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Innovation behavior and the use of research and extension services in small-scaled agricultural holdings

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Abstract

The aim of this research is to analyze the influence of farmers' innovation behavior on the use of research and extension services. Formulating a structural equation model, the authors examined the relationship between key factors of innovation behavior (market orientation, learning orientation, innovation attitude) and the use of research and extension services.

Keywords: *Market orientation, learning orientation, innovation attitude, extension services, structural equation model, agricultural innovation.*

1. Introduction

In the context of the EU strategy for this decade, innovation needs to be introduced in a smarter, sustainable and inclusive economy, in order to face a situation of 'innovation emergency' [1]. In accordance with the challenges that the agricultural sector face nowadays, farmers need timely access to knowledge and information, and to training and education. This has to be facilitated by agricultural knowledge and innovation services [2], which are currently promoted by the European Commission, within Horizon H2020 and the new rural development plans (RDP). The present contribution explores the ability of small-scaled agricultural holdings to adopt the instruments of knowledge transfer supplied by available research and extension services (RES). Are innovative farmers more prone to use such services? This research will allow to performing an evaluation of the effectiveness of the existing RES to meet farmers' needs. This may be the case of the region of Spain (Valencia), where we evaluate this topic by investigating a sample of farmers (253), with strong presence of small and medium sized farms. A survey was carried out to explore the relevance of farmers' strategic and cultural variables such as market orientation and learning orientation and their link with their innovation attitude, and if such factors affect the farmers' decision of using RES. Previous literature has described the agriculture sector in Spain as a low R&D intensive sector [3][4][5]. Agriculture innovation is relevant for the successful development of sustainable food production [6]. EU agricultural policies tend to positively assess measures that enhance market orientation and innovation of agricultural holdings [7]. Understanding the innovation behavior of agricultural holdings is a crucial step to design rural development strategies [8]. This contribution follows a Structural Equation Modelling (SEM) methodology based on a theoretical framework that we define in the next section.

2. Theoretical Framework

There are several behavioral and cultural factors that affect farmers' use of RES. In the present contribution we explore Market Orientation (MO), Learning Orientation (LO) and Innovation attitude (IAT), and we establish some hypothesis about their interdependences and their possible link with the use of RES.

MO has been extensively studied since the 90s. Narver and Slater (1990) [9a] observed MO as an organizational culture. In contrast Kohli and Jaworski (1990) [10] consider market orientation as a behavioral process. Recent works indicate that MO can be significantly boosted by the business ecosystem and national contexts [11]. In this paper we consider market orientation as a possible antecedent of the innovation behavior [12a][13] leading to our first hypothesis (H1) that MO has a positive impact on IAT.

LO refers as an organizational wide activity that uses knowledge to enhance competitive advantages [14a]. LO has an impact on the firm's organization using information and active learning [12b][15]. A considerable deal of research has suggested a relationship between LO and MO [16][17][18][19]. Cohen and Levinthal (1990) [20] proposed that LO is significantly associated with innovative thoughts in firms, and Trice and Beyer (1991) [21] asserted that MO and LO are very closely associated in the innovation process. Therefore we propose the hypothesis that LO has a positive impact on IAT (H2) and that LO positively correlates with MO (H3). Innovation processes are characterized by the involvement of many actors with multiplicity of interactions from which potential barriers may appear [22][23]. In our research, RES are thought to improve technological, economical and institutional changes in agriculture [24][25][26][27][28]. Labarthe et al. (2013) [29] represent the research and extension services "as the entire set of organizations that will enable the farmers to co-produce farm-level solutions by establishing services relationships with advisers so as to produce knowledge and enhance skills". Previous research has demonstrated that RES hide a huge diversity of conceptions and methods [30], including the importance of social interaction as well as the role of the external advisors. In the EU context the policies for RES has been revitalized during the last RDP, to empower human capital in agriculture [31]. Pascucci and Magistris (2012) [32], explored the extent to which farms react to this supporting services and also point towards the implicit effect of the IAT, which we hypothesized to have a positive impact on the demand for RES (H4). What needs to be clarify is if IAT mediates the positive influence between MO and RES (H5a) or LO and RES (H5b), so understanding the true motivations for farmers to use RES becomes crucial. In order to test such hypotheses, a SEM is built to examine and to measure the interaction between MO, LO, IAT and RES.

3. Data and preliminary analysis

A farmers' survey was designed for the Agrinnova Project[1]. The questionnaire contained a measuring scale from previous studies to relate factors to be measured through a series of variables or constructs. Data was collected from May to December of 2012, with 253 respondents returning usable surveys. Respondents provided answers using a seven-point Likert scale (1=strongly disagree, 7=strongly agree). The set of items from the questionnaire related to measures of MO, LO, IAT and use of RES those were adapted from previous research and well-accepted scales. For MO, we adopted 6-item from the previous work [9b].

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LO, was measured on a 6-item scaled development by Hurley and Hult (1998) [12c], Johnson et al. (1997) [33], Hult (1998) [34] and Calantone et al. (2002) [14b]. IAT, was measured on a 6-item scale from previous research of Harrison et al. (1997) [35] and, Venkatesh and Davis (2000) [36]. A use of RES scale was adapted from previous works by Segarra-Blasco and Arauzo-Carod (2008) [37], and Schwartz and Hornych (2010) [38]. We controlled for age and education level [39] as well as for farm size in terms of gross margin turnover [40], which can explain the effect of available resources on farmers' choices [41][42]. The farm holder profile of the final sample was, on average, 48 years of age, 49% of respondents with no studies or only basic education, and 66% of holdings with an average gross margin of less than 20,000 euros which represents the dominance of small holdings in the Valencia region. As a result of the confirmatory factor analysis (CFA) and removal of few items without significant impact on the factors reliability, internal consistency was examined through Cronbach's alpha for each factor, with values of 0.61 for RES (3 items), 0.89 for IAT (6 items), 0.77 for MO (3 items) and 0.7 for LO (3 items). [43]

4. Structural equation modeling

We examined the research model represented in the path diagram by Maximum Likelihood (Figure 1). The result of the CFA indicated a correlation among MO, LO, IAT and, RES, all variables showing significant relationships. Also all individual items showed acceptable factor loadings (>0.50) and significant p-values (***p <0.01). The measurement of the CFA model had a Chi-square ($x^2 =$ 125.967), df =81, and p = 0.001; and the CFA model fit indices: x^2/df= 1.555, CFI = 0.929, GFI = 0.938, RMSEA = 0.47 indicate that the data fit the model in a satisfactory way.

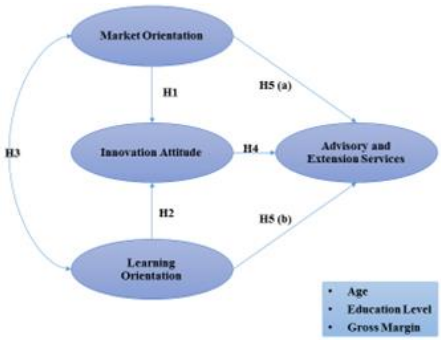

Figure 1. Path Diagram and hypothesized relationships

The correlation measured gives a $coefficient = 0.756$; (p =***) for the relationship between MO and LO, thus confirming H3. With a Chi-Square ($x^2 =$ 159.137), $df = 121$, and the p = 0.011 the structural model fit indices: x^2/df = 1.315, CFI = 0.977, GFI = 0.936, RMSEA = 0.35 are considered adequate to estimate the model. The results of the path analysis were decomposed into direct, indirect and total effects, in order to examine the all the others hypotheses. The result of the direct effects indicates a significant and positive relationship between MO and IAT, and between LO and IAT. However, the direct relationships

are not significant between IAT and RES. Thus H1 and H2 are supported, but H3 was rejected. As for control variables, only education showed a significant and positive effect, and farm holder's age and gross margin were not significant (Table 1).

Table 1. Parameters estimated for the model path: direct effect

Path			γ	p-value
MARKET ORIENTATION	--->	INNOVATION ATTITUDE	0,414	0,001
MARKET ORIENTATION	--->	RESEARCH EXTENSION SERVICES	0,034	0,853
LEARNING ORIENTATION	--->	INNOVATION ATTITUDE	0,316	0,018
LEARNING ORIENTATION	--->	RESEARCH EXTENSION SERVICES	0,456	0,023
INNOVATION ATTITUDE	--->	RESEARCH EXTENSION SERVICES	0,134	0,269
GROSS MARGIN	--->	INNOVATION ATTITUDE	-0,019	0,711
GROSS MARGIN	--->	RESEARCH EXTENSION SERVICES	-0,135	0,079
EDUCATION LEVEL	--->	INNOVATION ATTITUDE	0,125	0,019
EDUCATION LEVEL	--->	RESEARCH EXTENSION SERVICES	0,202	0,011
AGE	--->	INNOVATION ATTITUDE	-0,008	0,877
AGE	--->	RESEARCH EXTENSION SERVICES	0,082	0,260

** $p < 0.0$

In order to test the mediation role played by IAT between entrepreneurial factors (MO-LO) and RES use, we evaluated the results for the direct effect with and without mediator [44], and the resulting indirect effects [45]. For MO, direct effects with mediator and without a mediator were not significant. For LO, the result was significant only without the mediator $Coefficient = 0.501;\ p = 0.011$). The result of the indirect effects were not significant in both cases, questioning the role of IAT in the use of RES. (Table 2)

Table 2. Parameter estimates for the model path: mediation and indirect effects

Path	Direct effect without Mediator	Direct effect with Mediator	Indirect effect
MARKET ORIENTATION--->INNOVATION ATTITUDE---> RESEARCH EXTENSION SERVICES	0,085(0 ,644)	,034 (0,853)	0,273
LEARNING ORIENTATION--->INNOVATION ATTITUDE---> RESEARCH EXTENSION SERVICES	0,501 (0,011)	,456 (0,269)	0,164

The quantity in brackets refers the $p - value;$ ** $p < 0.05$

5. Discussion and conclusions

Even in context of agricultural systems dominated by small-scaled farming, MO and LO appear to be positively related, which confirms that synergies between both factors to provide a background for innovativeness [46]; MO and LO also show positive and significant effects on IAT, indicating that SMEs are likely to adopt innovations in contexts were resilience is enhanced by MO and LO as cultural values. By contrast, IAT does not appear to be a mediator in any of the relationship tested between MO, LO on the one hand, and RES, on the other. LO, keeps a significant direct effect on RES, suggesting that education and learning cultural values remain the key factor for small-scaled holding to use RES in the studied region. This is confirmed by the significance of the education level as a control variable, which appear to be more relevant than holder's age and holding size. Previous research suggest that young farmers and large holdings are more inclined to innovation activities [47] which points to the need for further research in other regions where there is a wider range of ages and farm sizes than in Valencia where small farmers are dominant. The role of RES is enhanced by LO, but innovative firms do not attach high values to RES. This result would invite to reflect about the way RES are functioning as a knowledge providers rather than entrepreneurship accelerators. RES need to be adapted to a dynamic ecosystem where RES supply innovation support services [48]. Our study seems to indicate a possible gap between RES users and providers of public services. Ongoing work within the present programing period for RDP should focus on bridging such gap by promoting operational groups, networking and a reflecting on the future role of regional technological centers.

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