Analysis of Relationships between Firm Performance and Open Innovation Strategies and Stages in the Turkish Food and Beverage Industry

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Jel codes: O31, L66, L25

Abstract

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

Keywords: *Inbound open innovation, Outbound open innovation, firm performance, food and beverage industry, Turkey.*

Résumé

L'objectif de ce travail est d'analyser les relations entre les stratégies et le niveau des pratiques d'innovation ouverte, d'une part, et la performance innovatrice et économique des firmes agroalimentaires, d'autre part. La littérature suggère que le niveau d'innovation ouverte dans les différentes étapes du processus de production, comme par exemple la conception des idées, le développement ou la commercialisation d'un produit, peut être influencé par les parties prenantes et avoir un effet important sur le rendement de l'entreprise innovante. Dans cette étude, nous allons explorer les différentes hypothèses concernant les effets des stratégies et des niveaux d'innovation ouverte. Les données retenues pour l'analyse économétrique ont été obtenues à partir d'une enquête menée auprès de 146 firmes agroalimentaires. Un des résultats empiriques principaux indique que la stratégie d'innovation ouverte n'est pas le seul facteur déterminant pour le niveau d'innovation. Un autre résultat empirique montre que l'innovation ouverte en phase de conception d'une idée exerce un effet positif sur la performance innovatrice de l'entreprise.

Mots-clés: innovation ouverte entrante, innovation ouverte sortante, performance de l'entreprise, industrie des aliments et des boissons, Turquie.

1. Introduction

Open innovation has frequently been emphasized in the 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 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 search efforts. 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 (Seyfettinoğlu and Taşdoğan, 2014).

Open innovation which was first cited by Chesbrough (2003) is a multidisciplinary approach and incorporates all stakeholders of the firm (e.g.: shareholders, suppliers, customers, research institutions) in innovation process. Open innovation enables firms to use external knowledge besides the knowledge internally produced which accelerates innovation process because of the interchanged knowledge by firms. This external availability of innovation for the market supports Chesbrough's argument about competitive power which could best be obtained through efficient use of internal and external knowledge rather than producing best and most ideas (Chesbrough, 2003). For instance, firms involved with open innovation experience considerable cost advantages in new product development and process recovery (Wallin and Krogh, 2010).

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

- 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 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.

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– Gaining competitive 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 stage. 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 stage of open innovation, which consists of 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 the impact of knowledge management abilities that affect type of open innovation; to determine application stage of open innovation; and finally to measure the effect of open innovation on innovative and economic performance among companies operating in food and beverage 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, conclusions are reported in section six.

2. Open Innovation in the Food and Beverage Industry

Firms operating in food and beverage industry are differentiated from other manufacturing firms due to their requirement of more natural resources and know-how in their production processes (Acosta *et al*., 2013; Ahn *et al*., 2013). Features of innovation in food and beverage industry could be listed as follows (Lazarotti *et al*., 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, 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 (Fortuin and Omta, 2009), rare use of patents (Teece and Pisano, 1997; Lichtenthaler, 2010), 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 Beverage 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 (TGDF, 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 lower when compared with others (Martinez and Briz, 2000). However, quality management and security standards will guide innovation in the food industry (Maurer and Drescher, 1996). 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).

Turkish Food Industry is not open to innovation. The main reason of this fact lies in the traditionalism of the industry. On the other hand, conservatism of the consumers and their reluctance in changing their food preferences limit innovation.

The main factor that increases the power of innovation is R&D activities. The results of "Turkish Statistical Institute R&D Activities Research" reveal that R&D Expenditures of Food and Beverage Industry have increased from 59.9 million TL in 2006 to 82.4 million TL in 2012, with an increase rate of 37.4%. This improvement is hopeful, yet not sufficient. The share of R&D Expenditures of Food and Beverage Industry in R&D Expenditures of production industry has been 5.1% in 2006, whereas it has regressed to 2.7% in 2007. This share has displayed a limited increase to 3.1%

in 2008 and 3.7% in 2009. In the subsequent years, the share has decreased to 3% in 2010, 2.9% in 2011, and 2.6% in 2012.

In food industry, innovation mainly emerges as new technologies, products, and innovative packaging developed in order to extend shelf life and increase food safety. In other words, mostly incremental innovation occurs. Supreme Council for Science and Techonology (SCST) has resolved in its 21st meeting held in 22 June, 2010 that "work groups should be organized with expert participation from relevant public and private sectors, and higher education institutes under the coordination of the Scientific and Technological Research Council of Turkey in order to prepare national R&D and innovation strategies in the fields of energy, water, and food; and these groups should prepare the said strategies" (decree N. 2010/101). Accordingly, efforts for constituting R&D and innovation policies in Food Industry would continue with the vision of "Turkey producing innovative food brands with high added value by using environment-friendly technologies in every stage of food production".

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 (Seyfettinoğlu and Taşdoğan, 2014). 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 (Lichtenthaler, 2008; Dahlander and Gann, 2010).

Although comprehensive, open innovation is generally performed through "inbound innovation", "outbound innovation" and "coupled innovation" (application of both inbound and outbound open innovation 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 universities – R&D institutions for product development, incorporating the customers or end-users in product development activities, and 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 research works reveal the fact that firms mostly employ open innovation strategy (Bianchi *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 knowledge take 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. 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 determining, perceiving, and changing 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, Jiménez-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 it 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 to 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 stages 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 stages in the firms operating in food and beverage industry and the strategy impacts on firm innovative and economic performances. The rapidly increasing open innovation literature revealed that open innovation implementation stages occurred during the production process are idea generation, development, and commercialization, and these are influenced by 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.

Hypotheses developed on the open innovation implementation stages 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 by the

Figure 1 - *Hypotheses on the Open Innovation Strategies of the firms.*

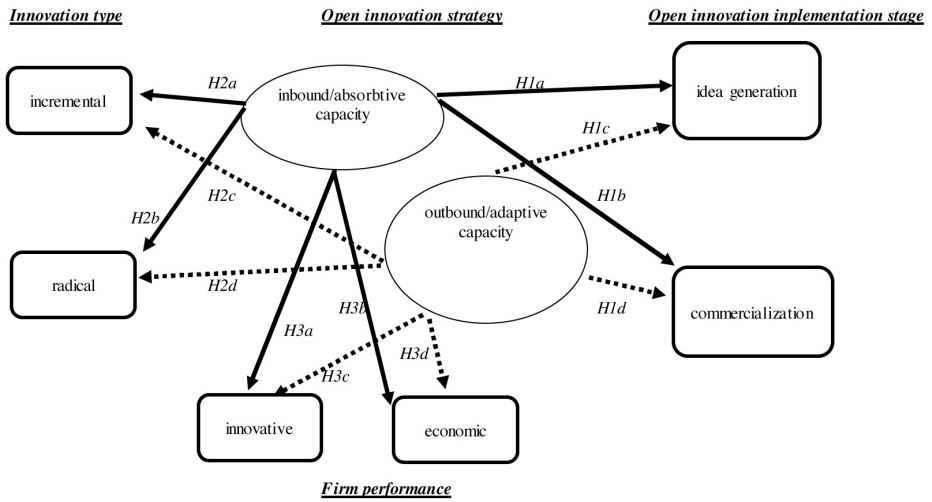
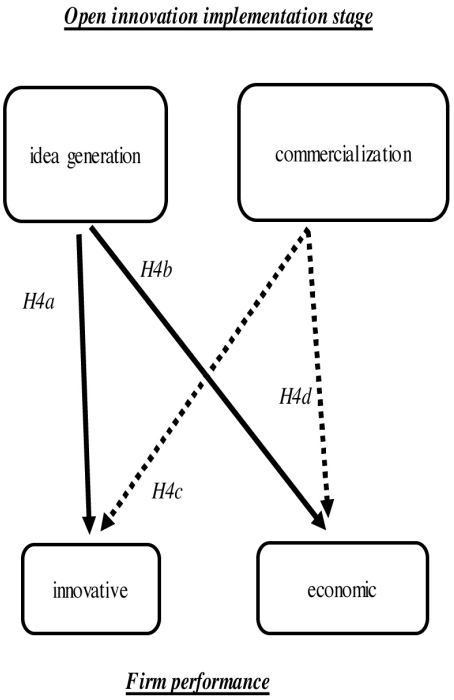


Figure 2 - *Hypotheses on Open Innovation Implementation Stage of the firm.*



open innovation practices in idea generation stage, hypotheses *4c* and *4d* posit that open innovation in commercialization stage does not have any effect on innovative and economic performance.

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. These firms are all large scale producers, operating in food and beverage industry in Turkey, and selected from the top 1000 firms with respect to their annual turnover listed by Istanbul Chamber of Industry (ICI) in 2011. Except only about 11 firms which employ between 50 and 100 people, the rest employes 850 people on the average. Other economic data[1] of the firms are also obtained from ICI 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[3]. A single item was used to determine the sub-sector of the firms. Pre-tests were carried out and some of the questions were excluded from the questionnaire.

4.2. Econometric Analysis

Econometric analyses were carried out with Eviews 8.0 econometrics software by transforming data of 2011, obtained through field work with the food firms, into dependant and independent variables. Variables were organized in discrete, continuous, ordered discrete and bounded continuous forms and in the analyses a linear functional form[4] (relationship) is assumed between the dependent and independent variables and among the independent variables. The dependent and independent variables used in the econometric analyses are given Tables A2 and A3 in Appendix. When we have continuous data for a dependent variable, we used the data as it is, for instance firm turnover data. If we have data collected on likert scale, in some cases we constructed a discrete dependent variable such as positive answers in likert scale is 1, the rest is 0. In some cases more than one question is used to create the dependent variable; in these ones we summed up the likert values under each question and created a continuous series. These can be observed from Table A2. Same methodologies are used while contructing the independent variables as well. Table A3 provides the information regarding these independent varaibles.

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[5]. All estimation results were tested with Glesjer and White tests for alternative hypothesis of heteroscedasticity[6].

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[1] This data covers firm employment, turnover, returns on investment, foreign trade, foregin capital, debt. Among these indicators turnover and exports are used to show firm economic performance and number of emplyees is used as an explanatory variable.

[2] (1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree, 4 = Neither agree nor disagree, 5 = Somewhat agree, 6 = Agree, 7 = Strongly agree)

[3] Firm's turnover in 2010 (in TL):
(1) 0 – 10.000.000 (2) 10.000.001 – 50.000.000 (3) 50.000.001 – 250.000.000 (4) 250.000.001 and over
Firm's return on investment in 2010 (in TL):
(1) 0 – 10.000.000 (2) 10.000.001 – 50.000.000 (3) 50.000.001 – 250.000.000 (4) 250.000.001 and over
Firm's share in total domestic market sales in 2010 (in %):
(1) %0-9,99 (2) %10-19,99 (3) %20-29,99 (4) %30-49,99 (5) %50-69,99 (6) %70-89,99 (7) %90 and over
Foreign capital financial participation in the firm (in %):
(1) %0-19,99 (2) %20-39,99 (3) %40-59,99 (4) %60-69,99 (5) %70-79,99 (6) %80-89,99 (7) %90 and over
Rate of last two years R&D expenditures in total sales revenue (in %):
(1) <0.5 % (2) 0.5 – 1.0 % (3) 1.0 – 2.0 % (4) 2.0 – 3.0 % (5) 3.0 – 4.0 % (6) 4.0 – 5.0 % (7) >5.0 %

[4] No other type of functional forms have been observed in the relevant literature.

[5] VIF values less than 5 were considered.

[6] Due to space limitations, covariance matrices, White and Glesjer test results, and VIF findings could not be provided within the text or in the Apppendix, yet they could be provided upon demand.

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 variables measuring inbound open innovation of the firm is listed in column one, dependant variables are listed in 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 composed of reduced time to market, reduced economic cost of innovation projects and reduced innovation risks while economic performance was measured with firm turnover.

One of the remarkable effects was found to belong to the variable that shows the cooperation between food industry firms and universities and research centres[7]. It was observed that this cooperation has positive effect on firm economic performance, on open innovation at idea development stage, and on open innovation that emerges through radical changes. The effect of same factor on open innovation in commercialization stage 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 stage 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 stages[8]. 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 stages 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 stage. 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. If 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 stages, 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 that have vertical relation would positively contribute to 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 incremental innovation more rather than radical innovation. 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 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

[7] This could be any type R&D projects that could improve the partial or full process from factory to the final consumer.

[8] This cooperation might involve acquiring feedback through elaborate and routine surveys from consumers and delivering it to firms to improve the whole process.

Table 1 - *Effects of Inbound Open Innovation Strategy*[+]

Dependant variable	Idea development (H1a)	Commercialization (H1b)	Practicing radical innovation possibility	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		

[+]: Under explanatory variables column "C" stand for constant term of the equation and the corresponding numbers in each column give the value of it.
*, **, ***: Denotes significance at 10%, 5%, and 1%, respectively.

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 stage. Positive effect of these practices on open innovation practices in commercialization stage, which makes personnel not only competitive 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 the 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 stage 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 to market conditions. Both quick adaptation and employment of best specialists indicate 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 stage. An additional factor positively affecting open innovation in commercialization stage 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 stage 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 stages and firm innovative and economic per-

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		-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

+: Under explanatory variables column "C" stand for constant term of the equation and the corresponding numbers in each column give the value of it.
*, **, ***: Respectively %10, 5 and 1 level of significance.

formance were tested. The only dependency relationship was found between open innovation in idea development stage and firm innovative performance.

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 and are among the top 1000 firms in Turkey in 2011.

Determination of open innovation strategy in food industry affects open innovation implementation stage. Hence, the effect of firm policies and changes, developed during strategy determination, on open innovation implementation stages 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 in one stage. In other words, choosing one stage for implementing open innovation facilitates achievement of the objectives. Choosing more than one stage for open innovation is more difficult to implement and requires more complex strategies, thus hindering efficiency.

Empirical findings indicate that firms in food industry could employ open innovation for production efficiency. Using open innovation implementation stages by food industry firms for improving economic performances may not yield the expected effect, yet open innovation in idea generation stage 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 the 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 research 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

Table A1 - *Open innovation application stage and firm performance relationship.*

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

Table A2 - *Dependent variables and calculation.*

Dependent Variables	**Data type (measurement)**
Phases in the innovation process	
Idea generation capability	Likert scale (1..7)
Commercialisation	Likert scale (1..7)
Firm focuses on radical rather than incremental innovation	Likert scale (1..7)
Innovative performance	Likert scale (1..7)
- Stimulate creativity and idea generation capability	
- Reduce innovation risks	
- Reduce new product/process development cost	
- Reduce time to market	
- Introduce new or significantly improved products or services	
- Introduce new or significantly improved production process	
- Opening of new markets	Continuous
Economic performance	
- Firm s turnover in 2010 (in TL)	

Table A3 - *Independent variables and calculation.*	
Independent Variables	**Data type (measurement)**
Size (number of employees)	Continuous
Public/private ownership	Discrete
Foreign participation	Discrete
Involved partners Universities and research centres Innovation intermediaries Government agencies Customers (i.e. retailers) and consumers Suppliers Competitors Companies operating in other industries	Likert scale (1..7)
Positive externalities Using common labour force (labour pool) Using common finance Benefitting from "knowledge economy" Decrease in the cost of coordination of external relations Flexibility to adopt market conditions Efficiency increase Performing innovation	Likert scale (1..7)
Drivers of collaboration Access to advanced technologies Increase our internal flexibility with regard to innovation Stimulate creativity and idea generation capability Reduce time to market	Likert scale (1..7)
Strategy ***Firm Strategy*** We continuously pursue new market opportunities We focus on new products and services We have a broad product/market portfolio ***Innovation Strategy*** We try to hire the best scientists and experts in the market We normally use innovative, flexible and non-routine technologies We have a broad technology portfolio	Likert scale (1..7)
Intellectual property Patents Design Trademarks Trade secrets Non-disclosure agreements and other contractual agreements (e.g. Joint Development Agreements) Copyrights	Likert scale (1..7)
Organisational and management interventions There is a formal organisational unit within the company to coordinate and support technological collaborations with external partners There are organisational roles within the company to facilitate cultural change by developing the understanding, knowledge, processes and skills required in technological collaborations with external partners	Likert scale (1..7)
Organisational and management actions Each collaborative project has a "champion" to ensure collaboration success We formally assess the trade-offs between internal development and external acquisition We use project management techniques to manage the collaborations We use internet-based systems to facilitate the search of potential partners We use simulation or virtual prototyping tools to facilitate the development of new products developed in collaboration projects	Likert scale (1..7)
Innovation Resources and Capabilities We give our staff time and resources to generate new ideas We set our staff creative and challenging objectives We allocate resources for our staff continuous professional development	Likert scale (1..7)
Collaboration Top management is fully committed to maximising collaborative results	Likert scale (1..7)
Our staff easily adapt to new situations There is a high level of collaboration within functional areas to identify and resolve emerging issues in innovation activities There is a high level of interaction across different functional areas in innovation activities	
Business environment Rapidly changing customer/consumer needs and preferences Nearly all technologies developed in our industry are protected by intellectual property rights, especially patents	Likert scale (1..7)