UNDERSTANDING INNOVATION IN A DYNAMIC AGRICULTURAL BUSINESS ENVIRONMENT: A MULTIVARIATE APPROACH

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Abstract

Some researchers have found that farmers' participation in social and commercial networks is an important driver of innovation in rural areas. The present article extends this traditional research with the objective of determining whether this result also holds in turbulent market conditions (i.e. dynamic business environments) caused by policy reforms. A probit analysis based on a proposed model of innovation revealed that in these environments, variables other than network participation (e.g. psychological variables) are involved in farmers' capacity to innovate.

Keywords: Networks; Innovation; Dynamic Business Environments

Theme Group: Innovation and leadership

Introduction

The capacity to innovate or innovative capacity (IC) is defined by Wang and Ahmed (2007) as "a firm's ability to develop new products and/or markets, through aligning strategic innovative orientation with innovative behaviours and processes (p. 38)". According to these authors, IC is composed of five interlinked areas: (*i*) product innovativeness; (*ii*) process innovativeness; (*iii*) market innovativeness; (*iv*) behavioural innovativeness; and (*v*) strategic innovativeness. Product innovativeness is defined as the novelty of new products introduced to the market in a timely fashion. Process innovativeness is related to the introduction of new production methods, new management approaches and new technologies that can be used to improve production and managerial processes. Market innovativeness is related to the novelty of market oriented approaches. Behavioural innovativeness corresponds to the formation of innovative cultures that are more receptive about the introduction of new ideas and innovation. Finally, strategic innovativeness is referred to the development of new competitive strategies that create value to the firm. In other words, this innovativeness consists of identifying external opportunities in order to deliver new products and explore new markets.

According to Delmas (2002), the capacity to develop IC depends on the ability to absorb and assimilate relevant external information. Macpherson *et al.* (2004) argue that this information can be found in networks related to new markets and within the supply chain. It is for this reason that participation in formal and informal networks has been considered as playing an important role in the development of IC in rural areas (Boahene *et al.,* 1999; and Virkkala, 2007). On the other hand, Harryson *et al*. (2008) explain that the essence of an innovative firm is the ability of an organization to adapt to market change and is influenced by the organizational integration of a skill base and the speed at which new competencies and skills can be developed to match the demands of the new technologies. The authors argue that participation in networks not only helps firms to develop IC by means of the acquisition of relevant information, but also helps organisations to obtain this information at the speed that is needed to innovate in response to rapidly changing environments (a similar argument has been provided by Wang and Ahmed, 2007). If this argument were verified, then farmers' participation in networks would constitute an important strategy to adjust to exogenous shocks such as the implementation of policy reforms. However, there is evidence showing that farmers, even when participating in networks, have not innovated in response to these

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policy changes. In other words, they have not introduced either new profitable products to the market at a timely fashion, or new production methods, or new management approaches and new technologies, or new market oriented approaches, or new competitive strategies that create value to the farm business. For example, some sugar beet farmers of the West Midlands of the UK (ESBF) did not innovate in response to the Sugar Regime reform introduced by the European Union on 20th February 2006 because they replaced sugar beet with low return traditional crops (*e.g*. oilseed rape and oats) even when participating in different commercial networks (May, *et al*., 2010). This evidence suggests that the effectiveness of network formation in driving innovation in dynamic environments depends on the nature of the business environment change. That is, most of the academic works studying the relationship between network formation and innovation in dynamic environments have considered technological change as the driver of business environment change. However, little attention has been paid to policy reforms as business environments' destabilisers. Since policy changes can be considered as single exogenous shocks rather than continuous technological changes, it is possible that relevant information obtained from networks cannot diffuse at the needed speed to quickly generate innovative responses to these policy reforms. As a consequence, it cannot be guaranteed that farmers' participation in networks can help these individuals to develop IC in dynamic business environments.

Researchers have considered other factors that could eventually affect farmers' capacity to innovate in response to policy changes. For example, two different types of tactical alliances have been found to help firms to adjust in dynamic environments because they can be formed relatively quickly in response to exogenous shocks. One of them, referred to in this article as *informational tactical alliance*, corresponds to alliances that facilitate the diffusion of the information that is needed to innovate in turbulent conditions. According to Hagedoorn and Duysters (2002), these alliances can help firms to increase negotiation power. This, in turn, allows these individuals to enter in new markets and to obtain the information that is needed to innovate. The other type of tactical alliance, referred to in this article as *investment tactical alliance*, corresponds to alliances that help farmers to innovate in dynamic environments in activities that demands high capital expenditure (*e.g*. expensive machinery used for the production of highly profitable crops). The reason is that these alliances offer the opportunity to spread the risk of this form of investment (Stiles, 1995). Researchers have also identified socioeconomic factors that can affect farmers' incentives to innovate such as education and farm size. Regarding education, Knight *et al*. (2003) found that this factor affects farmer's attitudes toward risk. This finding suggests that farmers who have received formal education (*i.e*. years of schooling of the household head including primary and secondary education) are more willing to innovate in dynamic environments because they are more risk averse. Regarding farm size, Boahene *et al*. (1999) found that large-scale farmers have more access to bank loans and this strongly increases their chance of innovation in response to exogenous shocks in comparison to small-scale farmers. Finally, innovation can also be affected by less obvious channels related to social and psychological factors affecting farmers' strategic decisions. For example, a farmer who values family farm tradition is probably less willing to innovate in new non-traditional technologies or enterprises. This line of argument has been developed using two different approaches: the multiple goals approach and the theory of planned behaviour. The multiple goals approach argues that farmers consider economic and non-economic goals when making their decisions (see for instance Gasson, 1973; and Solano, *et al*., 2001). The theory of planned behaviour, on the other hand, was proposed by Ajzen (1985) and establishes that intention is a good predictor of behaviour, and that intention is determined by attitudes, subjective norms and perceived behavioural control. That is, a person will have an intention (motivation) to behave in a particular way when she/he has a positive attitude towards this behaviour (*i.e*. attitudes), when the people who are important to him/her think that he/she should perform this behaviour (*i.e*. subjective norms), and when the person has the conviction that she/he will successfully execute a behaviour leading to a particular outcome (*i.e*. perceived behavioural control). Researchers have used the theory of planned behaviour to identify the underlying determinants of farmers' behaviour (see Beedell and Rehman, 2000; and Zubair and Garforth, 2006). In the case of innovation, it is possible

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that farmers' decisions on adopting innovative strategies also depend on their goals, attitudes towards different aspects of the farming activity, perceived behavioural control, and subjective norms.

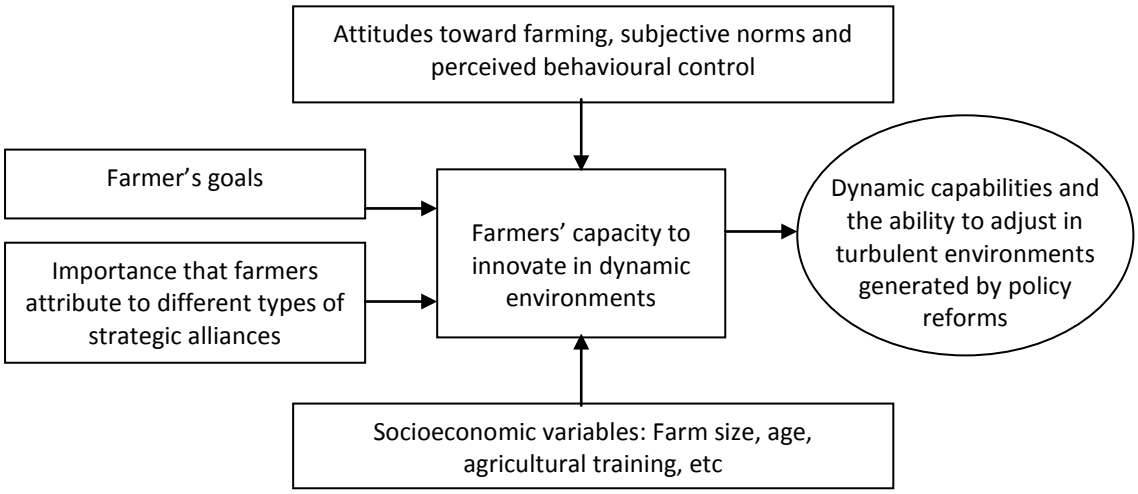
The objective of the present article is to gain an understanding of the factors that favour innovation in turbulent market conditions generated by policy reforms. For this purpose, a multivariate model of innovation that integrates possible drivers of innovation in dynamic business environments has been designed and applied to a sample of ex-sugar beet farmers of the West Midlands region of the UK (ESBF). A probit analysis based on the proposed model revealed that the capacity of these farmers to innovate in the turbulent environment generated by the Sugar Regime reform depended on different factors including socio-psychological drivers, but not on farmers' participation in social and commercial networks. This result suggests that policy recommendations obtained from academic works that have been developed considering technological changes have to be considered with caution.

The paper has been organised as follows: Section 2 shows the proposed multivariate model; Section 3 explains the methodology used in the research; results are presented in Section 4; and finally, Section 5 concludes the paper.

The proposed multivariate model

A farmers' decision making framework that integrates the multiple goals approach and the theory of planned behaviour was developed by Bergevoet *et al*. (2004). This integrative framework is referred to as a multivariate model. The multivariate model proposed in this paper extends the contributions of Bergevoet *et al*. (2004) with the objective of determining whether farmers' capacity to innovate in turbulent environments generated by policy changes is explained by the determinants described in the introduction. This model is presented in Figure 1.

Figure 1: Multivariate model of innovation in dynamic business environments



Source: Elaborated by the author based on the model developed by Bergevoet *et al*. (2004)

This model has been designed to test the following hypotheses:

H1: Farmers' capacity to innovate in turbulent business environments caused by policy changes is determined by farmers' participation in social and commercial networks; the capacity to form tactical alliances; by socioeconomic variables; and by socio-psychological variables.

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H2: Farmers' capacity to innovate in turbulent business environments caused by policy changes is determined by the capacity to form tactical alliances; by socioeconomic variables; and by socio-psychological variables.

Considering the proposed model, it is expected H1 to be rejected and H2 not to be rejected.

Methods and materials

A questionnaire was used to collect the relevant data on: (*i*) farmers' capacity to innovate after the incorporation of the Sugar Regime reform (SRR); (*ii*) the importance that farmers attributed to tactical alliances as tools to reduce market risk after the SRR; (*iii*) the importance that farmers attributed to tactical alliances as tools to increase negotiation power after the SRR; (i*v*) different statements on farmers' goals, attitudes toward farming, perceived behavioural control, and subjective norms; (*v*) socioeconomic variables including farmers' education (*i.e*. formal agricultural training such as Bachelor degrees or diplomas obtained from either colleges of universities), and farm's size measured as area of the farm in hectares; and (*vi*) farmers' participation in networks after the SRR. A five point Likert scale was used for questions included in groups (*ii*), (*iii*) and (*iv*). A dummy variable was used to reflect farmers' education. Likewise, a dummy variable was adopted to reflect farmers' participation in networks.

According to DEFRA (2010) statistics, the number of sugar beet growers in the West Midlands region in 2005 was 592. In order to obtain a sample of these farmers, 48 ESBF were sampled which correspond to 8.1 per cent of this total and had a 100% response rate. This sample was collected in a period of six months. The data collection method was based on a combination of cluster, stratified and snowball sampling techniques. The reason for using them was that there was not a list of ESBF available in the public domain. Before adopting these techniques, different unsuccessful attempts to obtain a random sample were made.

The sample cluster was selected considering the most relevant counties of the West Midlands region in terms of the number of ESBF. They corresponded to the counties of Shropshire, Worcestershire, Herefordshire, Staffordshire and surrounding areas accounting for 48%, 15%, 14%, 12% and 11% of the total sugar beet farm holdings in 2005, respectively. The sample considered relatively similar proportions for these counties in terms of the number of farmers that participated in the investigation accounting for 46%, 15%, 13%, 15% and 13%, respectively. A similar approach was adopted by the Rural Business Unit of the University of Cambridge and The Royal Agricultural College (2004) but in terms of regions rather than counties. The sample stratification was made considering the size of the farm in terms of the number of hectares. It was not possible to find official statistics on this variable. Nonetheless, a criterion was established based on the opinions of the 10 farmers that formed the pilot sample. The precaution was taken to include a balanced number of farmers to the classes defined by this measure. Table 1 shows the sample distribution for each county considering these criteria.

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Table 1: Sample distribution of farm sizes for each county

	FARM SIZE (Percentage)		
COUNTY	**Small < = 200 ha**	**Medium 200<600 ha**	**Large > = 600 ha**
Shropshire	30	52	18
Worcestershire	37	50	13
Herefordshire	17	66	17
Staffordshire	0	83	17
Rest	40	40	20
Whole sample	**27**	**56**	**17**

The snowball technique was developed separately in each relevant county. As a result, it was possible to find a number of ESBF that is consistent with the sample cluster strategy defined above. Given the difficulty of gathering data from primary sources, given the small population of ESBF, and given the limited budget supporting the present research, the sample used in this study was considered as appropriate in this context.

A probit analysis was used to identify the drivers that explain farmers' capacity to innovate in dynamic business environments. These individuals were explained the meaning of innovation used in the research. This meaning was based on the definition provided by Wang and Ahmed (2007) (see the introduction of the paper). Using this definition, farmers had to report that they were able to innovate if they developed at least one of the five interlinked areas described by these authors. Farmers who responded that they had the capacity to innovate after the implementation of the SRR were assigned a value equal to one. In contrast, farmers who responded that they were not able to innovate were assigned a value equal to zero. The variable p_i summarises this information. That is, p_i = 1 for farmer *i* means that this agent responded that he/she had the capacity to innovate after the implementation of the reform. Conversely, p_i = 0 for farmer *i* means that this agent responded that she/he did not have the capacity to innovate. The probit model is presented as follows (see Dougherty, 2007, and Davidson and Mackinnon, 1993):

$$p_i = \int_{-\infty}^{Z} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}Z^2} dZ \qquad (1)$$

where Z is a linear combination of farmers' goals (G_i), farmers' attitudes toward farming (A_j), perceived control (P_k) , subjective norms (N_l), importance that farmers attributed to tactical alliances as tools to reduce market risk (*TA1*); importance that farmers attributed to tactical alliances as tools to increase negotiation power (*TA2*); socioeconomic variables (SE_n); and farmers' participation in networks (*Net*). Considering all these variables, the linear combination Z is defined as:

$$Z = \beta_0 + \sum_i \beta_i G_i + \sum_j \beta_j A_j + \sum_k \beta_k P_k + \sum_l \beta_l N_l + \beta_{SA1} TA1 + \beta_{SA2} TA2 + \sum_n \beta_n SE_n + \beta_{Net} Net \qquad (2)$$

The probit model was estimated using Maximum Likelihood.

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Results and discussion

Of the farmers in the sample, 39.6% responded that they had the capacity to innovate when the Sugar Regime reform was incorporated. In contrast, 60.4% of these farmers responded that they did not have this capacity.

In order to test hypotheses H1 and H2, the probit model described in equations 1 and 2 was estimated. For this purpose, a bank of questions regarding each group of variables (*i.e*. farmers' goals, *G*; attitudes towards risk, *A*; perceived behavioural control, *P*; subjective norms, *N*; tactical alliances, *TA*; socioeconomic variables, *Edu* and *Size*; and participation in networks, *Net*) were utilised. The estimated model is presented in Table 2.

Table 2: Regression model for innovative capability

	(a)	(b)
Variables	Dependent variable p_i (n = 48)	Dependent variable p_i (n = 48)
Intercept	-16.69** (-2.25)	-17.51** (-2.41)
A4	3.45** (2.30)	3.93** (2.53)
P7	-2.20** (-2.55)	-2.32*** (-2.70)
N4	1.05*(1.89)	1.07**(1.97)
TA1	-2.79** (-2.23)	-2.42** (-2.13)
TA2	2.42** (2.12)	1.95** (2.03)
Edu	3.96** (2.36)	3.90** (2.46)
Size	-0.01*** (-2.70)	-0.01*** (-2.77)
Net	1.00 (0.98)	
McFadden R^2	0.63	0.60
S.E. Regression	0.34	0.33

*P < 0.1, **P < 0.05, *** P < 0.01, z–ratios in parenthesis.

Tables 2(a) and 2(b) shows that the variables *A4*, *P7* and *N4* of groups *A, P* and *N*, respectively, and the variables *TA1, TA2, Edu* and *Size* were all statistically significant (the meaning of these variables are formally explained below). The variable *Net*, in contrast, was not significant (this variable was excluded from the model in Table 2(b) with the objective of identifying whether the coefficients of the significant variables remained relatively stable). This implies that farmers' participation in networks does not explain farmers' capacity to innovate in turbulent business environments. As a result, the hypothesis H1 has been rejected. The rejection of H1 supports our argument that farmers' participation in networks does not necessarily help farmers to innovate in turbulent environments caused by policy reforms. As mentioned in the introduction, it is possible that relevant information obtained from social and commercial networks cannot diffuse at the needed speed to quickly generate innovative responses to these policy reforms. This suggests that there exist barriers that prevent this information from diffusing fluently across the actors that participate in these networks. The study of these barriers and their impact on the capacity to innovate in dynamic environments is left for future research.

The variables that resulted to be significant imply that the capacity of the ESBF to innovate in turbulent conditions was determined by the formation of tactical alliances; by socioeconomic variables; and by socio-psychological variables. As a consequence, the hypothesis H2 has not been rejected. These variables are explained as follows.

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a) *I regularly negotiate with suppliers and buyers* (*A4*): According to Table 2(b), farmers who had a more active participation in the supply chain had higher chance to develop IC in response to the SRR. This indicates that it was not network participation itself that provided these individuals the capacity to develop IC in this turbulent condition, but the intensity by which these individuals interacted with different actors of the supply chain. It is possible that the information that is needed to innovate can be obtained easily when this intensity is high.

b) *I don't make plans because they don't work out in reality* (*P7*): According to Table 2(b), this variable decreased the probability of developing IC in dynamic environments. This result can reflect the case of farmers who did not have full control over their resources. If they had, then they would have made plans. This lack of control over resources could be coupled with a lack of capacity to innovate. In other words, this result suggests that farmers who had limited control over their resources were less prepared both to make plans and to innovate in response to exogenous shocks.

c) *The increasing amount of regulation interferes with my plans for the future* (*N4*): According to Table 2(b), this variable increased the probability of developing IC in dynamic environments. A possible explanation for this result is that farmers who had faced increasing regulation had developed the skills to overcome this barrier by means of innovation. But these skills can be considered as a positive externality for the development of IC in turbulent environments caused by policy reform.

d) *Collaborative alliances to reduce market risk* (*TA1*): According to Table 2(b), this variable decreased the probability of developing IC in dynamic environments. This result is surprising and unexpected. As mentioned in the introduction, this type of alliance can help innovation that demands high capital expenditure because they offer the opportunity to spread the risks of this form of investment (Stiles, 1995). But the result obtained in the probit analysis indicates the opposite. A possible explanation for this result is that farmers who faced capital constraints were unable to invest in innovative activities, even when reducing market risk by means of the formation of strategic alliances. As a consequence, resources that were useful to develop IC in dynamic environments were wasted when applying them in the formation of these useless alliances under the existence of capital constraints. In fact, a significant number of farmers in the sample reported that they faced these limitations.

e) *Collaborative alliances to increase negotiation power* (*TA2*): According to Table 2(b), this variable increased the probability of developing IC in dynamic environments. This result is consistent with the argument given in the introduction. That is, the formation of this type of tactical alliances can help firms to increase negotiation power allowing farmers to enter in new markets and to obtain the information that is needed to innovate.

f) *Farmers' education* (*Edu*): According to Table 2(b), this variable increased the probability of developing IC in dynamic environments. This finding is consistent with the result obtained by Knight *et al*. (2003). As explained in Section 2, these researchers found that education affects farmers' attitudes toward risk. As a consequence, it is possible that farmers who received formal agricultural educational training (*i.e*. obtained diplomas of a bachelor degree in agricultural science from colleges of universities) were more willing to innovate in the turbulent condition generated by the SRR because they were less risk averse.

g) *Farm's size* (*Size*): According to Table 2(b), this variable decreased the probability of developing IC in dynamic environments. This result is also unexpected. According to Boahene *et al*. (1999), large-scale farmers have more access to bank loans and this strongly increases their chance of innovation in response to exogenous shocks in comparison to small-scale farmers. However, since most of the ESBF in the sample faced capital constraints independently of the size of their farms, this argument does not apply to them. On the contrary, a larger farm could indicate the existence of more

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resources to be controlled. But because it is easier to control a smaller number of resources, it is not surprising that farmers operating in small-scale farms had more opportunities to develop IC in the turbulent environment caused by the SRR. This argument is consistent with that given in part (b) above.

Summary and Conclusions

Researchers have found that participation in social and commercial networks is an important determinant of innovation either when business environments are stable or when these environments are affected by technological changes. However, the present research found that this does not necessarily hold in rural areas when these environments are affected by policy reforms. It is possible that this result reflects the fact that the information that is needed to innovate does not flow at the required speed to develop quickly innovative responses to these policy changes.

The probit analysis conducted in the investigation revealed that it is not network participation itself that provides farmers the capacity to be innovative in turbulent conditions, but the intensity with which these individuals interact with different actors of the supply chain. It was also found that the group of farmers who reported that they faced increasing legislation (81.3% of the farmers in the sample) had more chance to innovate in the unstable business environment caused by the Sugar Regime reform (SRR). Apparently, this is because these farmers had developed skills to overcome this barrier by means of innovation. As a result, they were better prepared to innovate in response to this exogenous shock. The formation of tactical alliances to increase negotiation power also was related to the capacity to innovate in dynamic environments. This is because the formation of these types of alliances can help farmers to enter in new markets and to obtain from them the information that is needed to innovate. It appears that these alliances were formed by innovative farmers. Finally, farmers' formal education was related to the capacity of these individuals to develop innovative activities in the turbulent condition caused by the SRR. According to Knight *et al*. (2003), formal education affects individuals' attitudes towards risk. Following this argument, it is possible that this result indicates that education corresponded to a mediate variable between innovation and farmers' attitudes towards risk.

The probit analysis also revealed that there were important inhibitors of innovation when farmers operated in the turbulent environment caused by the SRR. They were capital constraints and the capacity to control farm resources. Regarding capital constraints, it was found that when farmers faced this limitation, the formation of tactical alliances to reduce market risk was useless to develop innovative activities because they were unable to affect investment decisions on innovation. Regarding control of farm resources, on the other hand, it appears that farmers operating in small-scale farms had more opportunities to develop IC in the turbulent condition caused by the SRR because they had fewer resources to be controlled.

From a political point of view, policy makers could help the ESBF to innovate in response to future policy changes by encouraging the formation of tactical alliances to increase negotiation power; facilitating the interaction with different actors in the supply chain; promoting farmers' formal agricultural training; providing better access to capital for investment; and introducing training programmes designed to develop the skills needed to control farm's resources more efficiently. It is important to clarify, nonetheless, that generalisations from this research have to be made with caution because the sample used in the investigation was relatively small. It would be interesting, therefore, to extend this research including both larger samples and farmers operating in other industries.

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