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## Investigating the Nonlinear Effects of Absorption Capacity and Relative Backwardness on International R & D Inflows and Total Factor Productivity in Developing Countries (Panel Smooth Transition Regression approach)

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## EXTENDED ABSTRACT

### INTRODUCTION

Recent theories regarding economic growth show that research and development (R&D, hereafter) activities are of the most salient factors in the process of science production and play an important role in improving the productivity level of all production agents. That is why, developed countries pay special attention to such activities and allocate and invest high research budgets in these areas. However, due to low R&D budgets and limited capital resources for manufacturing enterprises in developing countries, these countries can benefit from the overflow of international R&D activities, hence improve the total productivity of their production agents. But the important issue is that, some internal and/or external factors, such as the absorption capacity of countries and/or the degree of their relative backwardness can affect the impact mechanism of the overflows with regard to productivity and cause some possible nonlinear effects. To investigate these possible nonlinear effects, more flexible methods are required to enable appropriate identification and investigation of the behavior of these factors in terms of the impact mechanism of international R&D spillovers.

Accordingly, in the present study, the threshold effects of absorption capacity and relative backwardness on international R&D overflows in developing countries is investigated. The nonlinear panel smooth transition regression (PSTR) is used in order to investigate the subject matter of the current study within the time period of 1995-2015. For this purpose, the impact channel of international research and development overflows on the total efficiency of production factors was used; in two separate estimates, the effectiveness of the two variables of absorption capacity transfer and relative backwardness on the performance of international R&D overflows, and consequently the total productivity of the production factors were examined.

### METHODOLOGY

Given that in regression models based on panel data, heterogeneous temporal and cross-sectional effects in the data are determined by the fixed and random effects model, and in such models the elasticities (coefficients of variables) ) Between countries and over time, a linear equation cannot allow changes in the productivity of total factors of production to reflect all possible nonlinear effects relative to the R&D overflow. In this study, in order to investigate and test the relationship between variables, the panel model uses a gentle panel regression econometric technique. For this purpose, following the study of Gonzalez et al. (2005) and colitis and Harolin (2006), a two-diet PSTR model with a transfer function is first defined as follows:

$$\begin{aligned} \ln TFP_{it} = & \alpha_i + \beta_0^d \ln S_{it}^d + \beta_0^h \ln H_{it} + \beta_0^f \ln S_{it}^f + \\ & \left[ \beta_1^d \ln S_{it}^d + \beta_1^h \ln H_{it} + \beta_1^f \ln S_{it}^f \right] G(q_{it}; \gamma, c) + \varepsilon_{it} \end{aligned}$$

In relation (1),  $i = 1, \dots, N$  and  $t = 1, \dots, T$ , respectively, represent the sections and time dimensions of the panel data. The dependent variable indicates the productivity of all factors of production, and the independent variables, respectively, indicate the overflow of domestic R&D, human capital and the overflow of international R&D. The fixed effects of sections and sentences are model errors that are considered as follows. It also represents a continuous and finite transfer function between zero and one. According to the theoretical and experimental foundations in the field of study, in this study, the variables of absorption capacity and relative backwardness (degree of development) have been selected as the transfer variable.

### FINDINGS

According to the results and considering the threshold effects of absorption capacity and relative backwardness, the international R&D overflows impact factor on the total productivity of production factors increases. In other words, the results showed that, the variable of absorption capacity, which is equivalent to the average years of human resource training, has a positive and significant effect on the international R&D overflows impact with regard to the total efficiency of production factors in developing countries. That is, by increasing the threshold limit of absorption capacity, the effect of overflows on the productivity also increases. Therefore, developing countries need a certain amount of human resource training in order to enable them to benefit from the effects of the international overflow on total productivity of the production factors. Also, the relative backwardness index acts directly, and with an increase of technological gap in developing countries and moving away from the leading country (the United States is considered in the current study) the extent of the international overflows impact on the total productivity of production factors increases. But this increasing trend will exist to some extent of the backwardness. Of course, it is worth noting that, according to the results, this direct relationship is established up to a certain threshold level of the absorption capacity and relative backwardness in developing countries and in countries with very high absorption capacity or are greatly lagging behind. The linear regime determines the behavior of variables and as such, the influence coefficient of overflows on the total productivity of production factors in these countries is reported to be weaker.

## CONCLUSION

Therefore, in order to reap the benefits of R&D international overflows to improve their productivity, it is recommended that developing countries should identify their potentials in international trade and consider the areas of R&D overflows that benefit them most. In addition, by efficiently training and educating specialized human resources and strengthening the internal absorption capacity, these countries will be able to absorb and localize new technologies and provide the ground for absorbing as many overflows as possible. Also, by proper policy-making in the use of domestic resources, these countries can allocate appropriate budgets for domestic R&D activities and seriously monitor them by strengthening domestic production to varying degrees of development. Accordingly, they might become able to reduce their technological gap from leading countries so that they can make the most out of their international trade, and by attracting more foreign technologies, compete effectively in the global arena and benefit from overflows to improve their productivity.

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#### Appendix:

The list of developing countries used in this study is as follows: Australia, Austria, Belgium, Denmark, Finland, Greece, Iceland, Ireland, South Korea, Lithuania, Luxembourg, Netherlands, Norway, Portugal, Singapore, Slovakia, Slovenia, Spain, Russia, Argentina, Brazil, Iran, Malaysia, Peru, Romania , Thailand, Turkey, China, Bulgaria, Colombia, Mexico, Kazakhstan, Armenia, India, Philippines, Ukraine, Burkina Faso, Paraguay, Egypt, Kyrgyzstan, Moldova, Nigeria.