repeating over again.

Based on this selection of variables, four hypotheses of extraordinary relevance for understanding the innovation behaviour of firms during the stages of economic expansion and recession are proposed:

H1: Companies change their perspective on cooperation to develop innovation according to the economic cycle.

H2: Companies change their views on the competitive need for innovation depending on the economic cycle.

H3: Companies change their views on the problems and barriers to entry for developing innovation according to the economic cycle.

H4: The firms' perspective on the competitive importance of innovation and the possible problems for the development of innovation conditions their response on whether or not to cooperate with technology centres.

It would be expected that firms would be more likely to cooperate with technology centres during times of economic crisis, as it is expected that it is in these periods that they would find it most difficult to innovate on their own. In the opposite case, it could be due to three main issues: managers consider that there are too many obstacles to innovate that they cannot overcome even by cooperating; managers do not consider innovation as a competitive determinant or at least not as a priority issue in times of

crisis; managers are unaware of the possibilities presented by technology centres for their innovation purposes.

The Pearson Chi-square method was used to test whether there are significant differences during the economic cycle in the companies' decisions to collaborate, as well as in their perception of the importance and barriers to innovate (hypotheses 1, 2 and 3). These results have been accompanied by mosaic graphs that facilitate the understanding of the outputs. Hypothesis 4, referring to whether the collaboration of companies with technology centres causes changes in their perception and decision to innovate, has been tested with the Mann-Whitney U method (MacFarland and Yates, 2016; Schulze and others, 2012).

In this research we have highlighted a prevailing need in Spain: a strong commitment to innovation in order to return to the path of economic growth. As has been pointed out, a number of researchers have previously denounced the lack of adaptation of the Spanish productive fabric to new high-tech trends, and as a result the effects of crises are exacerbated. We witnessed this during the last financial crisis, studied here, and we are once again looking into the abyss of job and wealth destruction in the COVID-19 crisis.

One of the solutions proposed from some areas of academic circles has been cooperation between stakeholders (especially from the three- or four-helix approach). In this regard, this research has studied whether those companies that cooperate with technology centres are the ones that have the greatest awareness of innovation, and at the same time are capable of resolving the difficulties that make Spain one of the least innovative countries in the European Union.

We have also added a new dimension to this research, dividing the perception of business people into three stages of an economic cycle (growth, crisis and recovery), something that has not been studied to date.

Our results, however, are not conclusive in their entirety. We can definitely state that the perception of the importance of innovation as well as the difficulties in undertaking innovation in firms varies over time, although not as much as we expected. For example, on average, managers rated the competitive effects of innovation higher before the crisis than after it. It is also surprising that companies that cooperate with technology centres have a lower perception of the importance of innovation than companies that do not cooperate.

In relation to the barriers encountered by companies to innovate, the financial crisis brought with it greater difficulties to be pushed forward innovative projects. On average, after the crisis, companies have seen their access to internal and external financing or the costs of innovating reduced. At the same time, however, due to rising unemployment in the economy, companies have greater access to highly educated human resources. This situation could certainly be repeated after the COVID-19 crisis in Spain. In this respect, companies that cooperate with technology centres report fewer problems in coping with the difficulties to innovate.

From these results we can highlight the differences between companies that cooperate with technology centres and those that do not. Those that cooperate show a lower perception of the importance of innovation, and at the same time less difficulty in innovating. On the other hand, those that do not cooperate have a greater perception of the competitiveness generated by innovation, and report stronger barriers to implementing their developments.

It is therefore clear that, as has been observed in previously cited articles, the role of technology centres in Spain can be called into question. Although we have no information on this, it is possible that the companies with which they cooperate are

mostly SMEs, and that even before the cooperation they may have had a lower perception of the importance of innovation for their business. But the companies with the greatest interest in innovation are being left out of this cooperation, something which must be quickly corrected by the managers of the technology centres in order to have as positive an impact as possible in the aftermath of the COVID-19 crisis.

An alternative explanation for this paradox is that firms that cooperate with technology centres show a relaxation in their concern to innovate. This could be due to the fact that companies feel supported by an agent of the innovation system. The lower perception of the importance of innovation in the competitive processes of the cooperating firms is therefore caused by the fact that the technology centre offers them knowledge focused on the most appropriate innovation process for each firm or for each ecosystem.

Although our results are conclusive and can serve to correct the actions of the technology centres with a view to economic recovery after the COVID-19 crisis, we must point out some shortcomings. Firstly, the survey used has reduced the volume of interviews carried out year after year since the economic crisis, although the volume is still very high, which allows for a more than correct analysis. Secondly, the anonymity of the sample offered by the INE prevents us from carrying out a time-series analysis, which would have allowed us to obtain more precise results. Finally, and as a challenge, the group of researchers in this article has set out to compare these results with those generated after the COVID-19 crisis in the future, although the slowness of the publication of results will prevent this from being done immediately.

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