# POLICY NOTE OF WORKING PAPER 4.28

## Do spillovers matter? CDM model estimates for Spain using panel data

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### OBJECTIVE

The general aim of this paper is to analyse the current relationship between R&D, innovation and productivity in Spain for the period 2004-2010. We use a structural model to capture the whole process: firm's decision to perform R&D, the amount of money they spend on it, how they turn this investment into innovations and the impact of these innovations on firm's productivity. In particular, the main goal of this paper is to assess the extent to which external knowledge may have an impact on firm's behaviour and performance. Thus, we analyse if firm's decision whether to undertake R&D activities or not is influenced by what other firms in its sector do as well as if firm's productivity is affected by innovation carried out by other firms (in the same sector or in other sectors). Additionally, firm's technology level is taken into account in order to ascertain whether there are any differences in this regard between high-tech and low-tech firms both in industrial and service sectors.

### SCIENTIFIC METHODS

We adopt a modified version of the model proposed by Crépon, Duguet and Mairesse (1998), also known as CDM model, which has been widely used in the literature to study the relationship between R&D, innovation and productivity. The idea behind this model is that firms need not only invest in R&D activities to increase their productivity, but also have the necessary mechanisms to transform their investment into innovations that indeed raise its productivity.

The authors estimate a structural model involving three stages: (i) the firms decision whether to engage in R&D activities or not, and the intensity of their investment in the case they do, (ii) the realisation of innovations from R&D expenditures and (iii) the impact of these innovation on firms productivity. This can be formalised as four sequential equations using the predicted values of one equation as an explanatory variable for the next one. We can summarise the model as follows:

*(i) First stage: The research equations*

The first equation is a selection equation indicating whether the firm performs R&D activities or not, and where our main variable is a spillover measure that tries to capture external knowledge. In particular, we define it as the proportion of firms in the same sector that undertake R&D activities the previous year.

The second equation is the intensity equation where firm's innovative effort is analysed. That is, once a firm has decide to undertake R&D activities, here it is studied how much money they invest in such kind of projects.

*(ii) Second stage: The innovation equation*
This step links the research activities above to innovation output. In this case we define innovation output as process innovation and the main explanatory variable is the predicted value of R&D expenditures obtained in the previous equation.

*(iii) Third stage: The productivity equation*
This last step is modelled by an augmented Cobb-Douglas production function which apart from the traditional inputs (labour and physical capital) also includes human capital, the predicted innovation from the previous equation and spillover. In this stage, two kinds of spillovers are considered: intra-industry externalities and inter-industry externalities. Following the idea behind the CDM model, the definition of spillovers seeks to capture not only the knowledge current in the sector, but also the fact that firms achieve a successful innovation output thanks to this knowledge. For this reason, intra-industry (inter-industry) externalities are defined as R&D expenditures carried out by the rest of the firms in the same sector (or in other sectors) provided that they have achieved a process innovation with their investment. By using this definition we do not take into consideration R&D investment of firms who have not reported any process innovation results.

## POLICY VALUE-ADDED

In view of the findings of this study, it would be interesting design some policies to foster R&D investment from government and public institutions in order to increase productivity levels and become more competitive. First of all, we have seen that the more a firm invests in R&D and the fact that it is done continuously, the more likely to achieve an innovation, which increases its productivity. Given that public funding is a clear determinant not only in the innovative effort but also in the firm's decision whether to engage in R&D activities or not, governments should maintain this financial support even though the current economic situation. It should be borne in mind that cut back public subsidies or any other funding will condition Spanish firms' behaviour. Moreover, as we have seen innovate is a learning process being the probability of achieving an innovation greater when it is done continuously. For this reason, financial support should not be aimed at particular projects, but it ought to be addressed to promote R&D activities in a continuous way.

On the other hand, the more firms undertaking R&D projects, the better, since, as we have seen this increases the probability of starting R&D activities. Moreover, the greater the R&D expenditures in a sector or in other sectors, the more a firm is going to increase its productivity. Thereby, government support to help one particular firm

would overtake the boundaries of this company, having a positive effect on both firm's behaviour as well as firm's productivity. In addition, firm size favour both firm decision whether to engage in R&D activities or not and the probability of achieving a process innovation. However Spanish economy is made up of small and medium firms. For this reason, policies should seek cooperation between these firms in order to palliate their small size, as well as, promote enlargement or fusion of firms. Last of all, the results obtained here point out that operating in international markets is a factor which encourages firms to start R&D projects. Therefore, helps aimed at promoting internationalization are also important and governments should bear this in mind when they design their policies.

Crepon, B., Duguet, E. and Mairesse, J. (1998) Research, innovation and productivity: An econometric analysis at the firm level, *Economics of Innovation and New Technology*, **7,** 115-158.