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Technological Innovation Drivers in Rural Small Food Industries in Iran

The first step in devising the best incentives to support innovation is to investigate factors that affect the development of innovations. This paper contributes to exploring such factors in small food industries in the rural areas of Tehran province, Iran. Using a census sampling method, 111 managers of 60 active firms were interviewed. The results showed that in general the level of technological innovation is low in the studied firms. The managers do not find the technological changes successful in bringing benefit to their firms. Even though correlation analysis indicated a complex association matrix between independent variables, only the firm's capacity of production was associated with technological innovation as a dependent variable. Furthermore, the regression analysis revealed that factors which influence technological innovation are the firm's age, formal R&D, fixed capital, and capacity of production. The results of this study were used to derive practical suggestions for managers and policy-makers to increase technological innovation in the studied industry.

KEYWORDS marketing and innovation, technological innovation, innovation management, entrepreneurial ventures, small food industries, SMEs

INTRODUCTION

The success and survival of the small food industries (SFIs) in challenging situations depends on their ability to compete with their rivals. In this regard, the ability to continuously launch innovations is recognized as a critical source of competitiveness (Subramaniam & Youndt, 2005; Lin et al., 2006; Martı´nez-Ros & Orfila-Sintes, 2009, Wang et al., 2008; Huang & Chen, 2010).

Innovation, by definition, is the use of new, or existing, scientific or technological knowledge to create new products, processes, knowledge or services to provide a degree of novelty either to its developer or the sector at a national or international level (Galanakis, 2006). According to the OECD (1981), 'technological innovation is the transformation of an idea into a new or improved saleable product or operational process in industry or commerce'. Technological innovation is regarded as a tool for strengthening competitiveness because it secures continued economic growth by reinforcing employment and income generation (Sikka, 1991). Technological innovations enable enterprises to become competitive or improve their competitiveness. But whether enterprises actually launch technological innovations and to what extent they employ them depend on many factors (Bala Subrahmanya, 2005).

The first step in devising the right incentives to support innovation in small-medium enterprises (SMEs) is an investigation into which factors affect innovation in SMEs and in which way they do so (Keizer et al., 2002). Several studies were carried out to understand factors that affect the generation of innovations. However, most studies were carried out in the context of developed and highly-industrialized countries; there is a lack of studies on innovation in small industries in developing countries like Iran, where SFIs have recently

encountered a challenging economic situation. According to the latest national survey on the industries, despite a 41 percent increase in the investment of small food industries (SFIs), there was a 0.5 percent decrease in active firms between 2005 and 2007 (Statistical Center of Iran, 2009). The situation in rural areas is much more challenging due to serious deficiencies in infrastructure and limited access to the market.

Since their share in the food production is low, the SFIs are underappreciated by researchers and policy-makers; and their role in rural development is neglected. Consequently, fewer budgets are invested in research in the rural and small industries compared to urban and large industries. This lack of research could be observed in other innovation fields in small industries, but in the technological innovation specifically the difference in the number of studies within the country is most pronounced. Accordingly, this study is an attempt to address this gap in Iran and tries to explore the technological innovation drivers in the SFIs. More specifically, the study aims to: i) identify the rate of technological innovations; ii) investigate the relationship between technological innovation, and the firms' and managers' characteristics; iii) investigate the relationship between technological innovation and internal and external linkages; and iv) investigate the relationship between technological innovation and competition intensity.

Hence, this article is structured in four main sections. After the introduction, the conceptual framework of the study is developed and the research methodology is explained. Next, the results are presented, followed by a discussion and conclusion.

CONCEPTUAL FRAMEWORK

The literature on technological innovation (TI) of SFIs reveals four potential drivers: the firms' characteristics, managers' characteristics, competition intensity, and internal and external linkages. The drivers are discussed in the below.

Firms' and Managers' Characteristics

Some studies show that the firms' and managers' characteristics affect innovation generally and TI particularly. The firms' characteristics include age, production, investment, having an R&D unit, and size. Mohammadi-Nejad (2006) in his study found that the firms' characteristics (investment, age, production, and having an R&D unit) and the managers' characteristics (age, education, experience, and attitude) are the most important factors which affect the technological advancement in the small industries in Iran. Roozbahani's (2009) study on factors influencing the technological innovation of SMEs in Iran shows that having an R&D unit affects TI positively. In the study by Tomlinson (2010), the relationships between the innovative performance and firms' size, having an R&D unit, and firms' age were confirmed. However, the results of Mahemba and Debruijn's (2003) study on the issues of the age and size of SMEs and innovativeness, did not demonstrate any significant differences between the innovative and non-innovative firms.

The managers' skills and capabilities, which include their experience and education, can potentially affect their ability to innovate. Goedhuys and Veugelers (2011) believe that TI is determined partly through accumulating skills and knowledge that is gained by formal education, and experience to manage technological changes. Furthermore, Mole and

Birkinshaw (2009) believe that the education of managers and workforce is potentially an important attribute of the firm and represents one of its key innovation sources.

Internal and External Linkages

The firms' internal linkages are recognized by many researchers as an effective means of sourcing, absorbing, and integrating external knowledge (Alcácer & Zhao, 2010). Additionally, external linkages help firms to improve innovations in technology. Hence, it is necessary for organizations to put together different capabilities and services, through cooperation between suppliers and customers, and service providers and scientific institutions to achieve innovations of high quality (Ebrahim et al., 2008).

Some studies show that internal and external linkages are complementary. For example Mole and Birkinshaw (2009) demonstrate that innovation comes about through interaction between the internal and external knowledge sources. Tomlinson (2010) studied the cooperation ties and innovation in the UK manufacturing. This study confirmed the positive significant association between inter-firm cooperation and innovative performance. Also the positive association between innovative performance and cooperation with suppliers and cooperation with buyers and competitors (external linkages) was confirmed. Similarly, Zeng et al. (2010) studied the relationship between the cooperation networks and innovative performance of SMEs in China. In this study, a significant positive correlation was shown between inter-firm cooperation and innovation performance of the SMEs. Also close linkage and cooperation with customers and suppliers have a significant direct impact on the innovation performance of the SMEs. Mahemba and Debruijn's (2003) study showed that, in comparison with non-innovative SMEs, a significantly higher percentage of

innovative SMEs, establishes relationships with local suppliers, research institutes and technology centers. Moreover, Roozbahani's (2009) study on the influencing factors of TI in Iranian SMEs showed that relationships with research institutes affect the technological innovation positively. However, González-Bañales and Andrade (2011) believe that collaboration with business networks can sometimes be more of an obstacle than a helping factor, especially for small-sized companies.

Competition Intensity

According to the literature, competition intensity can affect and be affected by innovation. With globalization, the competition intensity is rapidly increasing in the world. In this situation, companies require more efficient and productive innovations, and also need to offer what is expected from them (Utkun & Atilgan, 2010). Chen et al.'s (2011) study identifies the links between a firm's choice of innovation and its market environment (including competition intensity), and the industrial technological opportunities are identified. Also, Boone et al.'s (2011) study shows that more intense competition leads industries to innovate more. However, firms might innovate to reduce the competition as well. Hence, within an industry, the successful innovators of new products are those which face less intense competition after the innovation. González-Bañales and Andrade's (2011) study confirms the indirect relationship between competitive intensity and TI. However, Dhamvithee et al. (2005) found that lowered competition encourages innovation.

The drivers and the expected relationship between them are shown in Figure 1.

[insert Fig. 1]

METHODOLOGY

Population and Sample

"Rural small food industries" (RSFIs), as major contributors to the food manufacturing sector in Iran, are rural firms with less than 50 staff. To date, in Tehran province, the Ministry of Agriculture has formally registered 104 RSFIs among which 60 firms are active.[1] In this study, a total number of 111 managers in these 60 active firms were interviewed on a census basis. Depending on the size and structure of the firms, the managers could be identified as owners, directors, production managers, marketing managers, and human resource managers.

Indicators

To investigate TI, the interviewees were asked to indicate whether their firms have adopted new technologies or changed their existing technologies during the last 12 months. Additionally, they were asked to explain the four most important TIs. Furthermore, they were supposed to use the 5-point Likert continuum (from 1: not successful to 5: very successful) to evaluate the success of the innovations at bringing benefit to their firm, This variable (TI), which is associated with the number of innovations, was regarded as dependent variable. Accordingly, the total innovation score could range from zero (where no TI detected) to 20 (where four "very successful" TIs introduced). The firm's characteristics included: the firm's size (no. of employees); the firm's age (years); having a formal R&D unit (yes/no); having an informal R&D unit (yes/no); fixed capital (USD);

[1] At the time this research was conducted (2009-2010).

firm's capacity of production (Tons); and profitability (if the firm has been profitable) during the last 12 months (yes/no). The managers' characteristics were: education level (lower than high school, diploma, bachelors, masters, and PhD); age (years); and experience in the current job (years). External linkages were classified into three groups: links with customers, links with other producers and links with knowledge organizations such as research and extension centers. The strength of the linkages was estimated by the respondents using the Likert continuum (from 1: very weak to 5: very strong). The strength of the internal linkages was also determined by the managers through the Likert continuum (from 1: very weak to 5: very strong). At last, the competitors' intensity was measured from the managers' viewpoint using the Likert continuum (from 1: very low to 5: very high). The indicators and their constructs are summarized in Table 1.

[insert Table 1]

Content and face validity were conducted by a panel of experts who supplied some wording and structuring revisions on the instrument. A pre-test was conducted on 30 managers of other food industries to determine the reliability of the questionnaire. The reliability was estimated by Cronbach's alpha coefficient ($\alpha = 0.75$), which was acceptable. Data were analyzed by Spss/Win (version 15) software.

RESULTS

Firms' and Managers' Characteristics

Table 2 summarizes the characteristics of the managers and the firms. As the table shows, the average age of the managers was 42.4 years. Fifty-six percent of the managers hold, at least, a bachelors degree, while 23% did not have any academic education. The average work experience of the managers was 19.2 years.

[insert Table 2]

The studied firms in food sector were categorized into three groups of "Grains and cereals" (22 firms), "Dairy and meat" (30 firms), and "Fruits" (8 firms). The average number of firm employees was 24 persons and the average age of the firms was 7.6 years. In the last year, 24 firms were profitable, while the other 36 firms did not report any profit. Twelve firms had an R&D unit, and 36 firms employed some staff to be in charge of R&D activities (informal R&D), while the rest did not have any formal or informal R&D unit in their firms.

Technological Innovation Rate

Table 3 shows the number of the innovative firms, number of TIs, and TI score, which the latter is the success TI has in bringing benefit to the firm. According to the table, half of the studied firms changed their technologies radically or incrementally during the last 12 months. In the 30 innovative firms, 33 radical changes and 17 incremental changes were introduced in the last 12 months.

Radical changes in technologies mainly included developing or adopting new technologies for packaging, production, and information technology Incremental changes mainly included making slight changes in the existing technologies to improve product processing. Sixteen firms applied both incremental and radical changes in technology.

[insert Table 3]

As mentioned earlier, the respondents were asked to evaluate each innovation and estimate how successful the TIs have been in bringing benefit to their firm. By summing up the four variables, the total TI score was determined. The innovation scores range from 0 to 15, with a mean of 4.26. This finding shows that the studied firms have a very low level of TI. Generally, the number of the innovative firms is limited and also the managers did not find the technological changes successful in bringing benefit to their firm.

The analysis of variance in Table 4 shows that there are significant differences between the TI scores for the three subsectors; i.e. “grains and cereals”, “meat and dairy”, and “fruits” (F=4.904, Sig.=0.009).

[insert Table 4]

The Duncan test in Table 5 shows that the first two subsectors (“grains and cereals” and “meat and dairy”) are categorized in one group while the latter subsector (“fruits”) differs from them significantly.

[insert Table 5]

Correlation Analysis

To understand the factors associated with TI, correlation analyses were done. Table 6 illustrates the correlations between the key variables. According to the table, there is a significant association between the dependent variable (TI) and the firms "capacity of production" (r=0.267, Sig. =0.005). The association shows that the more capacity of production a firm has, the higher the level of TI it holds. Other factors were not significantly associated with TI.

[insert Table 6]

"Firm's size", which is defined as the number of employees, has a significant association with "fixed capital" (r=0.474, Sig. =0.00), "capacity of production" (r=0.437, Sig.=0.00), "formal R&D" (r=0.214, Sig.=0.024), and "managers' education" (r=0.245, Sig.=0.010). All the mentioned variables have positive correlation with the firm's size. In other words, those firms, which have more employees, have more fixed capital and production capacity. Also, they have formal R&D units and more educated managers. Moreover, the firm's age is associated positively with the managers' experience (r=0.437, Sig. =0.000). Other factors were not associated with the firm's age. "Fixed capital", which is invested in the firm, has significant association with "capacity of production" (r=0.610, Sig.=0.00), "managers' experience" (r=0.215, Sig.=0.024), and "managers' education" (r=0.382, Sig.=0.00).

The correlation between the "fixed capital" and "managers' experience" is negative. It means that the less experience managers have the more fixed capital they have invested in their firms. According to the table, their experience also has a significant negative correlation with "capacity of production" (r= -0.192, Sig. =0.045). On the contrary,

"managers' age" has a significant positive association with "managers' experience" (r=0.197, Sig. =0.020), and negative with "managers' education" (r= -0.272, Sig.=0.004). In other words, the older managers are more experienced and less educated.

"Formal R&D" has a significant meaningful association with "informal R&D" (r=-0.571, Sig.=0.00), "linkage with producers" (r=-0.187, Sig.=0.049), "linkage with customers" (r=0.243, Sig.=0.010), "linkage with knowledge organizations" (r=0.287, Sig.=0.002), "internal linkages" (r=0.523, Sig.=0.000), and "competition intensity" (r=-0.245, Sig.=0.010). The association between formal R&D and "linkage with producers" and "competition intensity" is negative. Therefore, those firms which had formal R&D had fewer linkages with producers and are perceived to have fewer competitors.

"Firms' linkage" with producers has significant relationships with "informal R&D" (r=-0.442, Sig.=0.000), "linkage with customer" (r=-0.481, Sig.=0.000), "linkage with knowledge organizations" (r=-0.240, Sig.=0.011), "internal linkages" (r=-0.201, Sig.=0.035), and "competition intensity" (r=0.248, Sig.=0.009). The association with competition intensity is positive, while it is negative for the three other variables. Accordingly, the more links the firms have with their producers, the more competition they have, and vice versa. Also, the stronger the links with the firms' raw material producers, the weaker the links with their customers, knowledge, and organizations are. Also those firms, which had stronger links with producers, have weaker internal linkages.

"Firms' linkage with customers" has significant association with "firms' internal linkages" (r=0.299, Sig.=0.011) and "competition intensity" (r=-0.464, Sig. =0.009). The association between the firm's internal linkages and their linkage with customers is positive. In other words, when one of the linkages improves, the other improves too.

However, the linkage with customer has a negative association with "competition intensity". It means that the more links are made between the firms and their customers, the less competition intensity they have. "Internal linkages" also has a significant association with "competition intensity" (r=-0.198, Sig.=0.037). This association is negative, therefore, when the competition intensity increases, the internal linkages decrease.

Factors Influencing TI

A regression model was applied to understand the relationship between the independent variables and TI. The results of the model are presented in Table 5. As Table 5 shows, factors that influence TI are 'firm's age', 'existence of a formal R&D unit', ' fixed capital', 'capacity of production', and 'competition intensity'. According to the table, the adjusted R^2 in the model shows that the independent variables can explain about 52.7 percent of the changes in the dependent variable (TI).

[insert Table 7]

The results show that the firm's age affects the firms' TI level. The effect is positive and significant at 95% confidence level (ß= 0.190, Sig. = 0.05). Hence, one unit increase in the firm's age can induce 19 percent increase in the TI. Furthermore, having a formal R&D unit affects TI as well. The effect is positive, therefore, those firms, which had a formal R&D unit, hold a higher level of TI. Beta coefficient (ß= 0.734, Sig. = 0.000) shows that this effect is the strongest effect among the variables. Accordingly the TI level in the firms which have an R&D unit is likely to be increased by 73.4 percent. Conversely, "Fixed capital" affects TI negatively (ß= -0.475, Sig.= 0.001) meaning that those firms with less fixed capital hold a higher level of the TI. As mentioned earlier, the fixed capital has a

negative association with the firm's age. As a result, those firms, which were established in previous years, could start their business with less investment (because investments costs are less inflated compared to currently).

"Capacity of production" affects TI positively; when the firms' capacity of production increases, TI increases too. Thus, one unit increase in the standard deviation of the capacity of production, would increase TI by 45 percent (ß= 0.451, Sig.=0.000). Finally, "competitions' intensity" affects TI positively (ß= 0.328). Therefore, those firms, which encounter more competition from their rivals, try to increase their level of innovation in technology. Other factors, which according to the literature could potentially influence TI, did not have significant effects for the studied firms.

DISCUSSION AND CONCLUSION

The main finding of this study is that the studied firms have generally, a low level of innovation in technology. Merely half of the firms developed or adopted new technologies during the last 12 months. Also, about half of these innovative firms applied incremental changes in their existing technologies during the last 12 months. Furthermore, the TI score shows that managers do not find the technological changes successful in bringing benefit to their firms. This finding is evidence of the necessity for improving the TI management skills in the studied firms. One way to improve the TI level within the firms is increasing their investments in technologies. Tang (2006) believes that promoting investment in technologies is possible by exposing the firms to current technologies.

The correlation analysis indicates that among independent variables, only "capacity of production" is associated with TI. Those firms which are more innovative in technology have more capacity for production. This finding reveals that the TI results in more production. Furthermore, the regression analysis shows that the firm's age affects the TI positively. This is in line with the findings of Mohammadi-Nejad (2006) and Tomlinson's (2010) studies, which explain that with increasing age, firms are more likely to innovate in their technology. Therefore, the older firms have higher TI levels. Additionally, the regression model shows that having a "formal R&D unit" improves the TI level. A similar finding was reported by Roozbahani (2009), Mohammadi-Nejad (2006), and Tomlinson (2010). In line with this finding, Malerba (2007) believes that investing in R&D, is an important ingredient of the firms' technological competence. Some authors even consider a closer link between R&D and innovation. For instance, Fershtman and Markovich (2006) regard R&D as a dynamic process that has various steps before the creation of an innovation.

As mentioned earlier, just one-fifth of the studied firms have a formal R&D unit. Therefore, it is necessary to establish and manage such units in the other firms, which have informal R&D or do not have any R&D unit. Establishing an external R&D resource that can provide services for food industries could be another option.

The findings also show that "fixed capital" affects TI negatively. Those firms which have more fixed capital have a lower level of TI. This finding is contrary to Mohammadi-Nejad's (2006) study, which showed that firms with more investments had a higher technological advancement. Such a contradiction can result from the fact that firms with more fixed capital are usually younger (according to correlation analysis). The older firms

with less fixed capital have more technological innovations and their technological changes have been more successful in bringing benefits to the firms. Indeed, although the fixed capital of the older firms is less monetary, it is more or less equivalent to the investment of younger firms, since the high level of inflation has resulted in multiplying the prices during the recent years.

Moreover, those firms which have more capacity for production have a higher level of TI. This is in line with findings of Mohammadi-Nejad's (2006) study, which showed that those firms which can manage to produce more products are more capable of improving their TI level. In other words, achieving a higher level of production in the industry has been a good incentive for firms to innovate their technologies. The implication of this finding is that encouraging more production in the studied firms, will improve the TI level. The advantage of encouraging production in comparison with encouraging TI is that the former would bring tangible benefit to a firm in a shorter time and as a result, it can be regarded as a faster strategy to improve TI.

Our findings also show that competition can affect the level of the TI positively. Managers who perceive a higher level of competition intensity for their firms have a higher TI level. This is in line with the findings of Chen et al.'s (2011) and Boone et al.'s (2011) studies, which confirmed the link between higher level of competition and the firms' intention to innovate.

In order to compete with their rivals, small industries in rural areas need to improve their technologies. One way to improve the firms' technological level is to expand their access to information about the appropriate technology. Nguyen and Mothe (2008) found that access to new information for developing new competitive products or processes, enhances their

capacity to innovate. Tomlinson (2010) emphasized the impact of co-operative ties in facilitating the exchange of knowledge and information for launching innovations. Another suggestion for increasing the access to information is providing consultancy services for firms, which are located in remote rural areas, but working in an environment with high a degree of competition at market level. Private sector provides such advisory services for industries, which are working in urban areas, and industries, which are more extended and can afford private advisory services. The consultancy services (e.g. co-operatives) for rural small industries should be supported by governmental funds at least in the initial stages (Azadi et al., 2010).

Our regression model shows that the managers' characteristics do not affect TI. It explains that increasing the managers' age, education and experience could not improve their ability to innovate more. Therefore, there is a need to try other alternatives in order to encourage managers to generate TI. For instance, introducing new technologies through technology exhibitions, short training courses, and providing managers with advisory services on technology could be some possible alternatives.

Although several previous studies illustrate that the internal and external linkages help to improve innovation, our regression results show that neither external nor internal linkages could affect TI. This might be explained by the fact that the linkages are not effective enough at improving TI. The implication of this for policy-makers is that the external linkages of the studied rural food industries should be strengthened and managed properly, so that it can have a stronger effect on TI. Lastly, the internal linkages the firms should be strengthened. According to Alcácer and Zhao (2010), a well-integrated organization with strong internal linkages may detect and absorb internal innovations more efficiently.

Besides which, such linkages can help to adopt external TI. A study by Robertson et al. (1996) on the role of networks in the diffusion of technological innovation in the UK manufacturing sector revealed that potential adopters engaged in a range of inter-organizational networks through which experts introduced them to new technologies. From Nooteboom's (1991) point of view, firms require some external sources of cognition and competence in order to create favorable innovations. That is the fundamental reason why inter-firm linkages are important, especially for innovation.

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