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"IMPLEMENTATION OF THE CDM MODEL TO THE ANALISYS OF THE HOTEL SECTOR"

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1. Aim

The main aim of this study was to determine the impact of innovation on productivity in service sector companies — especially those in the hospitality sector — that value the reduction of environmental impact as relevant to the innovation process. We used a structural analysis model based on the one developed by Crépon, Duguet, and Mairesse (1998). This model is known as the CDM model (an acronym of the authors' surnames). These authors developed seminal studies in the field of the relationships between innovation and productivity (see Griliches 1979; Pakes and Grilliches 1980). The main advantage of the CDM model is its ability to integrate the process of innovation and business productivity from an empirical perspective.

2. Methodology

The CDM model approach used in this study is specified by a system of recursive nonlinear equations without feedback effects that are divided into three stages. In line with Griffith et al. (2006), the structural CDM model is very simple: firstly, a company decides if it wants to engage in some type of innovation and calculates the cost of this effort; secondly, innovation is produced as a result of the investment; and finally, production is conducted using this innovative knowledge in collaboration with other production factors. These three basic stages follow the sequence of a company's decisions in terms of innovation activities and results (Hall et al., 2009), and are represented in the four equations used in the econometric model presented. These four equations are as follows:

A: *R & D equations*: In this model, the first decision that the company has to make concerns the possibility of investing in R & D and its cost. This decision may be described

by two equations: the first that allows to select companies that decide to invest in R&D; and the second that determines the company's innovative intensity or effort. This procedure was developed based on Heckman (1979) selection model.

B: *Innovation or knowledge production equation*: The innovation production equation takes into account three areas of innovation (in products, processes, and the organization) as sources of improvements in the firms' productivity. The probability of implementing each of these types of innovation will be influenced by the innovative effort predicted in the previous stage. This stage was developed using the simulation method for trivariate probit regression using the STATA statistical software package. This approach was suggested by Cappellari and Jenkins (2003), which uses the Geweke-Hajivassiliou-Keane (GHK) simulation method for maximum likelihood. This stage generates a predicted value for each of three probabilities of making innovations (in the product, process, and the organization) that are used as explanatory variables in the final stage.

C: *Productivity equation*: The third equation of the proposed model includes the impact on production of the three types of innovation on work productivity. Under a Cobb-Douglas technology, companies produce goods or services whose inputs are capital, labour (with constant returns to scale), and knowledge or product, process and organizational innovation. This relationship can be expressed as follows:

$$y_i = K_i\alpha_1 + L_i(\beta_1 - 1) + g_{i,1}\pi_1 + g_{i,2}\pi_2 + g_{i,3}\pi_3 + o_i\omega + v_i$$

3. Results/Findings

The database used in this study comes from the Technological Innovation Panel (PITEC). As described in the Spanish R+D+I Observatory website[1], PITEC is a panel type database (for 2008-2013), which was developed jointly by the Spanish National Institute of Statistics (INE) and the Spanish Foundation for Science and Technology.

For the sake of brevity, we only present the results of the final stage of the CDM model in Table 1, in which the dependent variable is the logarithm of labour productivity.

Table 1. Productivity equation.

Variables	Coefficient	SD	
Predinnoprod	0.0794**	0.0339	Obs. 7433 (1703 firms)
Predinnoproc	0.0433*	0.0111	Adjusted R^2: 0.2107
Predinorgn	0.1319*	0.0427	F test: F(15, 7417), 133.29*
Capital stock (log)[1]	0.1792*	0.0078	RSS: 7745.17
Number of workers (log)[1]	- 0.1598*	0.0122	[1]Wald test H_0: $\alpha_1+\beta_1=1$: 4.14 (0.0420)
Belongs to a business group	0.2708*	0.0290	Notes: Significant at: * 1%, ** 5.
Foreign capital participation	0.2065*	0.0478	White-corrected standard errors.
Hospitality	- 0.3561*	0.0644	The coefficients of the variables
Company based in Madrid	0.2056*	0.0323	corresponding to the year of each
Company based in Catalonia	0.1799*	0.0322	observation have been estimated.
Company based in Andalusia	- 0.1108**	0.0452	Source: PITEC
Cons.	9.2328*	0.0966	

4. Conclusions

1. The development of innovations in products, processes, and business organization in service companies that take into consideration the reduction of environmental impact among its objectives is positively and significantly associated with productivity. The impact of organizational innovation is greater than that of product and process innovation (7.94% and 4.33%, respectively) reaching a value of 13.19%.

2. The elasticities of the productivity in relation to the production factors (α_1= 0.1792 and β_1= 0.8402) suggest constant returns to scale.

3. Belonging to a business group and the participation of foreign capital is also positively related to productivity (27.08% and 20.65%, respectively).

4. Service companies based in Madrid and Catalonia have better productivity than those in the rest of Spain (20.56% and 17.99%, respectively). In contrast, companies based in Andalusia have 11.08% lower productivity than those in the rest of Spain.

5. Companies in the hospitality sector that value the reduction of environmental impact as an innovation aim had 35.61% lower productivity than the other service sector companies in the sample.