Analysis of Relationships between Firm Performance and Open Innovation Strategies, and Levels in Turkish Food and Beverage Industry

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Abstract

The main purpose of this study is to reveal the relationships between open innovation strategies, application levels and innovative and economic performance of food industry firms. The literature suggests that open innovation that may arise at various levels of production process such as idea generation, development and commercialization might be influenced by the stakeholders that the firm is in collaboration with and might significantly affect productivity of the firm which is measured with innovative and economic performance. From the above perspective the study is based on tests of various hypotheses related to effects of open innovation strategies and levels. Data set used in the econometric analyses is obtained through the field survey carried out on 146 firms in food industry. One of the main empirical findings suggests that firms' open innovation strategy is not the sole determinning factor on open innovation level. Another finding is that open innovation that arises during idea generation has positive impact on innovative performance of the firm.

Keywords: *Open Innovation, Inbound Open Innovation, Outbound Open Innovation, Food and Beverage Industry, Firm Performance.*
JEL Classification: *O31, L66, L25.*

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1. Introduction

Open innovation has been a frequently emphasized term in literature recently. In closed innovation strategy, firms and corporations conduct their R&D operations in secrecy and with internal resources. The communication of companies with the consumers (customers) is maintained only through marketing practices. However, reasons such as the increased cost of innovation, shortening of product life cycles and thus diminishing of product revenues, mobility of qualified human resources, and technological advances that cause rapid spread of knowledge have reduced the success of closed innovation practices and led to new ways of searching. With open innovation, the costs that incur during innovation process are shared, the length of new product/process development is decreased, speed of entry for new markets rises and by this way, significant income increases could be obtained. In the OECD report, titled "The new nature of innovation", it is stated that companies should monitor consumer trends, cooperate with other firms and corporations, and make their innovation strategies more explicit in order to sustain their existence. The driving forces of innovation in this transformation process are defined as deeply and precisely perceiving consumer needs, and involving them in the preliminary stages of innovation process.

In open innovation, which was first cited by Chesbrough (2003), firms should use external knowledge as much as the knowledge produced via their internal processes. Open innovation is a multi-disciplinary approach (e.g.: economics, psychology, sociology, cultural anthropology) and includes all stakeholders of the firm (e.g.:shareholders, suppliers, customers, research institutions) in innovation process. Open innovation enables interchange of knowledge by firms which accelerates innovation process. Thus, innovation becomes available for the market externally (Chesbrough, 2006:3). Chesbrough mentions that competitive power could best be obtained through efficient use of internal and external knowledge rather than producing best and most ideas (2003: xxvi). By this way, practitioner firms could have considerable cost advantages in new product development and process recovery (Wallin and Krogh, 2010:145).

Principles of open innovation could be listed as follows (Chesbrough, 2003: xxvi; 2006:8-11):

- Firms could not employ all the skilled-smart workers. But, they could prefer working with people of such capability both inside and outside the firm.

- Innovation that is created outside the firm is of significant value and should be benefitted from in the in-house innovation.

- Instead of being the first to enter the market, it is better to have a good business model for competitive advantage.

- Gaining competitive power/advantage requires efficient use of external and internal ideas.

- Management of intellectual property should be considered as a condition that makes exchange of valuable knowledge between firms easier. By this way, a firm will advance its business models by using properties of other firms while profiting by letting another firm to use its intellectual property.

Open innovation could lead to a variable efficiency due to its type and application level. Theoretically, this efficiency includes innovative and economic performance. Knowledge management abilities and strategic orientations of the firms would lead to a process of outbound, inbound or coupled flow of knowledge. This difference in the process would be more effective on various efficiency areas. Another factor that causes variable effect on efficiency is the application level of open innovation, which is idea production, idea development, and commercialization. Moreover, "dynamic capacity", which is one of the main explanatory variables of firm innovativeness, would affect efficiency of open innovation practices.

From the above perspective on open innovation, the main purpose of the research can be stated as to determine the type of open innovation; to measure impact of knowledge management abilities that affect type of open innovation; to determine application level of open innovation; and finally to measure the effect of open innovation on innovative and economic performance among companies operating in food and beverages industry in Turkey and listed among the top 1000 companies by Istanbul Chamber of Commerce in 2011.

The following section provides brief information regarding open innovation in the food industry. This is followed by definitions of key strategies in the third section. Section four provides empirical methodology and findings are given in section five. Finally the paper concludes in section six.

2. Open Innovation in Food and Beverages Industry

Firms operating in food and beverages industry are differentiated from other manufacturing firms due to their requirement of more natural resources and know-how in their production processes (Acosta, Coronado and Ferrandiz, 2013; Ahn, Montana and Minshall, 2013). Features of innovation in food and beverages industry could be listed as follows (Lazarotti, Garcia, Manzini and Sanchez, 2012):

- Innovation process is generally demand-pull as the stimulators of innovation are the changes in demand.
- R&D investments are not high. Technological change is more stagnant. Dynamism and turbulence are limited.
- Incremental innovation is more common than radical innovation which is mainly due to the limitations on demand side. Consumers are extremely conservative in their food choices and hence innovation could rarely occur.
- Protection of property rights is not strict. It mainly depends on the use of trade mark and commercial secrets. Patents are not common.

It is considered that, besides the demand-pull nature of innovation process, all other features of food industry limit the attitude towards open innovation. Limited nature of technological innovation and turbulence (Fourtin and Omta, 2009; Ozman, 2008), rare use of patents (Lichtenthaler, 2010; Teece and Pisano, 1997), and low R&D density limit the open innovation practices in food industry (Lichtenthaler, 2008).

A linear relationship between R&D density and firm size has been proved (Galizzi and Venturini, 1996). Food industry is mostly made up of small enterprises. Financial difficulties of small enterprises in sustaining their R&D activities prevent R&D investments. In literature, food industry is considered as the industry with the least R&D investment among manufacturing industry sub-sectors (Martinez and Briz, 2000). This is also valid for Turkish Food and Beverages Industry for which this research is carried out. During 2003-2009 period, the share of food and beverage industry in R&D spending of total manufacturing industry is between 2.7% - 6.5% while it is 3% for R&D personnel for the said period (TGİSD, 2011).

Technological developments and improvements in food industry are relatively low when compared with other sectors (Galizzi and Venturini, 1996). Therefore, food industry is defined as a low-technology industry. It has been determined that technological change rate in

food industry is less dynamic than other manufacturing sectors (Martinez and Briz, 2000). In Turkey, between the years 1998-2010, only 29-30% of the firms operating in Food and Beverage Industry were found to be involved in innovation activities (http://www.tuik.gov.tr/PreTablo.do?alt_id=1039).

It has already been known that in food industry, practices causing unfair competition do exist and the number of registered products is less than other sectors (Martinez and Briz, 2000). However, quality management and security standards will guide innovation in the food industry (Maurer and Drescher, 1996:221). In Turkey, when the national utility model certificates taken between 1998-2003 are considered, the share of Food and Beverage Industry among all sectors is found to be about 1%. Its share in national patents secured in the same period is 3.6% (Karaöz and Albeni, 2004).

Despite the above-mentioned limitations and limited openness level, food and beverage industry is required to change its attitude regarding open innovation. Above all, high technological dynamism necessitates interaction of diverse technological and scientific areas. Technological turbulence directs firms to external knowledge. On the other hand, globalization of the market and technologies also has considerable effects. Competitive environment, which has been reshaped by globalization, compels firms to increase their innovation efforts (Lazzarotti and Manzini, 2012). The positive relationship between openness level of innovation process and innovation performance of the firm has been proved. Firms practising open innovation have notable cost and time saving advantages and the innovation process becomes more open as a result of the necessity to become more competitive (Lichtenthaler, 2008). These circumstances make it interesting to deal with open innovation approach.

3. Open Innovation Strategies

Open innovation is not a precise and fully-defined concept and could emerge in various forms. This vagueness prevents theoretical improvement while enriching the concept. Under these circumstances, in addition to the contrast between open and closed innovation, defining open innovation and comparing it with closed innovation is considered as a significant and

meaningful step in the conceptualization process[1] (Lichtenthaler, 2008; Dahlander and Gann, 2010).

Although comprehensive, open innovation is generally performed through "inbound innovation", "outbound innovation" and "coupled innovation" (application of them together). Moreover, each one of these practices could be more or less "open". Therefore, it should be considered in mind while handling open innovation practices that it has a multi-dimensional structure (Huizing, 2011).

Inbound open innovation is defined as the use of knowledge that belongs to the stakeholders of the firm in the innovation process internally. It could be defined as exploitation and integration of the external knowledge in order to use and improve technology (Parida *et al*., 2012).

Inbound open innovation practices include the following activities: cooperating with other firms or university – R&D institutions for product development, incorporating the customers or end-users in product development activities, purchasing intellectual property rights of other organizations (Parida *et al*., 2012).

Outbound open innovation is the exploitation of internal knowledge by the stakeholder. It includes being involved in new ventures (right of use and licence transfer, etc.), which emerge depending on the previously developed products or technologies, and product development via external contribution. Making use of the technological capacity of the firm is actually allowing the internal and external methods together for commercialization (Chesbrough, 2003; Chesbrough and Crowther, 2006).

Empirical researches reveal the fact that firms mostly employ open innovation strategy (Bianchi *et al.*, 2010; Cheng and Huizing, 2010; Chiaroni *et al*., 2010). An innovation practice of another firm is a must in inbound open innovation practice. This behaviour of the firms not only increase licensing costs, but also causes the use of a limited part of their own technologies. These facts remind the fact that firms do miss important opportunities in innovation activities (Van de Vrande *et al*., 2009).

Inbound open innovation is generally prevalent in low-tech industries (Chesbrough and Crowther, 2006). In high-tech industries, on the other hand, use and discovery of external

[1] An appendix is also provided to explain the empirical relationship between innovation and firm economic performance whici is one of the focus points of this study.

knowledge takes place in the forms of giving technology licence to other firms and/or developing technology through new initiatives.

While analysing open innovation, factors contributing to the openness of a firm should be considered as the main explanatory variables. One of these variables is the "***dynamic capabilities***" of the firm (Dahlander and Gann, 2010; Huizing, 2011). Dynamic capability enables re-arranging and re-organizing firm capabilities according to environmental factors (Wang and Ahmed, 2007). Dynamic capabilities are divided into two groups: absorptive capacity and adoptive capacity.

Absorptive capacity refers to the capability of the firm in noticing, acquiring, distributing within the firm, transforming and utilizing the external knowledge, which was not produced in-house. Researchers have defined the concept from different perspectives. Cohen and Levinthal (1990) defined absorptive capacity as the capacity of discovering the external knowledge, absorbing and commercializing it. The authors emphasize two features of the absorptive capacity. According to the first one, absorption ability is the result of a cumulative process, which means that occurrence of the absorptive capacity in a certain period provides more efficient capacity accumulation for the subsequent period. The second feature suggests that absorptive capacity is field-specific and is related with the past. Thus, it becomes easier for a firm to perceive and evaluate the external knowledge about that field (1990).

Absorptive capacity was defined by Mowery and Oxley (1995) as the aggregation of the capabilities required to determine, perceive, and change the knowledge produced externally. Zahra and George (2002), on the other hand, considered the concept as the total of organizational procedures and strategic processes that the firm acquires, assimilates, transforms, and utilizes in order to create dynamic capabilities. Murovec and Prodan (2008) defined absorptive capacity as the ability of the firm to transform external knowledge into commercial product. Analysing these definitions, Jime´nez-Barrionuevo et al. (2011) framed absorptive capacity as the relative capacity that the firm has on developing cluster of organizational procedures and strategic processes where the firm acquires knowledge externally and absorbs, transforms and benefits from this knowledge.

According to Zahra and George (2002) absorptive capacity has two dimensions, which are "potential" and "realized". Potential capacity incorporates all the stages in acquiring, analyzing, interpreting, and understanding external knowledge, yet it does not guarantee benefit. Realized capacity, on the other hand, indicates the level of the firm's ability to blend

the new knowledge with the accumulated knowledge, to transform and to benefit from this knowledge.

Adoptive capacity is determined by the responsiveness of the firm to the product and market opportunities, marketing practices performed to respond these opportunities, and firm's speed in its responsiveness (Changi, 1995). Adoptive capacity enables the firm to discover and utilize the opportunities in the market (or in a specific region) (Staber and Sydow, 2002).

Adoptive capacity plays a significant role in determining market opportunities, investing in these opportunities, and creating resources in order to gain sustainable competitive advantage. Although it raises costs due to the resources used, it increases firm performance in the long run (McKee *et al.,* 1989).

Firms with improved adoptive capacity could perform novel and different marketing practices, could launch new products, could enter new markets, and could be more willing for new strategy practices (Boeker and Goodstein, 1991).

Open innovation applications during production procedure are grouped under three levels as in the following.

- ***Idea generation*****,** discovering market opportunities or problems, predicting suitable fields for technical progress, doing basic and applied research,
- ***Idea development*****,** developing a deep product and service perception, providing a model for a product or service, testing the product and/or process,
- ***Commercialisation*****,** production, promotion, distribution, and sales of a product/service/technique.

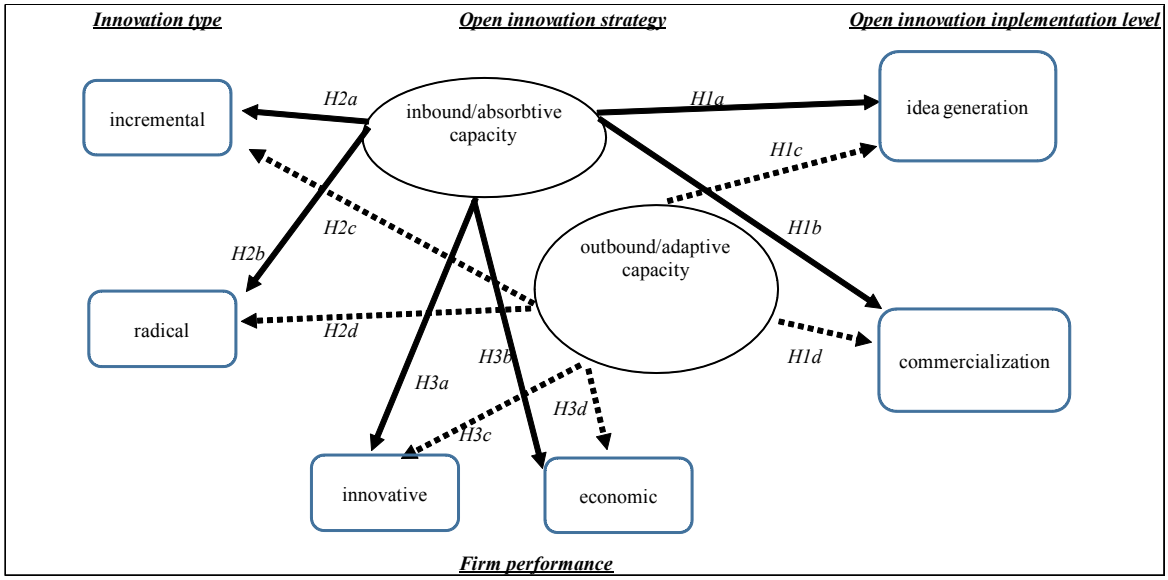
4. Methodology

The objective of the research is to reveal the relationship between open innovation strategies and its levels in the firms operating in food and beverages industry and the strategy impacts on firm innovative and economic performances. The rapidly increasing open innovation literature revealed that open innovation implementation levels occurred during the production process are idea generation, development, and commercialization, and these are influenced from the stakeholders of the firm and could significantly affect the efficiency of the firm measured with innovative and economic performance. With this purpose, the study is

developed on the hypotheses regarding the effects of strategies and practices of open innovation.

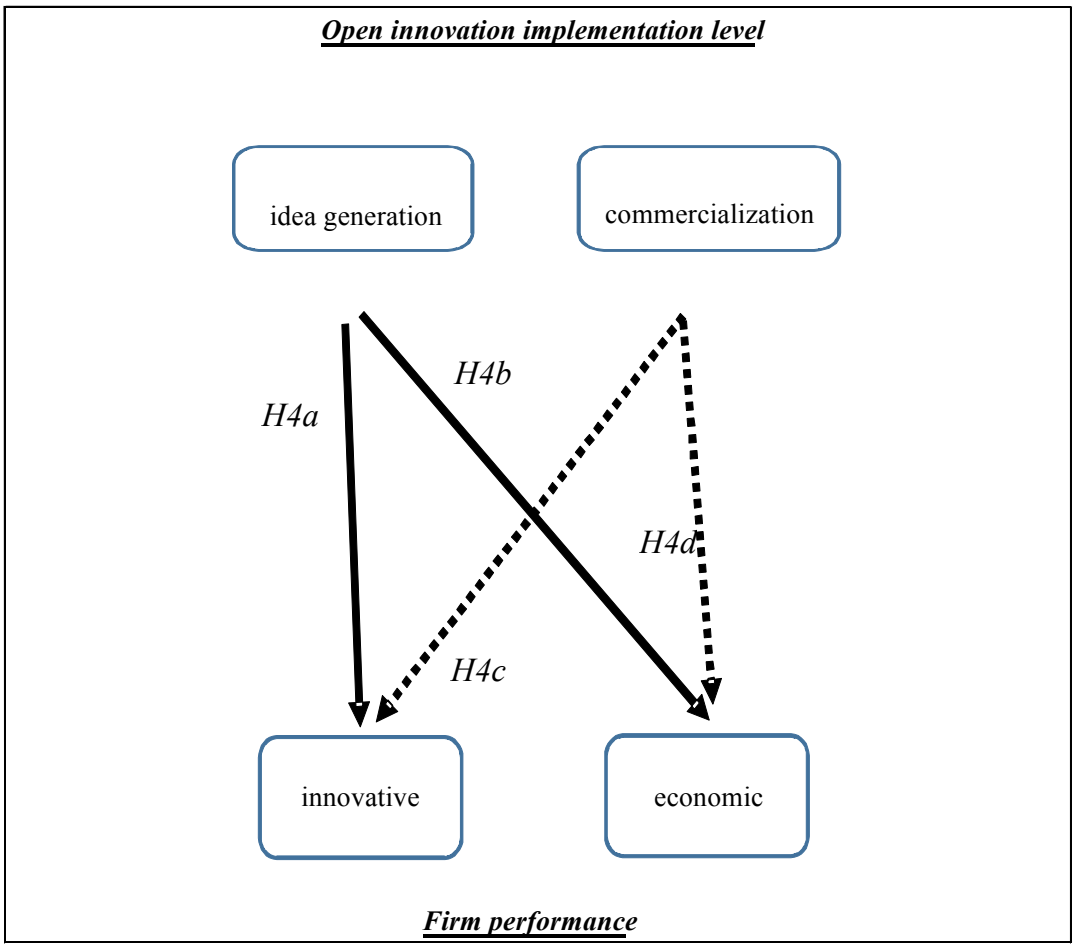
Hypotheses developed depending on open innovation strategy of the firm are displayed in Figure 1. Under the hypotheses 1 to 3, while the sub-hypotheses of *a* and *b* propose that absorptive capacity (inbound open innovation strategy) does not have any effect on the related variables; sub-hypotheses *c* and *d* propose that adoptive capacity (outbound open innovation strategy) does not have any effect on the related variables.

Figure 1: Hypotheses on the Open Innovation Strategies of the Firms



Hypotheses developed on the open innovation implementation levels of the firms are demonstrated in Figure 2. Whereas hypotheses *4a* and *4b* suggest that innovative and economic performance of the firm are not affected from the open innovation practices in idea generation level; hypotheses *4c* and *4d* posit that open innovation in commercialization level does not have any effect on innovative and economic performance.

Figure 2: Hypotheses on Open Innovation Implementation Level of the Firm



4.1. Data Set

In order to quantitatively prove the above-mentioned relationships, and due to the non-existence of secondary data on this topic, the authors first performed face-to-face interviews with 146 firms, constituting population of the study. The firms, operating in food and beverages industry, are selected from the top 1000 firms listed by Istanbul Chamber of Commerce (ICC) in 2011. Other economic data of the firms are also obtained from ICC reports.

Questionnaire items were constituted with the purpose of revealing innovative and economic performances, and the type and strategy of open innovation practices of the firms. The questionnaire consisted of 20 questions and 85 statements. 11 questions were measured on

seven point Likert type scale[2], 3 of the questions were replied as yes/no, and 6 questions were answered in certain ranges. A single item was used to determine the sub-sector of the firms. Pre-tests were carried out and some of the questions (items) were excluded from the questionnaire.

4.2. Econometric Analysis

Econometric analyses were carried out by transforming data of 2011, obtained through fieldwork with the food firms, into dependant and independent variables. Variables were organized in discrete, continuous, ordered discrete and bounded continuous forms. As the data belongs to a single year, econometric analysis depends on cross-sectional data and sample size is 146 firms. Least squares and probit estimation methods were used in econometric analysis, whereas chi-square test was used in statistical analysis. Only the results of the models with highest explanatory power and with no diagnostic problems were included in the study. Before carrying out econometric estimation, covariance matrices were generated for each model and controlled for multicollinearity. After the estimation, variance inflation factors (VIF) were calculated[3]. All estimation results were tested with Glesjer and White tests for alternative hypothesis of heteroscedasticity[4].

5. Empirical Findings

Table 1 displays the effect of "inbound open innovation" strategy of the firm (absorptive capacity of the firm) on various dependant variables. While inbound open innovation of the firm is listed in column one, dependant variables are listed on columns two to six.

Through 5 econometric estimations, the effect of absorptive capacity on open innovation in idea development, in commercialization, on radical open innovation, on firm innovative performance, and firm economic performance was searched. Innovative performance was measured with an index that composed of reduced time to market, reduced economic cost of innovation projects and reduced innovation risks while economic performance was measured with firm turnover.

[2] (1=Strongly disagree, 2=Disagree, 3=Somewhat disagree, 4=Beither agree nor disagree, 5= Somewhat agree, 6=Agree, 7=Strongly agree)
[3] VIF values less than 5 were considered.
[4] Due to space limitations, covariance matrices, White and Glesjer test results, and VIF findings cold not be provided within the text or in the Apppendix, yet could be provided upon demand.

One of the remarkable effects was found to belong to the variable that shows the cooperation between food industry firms and university/research centres. It was observed that this cooperation has positive effect on firm economic performance, on open innovation at idea development level, and on open innovation that emerges through radical changes. The effect of same factor on open innovation in commercialization level is negative. These findings suggest that the cooperation of food industry with universities and research centres yields results generally in mid- to long-term, and is R&D oriented. Open innovation at commercialization level which is expected to yield results more in short-run, does not emerge as a result of the cooperation between firms and universities. Cooperation with both consumers and customers is found to have a positive effect on open innovation at idea development and commercialization levels. This effect of cooperation with consumers is expected as food industry is more demand pull when compared with other industries. The same factor has positive effect on firm innovative performance. The effect of consumers in the hypothesized manner is expected as the definition of innovation in food industry includes packaging and product variety.

A consumer-related factor that is observed to have negative effect on open innovation in both idea development and commercialization levels is the speed of change and variability in consumer preferences. Relative low-cost of product and marketing method diversity in food products, and relative demand inelasticity of these products could increase consumer demand variability rates. This would hinder open innovation in any level. On the other hand, the fact that same factor could increase innovative performance could be due to its being considered as a favourable factor. Using simulations and virtual prototype tools by food industry firms in new product development is found to have negative effect on open innovation in idea development and commercialization stages, just like the previous factor. The same factor was found to have negative effect on firm economic performance. When developing virtual prototype is considered as a cost increasing factor with mid-long term revenue, its negative effect on firm economic performance could be understood. On the other hand, this cost incurred by the firm and time cost caused by this factor could be expected to negatively affect open innovation in idea development and commercialization.

Another factor that affects open innovation in idea development and commercialization levels, and innovative performance of firms operating in food industry is the objective of working with high technology. In firms aiming to use high technology, strategies formulated

with this purpose would naturally consist of increasing open innovation performances and thus, innovative performance would increase.

Cooperation with firms that supply input to food companies and cooperation with firms in other sectors have positive effect on open innovation in commercialization. Grounding on this finding, cooperation of the firms operating in food industry with the firms they have vertical relation would positively contribute to the open innovation in commercialization. It is also observed that cooperation with competitors increases the possibility of radical innovation practices. These findings suggest that whereas vertical relations positively affect open innovation in commercialization, horizontal cooperation affect radical innovation possibility. Protection of intellectual property rights increases innovative performances of the firms. Increase in the innovative performances of the firms is expected as long as their intellectual properties such as patents and trademarks are protected from robbery and imitation; and the findings also support these expectations. Cooperation with public agencies and institutes not only direct firms to radical innovation, but also increase innovation performance. These findings could be ascribed to the institutional and innovative performances of the public sector rather than private. Cooperation with innovation agents is observed to have negative impact on firm performance and to support more incremental innovation rather than radical. Innovation agents are not prevalent in Turkey, and it is considered that this problem is perceived mistakenly in the interviews.

Two factors that positively affect open innovation in idea generation of firms in food industry are development of project techniques for cooperation and of suitable capacity in-house in order to use external knowledge. While the first factor affects firm innovative performance positively, the second one increases radical innovation practice possibility. The second factor also has positive effect on economic performance. Whereas technology portfolio of the firm prevents open innovation practices in idea development, using extraordinary technology hinders open innovation practices in commercialization. Both factors increase the possibility of radical innovation practices in firms operating in food industry.

Table 1. Effect of Inbound Open Innovation Strategy

Dependant variable	Idea development (H1a)		Commercialization (H1b)		Practicing radical innovation possibility (H2a,b)		Innovative performance (H3a)		Economic performance (H3b)	
Methodology	Least squares		Least squares		Probit		Least squares		Least squares	
Sample	n=146		n=146		n=146		n=146		n=146	
Explonatory variables										
C	53,26		49,66		-15,08		21,71		3,32	
Cooperation with universities and research centres	0,13	***	-0,13	*	0,02	**			0,91	***
Cooperation with customers (i.e. retailers)	0,23	***	0,29	***			0,05	*		
Cooperation with input suppliers			0,23	**						
Cooperation with firms in other industries			0,17	**						
Objective of reaching high technology	0,34	***	0,48	***			0,23	***		
Having a wide technology portfolio	-0,18	***			0,07	***				
Using innovative, flexible and non-routine technologies			-0,20		0,05	***				
High uncertainty in customer/consumer demand and preferences, rapid change and difficulty in estimating needs and preferences	-0,27	***	-0,34	***			0,08	*		
Using project management techniques to manage the collaborations	0,23	**			-0,04		0,14	***	0,12	
Using simulation and virtual prototypes in cooperation to encourage/provide new product development	-0,18	**	-0,27**						-0,16	***
Using internal research capacity more in order to scan and evaluate external knowledge	0,17	**			0,04	**			0,11	**
Trade marks			0,15							
Innovation intermediaries					-0,03	**	-0,08	***	-0,04	*
Government agencies					0,04	***	0,13	***		
Competitors					0,06	***				
Using intellectual property protection mechanisms							0,22	***		
	R^2	0,46	R^2	0,35	McFadden R^2	0,52	R^2	0,59	R^2	0,52
	Adj. R^2	0,43	Adj. R^2	0,30	Regression st. er.	0,46	Adj. R^2	0,57	Adj. R^2	0,51
	F-stat	14,61	F-stat	8,05	LR stat	40,13	F-stat	24,60	F-stat	26,72
					Prob (LR)	0,00				

*, **, ***: Respectively %10, 5 and 1 level of significance.

Table 2 represents effects of "outbound open innovation" strategy (adoptive capacity of the firm) on the dependant variables listed in Table 1. Strategies developed and practices implemented regarding firm personnel are observed to be the most effective adoptive capacity (outbound open innovation strategy) factor. For example, quick adaptation of firm personnel to new conditions negatively affects the innovation practices in commercialization and idea development stages. Having labour force that could adapt various conditions probably diverts implementing open innovation practices in each stage. In other words, it is predicted that such labour force renders open innovation need unnecessary. It is again observed that the firm possibly prefers radical innovations when it has this type of labour force. In this case, the success of employees in adapting new conditions and processes affects innovation type. Setting challenging goals for firm personnel and allocating resources for their professional improvement positively affects open innovation in commercialization level. Positive effect of these practices on open innovation practices in commercialization level, which makes personnel not only competitive and but also flexible and qualified, is an expected outcome. Furthermore, it is revealed that these two factors increase the probability of incremental innovation instead of radical innovative changes. Continuous challenging goals and supporting the personnel accordingly could affect firm innovation in mid- to long-term. In this case, it is also expected that these might positively affect incremental innovation. Another effective factor concerning firm personnel is allocation of time and resources for idea generation. This factor is found to affect both open innovation in idea development and commercialization, and firm innovative performance.

Another group of factors determining firm adoptive capacity is related to internal operation strategies of the firm. For example, whereas success of the firm in adapting to the changing market conditions and noticing new market opportunities within this context affect open innovation practices in idea development level positively, focusing on new products and services has negative effects on the same dependant variable. It is observed that attempts of the firm itself regarding final product limits shareholder cooperation in innovation. It is seen that firm focus on new product and services positively affects economic performance. Employment of the most qualified specialists and scientists of the market by firms operating in food industry increases the probability of radical innovation practices. A similar effect could be present when the firm quickly adapts market conditions. Both quick adaptation and employment of best specialists indicates innovation capacity of the firm. Under these circumstances, the above-mentioned findings are expected.

Another factor determining adoptive capacity is confidentiality agreement and other agreements signed by the firm. It is determined that such agreements have positive effect on innovative and economic performance, while increasing radical innovation possibility and positively affecting open innovation in commercialization level. An additional factor positively affecting open innovation in commercialization level is the determination of top management in this aspect. It is seen that patents, business secrets, virtual prototypes used in product development have negative effect on open innovation in commercialization stage.

Chi-square test results on the dependency relationship between open innovation realization level and firm economic, and innovative performance are presented in Table A1 in Appendix. In other words, hypothesis of independency between implementation of open innovation in idea development and commercialization levels and firm innovative and economic performance were tested. The only dependency relationship was found between open innovation in idea development level and firm innovative performance.

Table 2. Effect of Outbound Open Innovation Strategy

Dependant variable	Idea development (H1c)		Commercialization (H1d)		Practicing radical innovation possibility (H2c,d)		Innovative performance (H3c)		Economic performance (H3d)	
Methodology	Least squares		Least squares		Least squares		Least squares		Least squares	
Sample	n=146		n=146		n=146		n=146		n=146	
Explonatory variables										
C	109,33		28,37		-24,40		38,36		-7,77	
Number of employees									0,92	***
We have a broad product/market portfolio									-0,09	*
We give our staff time and resources to generate new ideas	0,43	**	0,61	***						
Our staff easily adapt to new situations	-0,26	*	-0,15	*	0,15	***				
We set our staff creative and challenging objectives			0,30	**	-0,03	*	0,18	***		
We allocate resources for our staff continuous professional development			0,33	*	-0,07	**	-0,12	**		
Flexibility in adapting market conditions	0,19	**			0,03	***				
We continuously pursue new market opportunities	0,25	***								
We focus on new products and services	-0,27	**							0,15	***
We try to hire the best scientists and experts in the market	0,11				0,05	***				
There is a high level of interaction across different functional areas in innovation activities	-0,60	**			-0,06	**				
Patents			-0,23	**			0,10	***		
Trade secrets			-1,02	***	-0,28	**	-0,15			
Non disclosure agreements and other contractual agreements (e.g. joint development agreements)			1,22	***	0,27	***	0,17	*	0,11	**
We use simulation or virtual prototyping tools to facilitate the development of new products developed in collaboration projects			-1,01	***						
Top management is fully committed to maximising collaborative results			0,43	***						
Each collaborative project has a "champion" to ensure collaboration success			-0,54	***						
Increase our internal flexibility with regard to innovation			0,34				0,23	***		
Copyright							-0,12	***		
	R^2	0,52	R^2	0,58	McFadden R^2	0,53	R^2	0,51	R^2	0,52
	Adj. R^2	0,46	Adj. R^2	0,48	Regression st. er.	0,46	Adj. R^2	0,48	Adj. R^2	0,51
	F-stat	8,32	F-stat	5,71	LR stat	40,68	F-stat	18,03	F-stat	33,26
					Prob (LR)	0,00				

*, **, ***: Respectively %10, 5 and 1 level of significance.

6. Conclusion

Relevant literature review suggests that in food industry, all industry-specific features limit open innovation, except for demand-pull nature of innovation process. Demand-pull nature also constitutes another limitation as consumers are generally loyal to their preferences and resistant to change their food consumption behaviour. Furthermore, food products demand has relatively lower income and price elasticity measures which cause another limitation for innovation practices of the firms. Other features of food industry aside from the above-mentioned could be summarized as follows: R&D investments are not high, technological change is slow, dynamism and turbulence are limited, incremental innovation is more prevalent than radical innovation, and intellectual property protection is not common except for trademarks and commercial secrets.

Under the light of these findings, the current study analyzes open innovation behaviour of the firms and tests hypotheses developed to measure the relationship between open innovation strategies and firm innovative and economic performance through its sample of 146 firms which are operating in food industry among top 1000 firms in Turkey in 2011.

Determination of open innovation strategy in food industry affects open innovation implementation level. Hence, the effect of firm policies and changes, developed during strategy determination, on open innovation implementation levels could be estimated. This finding suggests that firms might have the possibility of implementing goal-oriented strategies.

Firms in food industry could employ mixed strategy in order to implement open innovation (only) in one level. In other words, choosing (only) one level for implementing open innovation facilitates achievement of the objectives. Choosing more than one level for open innovation is more difficult to implement and requires more complex strategies, thus could hinder efficiency.

Empirical findings indicate that firms in food industry could employ open innovation for production efficiency. Using open innovation implementation levels by food industry firms for improving economic performances may not yield the expected effect, yet open innovation in idea generation level is expected to positively affect firm innovative performance and this would indirectly affect economic performance positively. Therefore, focusing on idea generation in food industry would influence innovative performance directly, and economic

performance indirectly. However, commercialization occurs not only according to firm but also to market conditions, and thus, non-existence of its direct relationship with firm economic and innovative performance is an expected result.

Findings of the study suggest some implications for both private and public sector. Using the information that main determinant of firm innovation and economic performance in food industry is consumers' demand, public sector could have a leading role for preparing the required environment to incorporate consumers in innovation process.

Encouraging the firms to use intellectual property tools and public sector initiative on this matter could positively affect firm economic and innovative performance.

Following other firms in industry is crucial for innovation practices. Besides the industry, firms should monitor university researches and public policies in order to determine their strategies. Establishment of institutional structure to facilitate this follow-up, and encouraging chambers of industry and commerce, and also the unions in this way by public sector would ease this pursuit.

Firms should train their employees on innovation and its positive effects, should communicate innovative behaviour as part of corporate culture, and should sustain employment of human resources who are qualified in this respect.

Although university-industry cooperation has recently been encouraged by institutions such as Ministry of Development, Ministry of Science, Industry and Technology, and Scientific and Technological Research Council of Turkey, it is evident that this cooperation is lagging behind when compared with developed countries. However, university–industry cooperation is indispensible for innovation success. Public industry should take responsibility of developing mechanisms to establish this cooperation.

Increased technology development costs, shortening of product life-cycles and decrease in product revenues accordingly directed firms to open innovation processes. This would enable sharing product development costs and income increase through quickly getting into new markets. Open innovation practices and focusing on new product development during this process would increase firm performance.

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APPENDIX-A

Open Innovation – Firm Performance Empirical Relationship

The relationship between open innovation, and innovation and firm performance is generally explained by incorporating "knowledge capital" as an input in production function (Wagner, 2006; Liao *et al.,* 2010).

In general, when input and output are combined within the framework of a production function in Cobb-Douglas form (equation 1), Q denotes output, whereas C and L represent capital stock and labour, respectively. The difference in production amount between the firms with same capital stock and labour is accounted for productivity coefficient (A). For separate firms (i) and separate times (t), logarithm of both sides of the equation is taken (equation 2) and when a_{it} is taken to the left side of the equation, total factor productivity could be expressed as in equation 3 (Hall, 2011).

$$Q = AC^{\alpha}L^{\beta} \quad \textbf{(1)}$$

$$q_{it} = a_{it} + \alpha c_{it} + \beta l_{it} \quad \textbf{(2)}$$

$$TFP \equiv a_{it} = q_{it} - \alpha c_{it} - \beta l_{it} \quad \textbf{(3)}$$

In this situation, physical quantities of all variables in production function are required in order to measure total factor productivity. However, this measurement is seriously problematic. Instead, logarithm of both sides is taken by including firm income which yields equation 4. Demand elasticity calculated from this equation gives equation 5 (coefficient equals negative demand elasticity). Combining equations 2 and 4 results in equation 6, which represents firm income depending on inputs and total factor productivity (Hall, 2011).

$$r_{it} = p_{it} + q_{it} \quad \textbf{(4)}$$

$$q_{it} = \eta p_{it} \quad \textbf{(5)}$$

$$r_{it} = \frac{\eta + 1}{\eta}(a_{it} + \alpha c_{it} + \beta l_{it}) \quad \textbf{(6)}$$

In equation 7, production function is expanded by "knowledge capital" (K) (Hall, 2011). In other words, the effect of innovation on production could be measured by including "knowledge capital" into the function. Employing the approach used when formulating equations 2 and 4, equations 8 and 9 could be formulated. Then, when income (r) is taken to the left side of the equation (equation 10), "knowledge capital" turns out to contribute income and thus, productivity increases in two ways: the first one is by directly increasing production

efficiency; the second one is by causing increase/shift in demand. In this case, whereas price elasticity of demand (η) is negative, "knowledge capital" elasticity (ϕ) is positive.

$$Q = AC^{\alpha}L^{\beta}K^{\gamma} \quad \textbf{(7)}$$

$$q_{it} = a_{it} + \alpha c_{it} + \beta l_{it} + \gamma k_{it} \quad \textbf{(8)}$$

$$q_{it} = \eta p_{it} + \phi k_{it} \quad \textbf{(9)}$$

$$r_{it} = \frac{\eta + 1}{\eta}(a_{it} + \alpha c_{it} + \beta l_{it}) + (\frac{\gamma(\eta + 1) - \phi}{\eta})k_{it} \quad \textbf{(10)}$$

Starting with equation 11 in a similar manner (when C and L are capital and labour, M is other input, and K is "knowledge capital"), equation 12 is obtained by representing productivity as added-value per labour, and taking logarithms of all variables (Leeuwen and Klomp, 2002). In this case, whereas a_1 represents capital elasticity of added-value, $(\alpha_1 + \beta_1 - 1)$ denotes deviation from constant returns to scale.

$$Q_{it} = AC_{it}^{\alpha}L_{it}^{\beta}M_{it}^{\chi}K_{it}^{\gamma} \quad \textbf{(11)}$$

$$y_i - l_i = a_1 + \alpha_1(c_i - l_i) + \gamma_1 k_i + (\alpha_1 + \beta_1 - 1)l_i \quad \textbf{(12)}$$

When logarithm of equation 11 is taken and re-written as difference (equation 13), measurement problem of the variables would occur, as explained above. In this case, it is required to re-formulate the equation in terms of income (Leeuwen and Klomp, 2002).

$$\Delta q_i = \alpha\Delta c_i + \beta\Delta l_i + \chi\Delta m_i + \gamma\Delta k_i \quad \textbf{(13)}$$

While ρ represents marginal product of "knowledge capital" (equation 14), removing $\gamma\Delta k_i$ from equation 13 would result in equation 15. This means that, change in "knowledge capital" is calculated by multiplying marginal product of "knowledge capital" with per output R&D spending. In this case, formulation of production function R&D intensity would be as in equation 16.

$$\rho\frac{\partial Q}{\partial K} \quad \textbf{(14)}$$

$$\gamma\Delta k_i = \frac{\rho\Delta k}{Q} = \frac{\rho(R - \varsigma K_{-1})}{Q} \approx \rho\frac{R}{Q} \quad \textbf{(15)}$$

$$\Delta q_i = \alpha\Delta c_i + \beta\Delta l_i + \chi\Delta m_i + \rho(\tfrac{R}{Q})_i \quad \textbf{(16)}$$

When productivity is re-written as added-value per labour and logarithms of all variables are taken, equation 17 is obtained and $\ln t_i$ in this equation denotes the difference between technological capacities (i.e. "knowledge capital" and its positive effect).

$$y_i - l_i = a_2 + \alpha_2(c_i - l_i) + \gamma_2 \ln t_i + (\alpha_2 + \beta_2 - 1)l_i \quad \textbf{(17)}$$

As can be seen above, whereas direct effect of "knowledge capital" (innovation) is on productivity/efficiency, its indirect effect is on demand, i.e. on sales turnover.

As sales turnover could occur in either domestic or foreign markets, firm performance could be expressed not only by turnover, but also via export (Martinez and Briz, 2000; Lefebvre and Lefebvre, 2002; Kleinknecht and Oostendorp, 2002). While Enzing et al. (2008) considered firm performance as growth rate of sales and/or turnover; Georski et al. (2002) expressed firm performance through cash flow.

APPENDIX-B

Table A1. Open Innovation Application Level and Firm Performance Relationship

	Result	Asymp. sign.	Result	Degree of Rel.
H4a: Applying open innovation in idea generation level does not have significant effect on firm innovative performance.	0,36	0,07	Reject*	0,19
H4b: Applying open innovation in idea generation level does not have significant effect on firm economic performance.	0,82	0,66	Do not reject	
H4c: Applying open innovation in commercialization level does not have significant effect on firm innovative performance.	1,43	0,49	Do not reject	
H4d: Applying open innovation in commercialization level does not have significant effect on firm economic performance.	0,27	0,87	Do not reject	

* significance level %10
** significance level %5
*** significance level %1