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Analyzing effects of external integration on innovations outcomes in large and non-large Brazilian food companies

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Abstract

Purpose – The purpose of this paper is to explore the relationship between external integration and innovation outcomes in the Brazilian food companies.

Design/methodology/approach – Based on a survey questionnaire with 84 participants from large and non-large food companies of Brazil, the paper has used linear regression to examine the relationship between external integration and innovation outcomes. Next, the paper used the Wilcoxon-Mann-Whitney Test to compare the two sets of companies, i.e. large companies (annual sales > US\$5 million), and non-large companies (annual sales US\$1-5 million).

Findings – The paper found that external integration with suppliers and customers is positively related to innovation outcomes in food companies. Besides, radical innovation is directly related to large companies rather than non-large food companies. Furthermore, customer integration is perceived in large food companies rather than non-large. To the best of the knowledge, this is pioneering information in food companies.

Research limitations/implications – This research has been tested based only on participants' perceptions. Therefore, the findings should also be verified through of a longitudinal fashion or in deep study.

Practical implications – The main practical implication lies with the embedding of these concepts in a research from the perspective of a developing economy. Seen in this light it is noteworthy that such findings may contribute to the understanding of innovation outcomes in other developing countries.

Originality/value – There are few empirical studies that explore the relationship between external integration and innovation outcomes in food companies. Besides, there is little knowledge about differences between large and non-large food companies regarding to incremental and radical innovation. Our research is the first study analyzing these issues in large and non-large food companies in the Brazil.

Keywords Supply chain management, Food industry, Survey

Paper type Research paper

1. Introduction

In the production and operations management literature, external integration is often mentioned as a key driver to enable innovation and the long-term competitiveness of the supply chain as a whole (Cao and Zhang, 2011). According to Childerhouse and Towill (2011, p. 7441) “in the current climate of global supply chain competition, integration is regarded as a prerequisite for winning performance.” In the supply chain context, historically, integration research has focussed on long-term collaborative relationships (Zacharia *et al.*, 2011). According to Soosay *et al.* (2008, p. 160) “collaborative relationships enhance continuous innovation in the supply chain.”

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Integration with both customers and suppliers affects the innovative market performance of firms (Faems *et al.*, 2005) and positively impacts financial performance (Lee *et al.*, 2011). In line with Emden *et al.* (2006) we understand that innovation demands greater coordination, cooperation, and integration among companies. In particular, we view collaboration as a mechanism to deploy external integration (Zacharia *et al.*, 2011), and external integration as a mechanism to deploy innovation, which in turn exert effects on the improvement of firm performance (Yang, 2012).

Ganotakis and Love (2012, p. 1) argue that “innovation is central to the survival and growth of firms, and ultimately to the health of the economies of which they are part.” Besides, as pointed out by Capitanio *et al.* (2010, p. 503) “innovation is considered one the most important factors to enhance competitiveness on both national and international markets.” Overall, the literature on food industry says little about the wider role of suppliers and customers in innovation. While there have been several studies focussing on the relationship integration-innovation in many industrial sectors (e.g. Faems *et al.*, 2005; Emden *et al.*, 2006; Soosay *et al.*, 2008; Cao and Zhang, 2011; Yang, 2012) there are few empirical studies that actually show how external integration improves the overall performance in innovation of food companies (Hartwich and Negro, 2010). Besides, there is little knowledge about differences between incremental and radical innovation regarding to large and non-large food companies (Trail and Meulenberg, 2002).

In line to Herath *et al.* (2008) we understand that much of the existing literature on innovation in food companies has been analyzed with a focus from developed world. Hence, relatively little is known about the factors which enhance a food firm’s ability to undertake incremental/radical innovation in developing countries. This paper investigates this relationship in Brazil, currently, a global agribusiness center that playing a very important role in many global agri-food supply chains.

In this study, our aim is to examine the relationship between external integration and innovation outcomes in the Brazilian food companies. More precisely, we address the following research questions:

- RQ1. Do external integration is related to innovation outcomes in food companies?
- RQ2. Are large firms stronger in radical innovation rather than non-large firms in this sector?
- RQ3. Are there significant differences in terms of suppliers/customers linkages between large and non-large food companies?

We have chosen to analyze the relationship between external integration and innovation outcomes under firm size perspective (large and non-large), due the following reasons:

- In recent years, it became apparent that smaller and medium-sized firms (SME) are involving suppliers and customers in their innovation process (Gassmann *et al.*, 2010). In this scenario, we highlight that this sector (food companies) is of special interest due to important roles played by small to medium-sized enterprises (Herath *et al.*, 2008).
- Currently, even food SMEs need to innovate to ensure their continuity in the national and international markets (Triguero *et al.*, 2013). In this context, it is expected that empirical evidences of the significance of integration management

may assist managers to identify opportunities in the relationship with suppliers and customers, in order to improve innovation outcomes.

- While firm size has been one of traditional explanatory variable included in the innovation studies (Triguero *et al.*, 2013) the literature do not suggest any clear relationship between company size and innovation outcomes in food sector (Trail and Meulenber, 2002).

In addition, while previous studies have often examined the influence of external integration on innovation outcomes, these studies have generally examined only customers' perspectives or only suppliers' perspectives; this research expands on such previous research by comparing both "sides" of the equation. Moreover, much of the existing knowledge on external integration that affects innovative capacity of firms has been developed outside of developing countries, largely with an European focus (Herath *et al.*, 2008). These arguments explain our interest in analyzing effects of external integration on the innovation outcomes of food companies in a developing country. Our research is – to the best of our knowledge – the first study analyzing these issues in the Brazilian food companies.

This paper is organized as follows. First, the theoretical background is described. Next, the research methodology is presented, followed by the presentation of the analyses and results. Subsequently, managerial implications are discussed. Finally, main conclusions are drawn, together with limitations of this study and suggestions for future research.

2. Theoretical background

In this paper, we have carefully defined each construct in terms of essential characteristics from the relevant literature base (Yang *et al.*, 2011). The definition for each construct and the supporting literature is summarized in Table I.

Construct	Definition	Supporting literature
Supply chain integration (SCI)	It involves interfaces that facilitate coordination and the effective and efficient flows of information, material, money, and decisions which aim to create customer value and reduced overall costs	Elmuti <i>et al.</i> (2008), Green Jr <i>et al.</i> (2008), Flynn <i>et al.</i> (2010), Lockstrom <i>et al.</i> (2011), Shoenherr and Swink (2012)
Supplier and customer integration	A set of practices focused on integration with its key supply chain members in order to fulfill end customer requirements	Stank <i>et al.</i> (2001), Chen and Paulraj (2004), Won Lee <i>et al.</i> (2007), Quesada <i>et al.</i> (2008), Zhao <i>et al.</i> (2011)
Incremental innovation	Incremental innovation refers to minor changes, from existing technologies, which provide new features and new improvements to existing process or products	Daft (1978), Teece (2000), Jansen <i>et al.</i> (2006), Herrmann <i>et al.</i> (2007), Sherwood and Covin (2008), Valle and Vázquez-Bustelo (2009), Capitanio <i>et al.</i> (2010), Kim <i>et al.</i> (2012), Triguero <i>et al.</i> (2013)
Radical innovation	It is the introduction of processes or products (or services) that incorporate substantially different technology from that now in use for existing products or processes	

Table I.
Constructs, definition, and supporting literature

2.1 Supply chain management (SCM)

According to Mentzer *et al.* (2001, p. 4) supply chain is “a set of three or more entities directly involved in upstream and downstream flows of products, services, finances and/or information from a source to a customer.” In this sense, the external integration with suppliers and customers is referred to by Bowersox and Closs (1996) as SCM. This concept was introduced by consultants in the early 1980s, and has subsequently gained the attention of academics and practitioners worldwide. Chen and Paulraj (2004, p. 132) highlight that “analytically, a typical supply chain is simply a network of materials, information and services processing links with the characteristics of supply, transformation and demand.” However, the literature shows that effective SCM is a source of sustainable competitive advantage for organizations, enabling to develop connections between a single firm and critical entities of its supply chain (Barratt and Barratt, 2011).

Over the years the attention of practitioners and academics on integration practices into supply chain context has significantly grown (Danese *et al.*, 2013). Scholars in the area of SCM commonly agree on the positive relationship between SCM and organization's performance, due, mainly, to benefits enjoyed from the external integration (Kotzab *et al.*, 2011). For this reason, linkages with suppliers and customers, aimed at coordinating upward information and downward material flows along the supply chain is actually viewed as a crucial issue in industrial management (Danese *et al.*, 2013). In line with Shoenherr and Swink (2012), in this paper we view external integration as part of supply chain integration (SCI) concept. In addition, considerable evidence suggests that external integration varies in terms of firm size (Flynn *et al.*, 2010).

2.2 Innovation

Much attention in the worldwide research has been devoted to innovation in the industrial context. Overall, innovation refers to new applications of knowledge, ideas, methods, and skills that can generate unique capabilities and leverage operational, financial, and market performance of an organization (Daft, 1978). This definition enables to see a broader approach of innovation by covering both administrative and technological innovation, as well as both radical and incremental perspectives. In a turbulent economic environment of global market, firms should have the ability to identify new opportunities, in order to achieve competences and knowledge to accomplish a sustainable, competitive advantage (Teece, 2000). In this context innovation is a strategic driver in seizing new opportunities and protecting knowledge assets.

According to Kim *et al.* (2012) there are five types of innovation: incremental product, incremental process, radical product, radical process, and administrative. Administrative innovation refers to the application of new ideas to improve organizational structures and systems, and processes pertaining to the productive structure of an organization (Valle and Vázquez-Bustelo, 2009). Technological innovation (process or product) can be divided into incremental and radical innovation. Product innovation refers to changes at the end of providing products or services, while process innovation is defined as changes in the method of producing products or services (Jansen *et al.*, 2006). Process innovation is described as changes in the way that an organization produces products or services (Kim *et al.*, 2012). Our focus is in this innovation types (except administrative innovation).

2.3 Theoretical support to the link between external integration and innovation outcomes

Integration in the supply chain perspective involves the processes of collaboration with suppliers and customers to achieve mutually acceptable results (Pagell and

Krause, 2004). Soosay *et al.* (2008) assert that the supply chain must be managed as a single organization for barriers to interorganizational learning and innovation to be broken down.

The literature supports that integration with suppliers and customers helps firms improve performance in innovation, and it suggests that the degree of integration is a determinant factor in the innovative performance of firms (Faems *et al.*, 2005). Earlier research has shown the direct linkages between supplier and customer integration and innovation (e.g. Petersen *et al.*, 2003; Magnusson, 2003; Fortuin and Omta, 2009; Antikainen *et al.*, 2010). According to Panayides (2006), innovativeness in the supply chain context is influenced by the relationship orientation between two or more partners in a business-to-business setting.

Besides, our review of the literature has shown that adequate follow-through competencies and the ability to develop internal infrastructure (Assink, 2006), interaction based on informational activities and the establishment of sound relationships (Talke and Hultink, 2010), and knowledge-sharing in external settings (Wagner and Bukó, 2005) have positive effects on innovation. Tan *et al.* (1998) suggest that when companies are integrated and act as a single entity, performance is shared throughout the chain. Similarly, collaborations and combined experience of both parties can help reduce errors, defects, or flaws in routine, which can lead to improved operational performance (Zacharia *et al.*, 2011).

According to Panayides (2006), innovativeness in the supply chain context is influenced by the relationship orientation between two or more partners in a business-to-business setting. Further, our literature review has shown that innovation from the SCI perspective involves issues such as: the number and type of partners with whom the company collaborates (Lazzarotti *et al.*, 2011); company age, company size, and regional economic performance (Avermaete *et al.*, 2003); the convergence of technologies delineation of roles within value chain business networks and, facilities in the emergence of innovative interaction strategies among network participants (Walters *et al.*, 2011).

Regarding the size of the firm, empirical researchers have demonstrated that this variable may contribute positively to the efficiency with which firms develop new innovations (e.g. Cetindamar and Ulusoy, 2008; Ganotakis and Love, 2012; Inauen and Schenker-Wicki, 2012). Besides, considerable evidence suggests that innovation performance depends on firm size. According to Van Gils *et al.* (2009) large firms have proportionally greater resources available to devote to R&D-activities than small firms. Many other researchers argue that large firms develop more innovations due formal collaboration teams be more common among larger than smaller firms (Sherwood and Covin, 2008). In addition, large companies are more likely to partnership process rather than small and medium size companies (Van Gils *et al.*, 2009).

2.4 External integration and innovation outcomes in food companies

This paper agrees with previous studies (e.g. Triguero *et al.*, 2013) regarding that there are differences in innovation between food and manufacturing companies. For instance, most product innovations in the food industry are incremental rather than radical (Herrmann, 1997). However, as suggest Trail and Meulenber (2002, p. 1) “food and agribusiness industry, traditionally low-tech, is becoming more technology intensive.” Nevertheless, innovation in the food industry is a rather complex process and can involve different actors throughout the supply chain (Capitanio *et al.*, 2010). As highlighted by Hartwich and Negro (2010, p. 428) “scholars studying innovation

and development in value chains argue that dynamics of innovation are not only individual but involve various agents in the chain that produce and process the commodity.”

Capitanio *et al.* (2010) confirm that studying the innovativeness of food companies requires analysis of various factors which affect firm organization, specially, factors involving the vertical relations in which the firm is embedded. In this context, Siriwongwilaichat and Winger (2004) pointed out that due the rapid changes markets, food companies are challenged to develop food products that best meet consumers' needs. Thus, in the food sector the relationship between external integration and innovation is particularly important as it deals with the adoption of new technologies that allow firms to respond to higher quality standards, with new ways to present more traditional products, with product diversification, that is the increase in the set of available goods, with new and different functions to be embodied in food products (Capitanio *et al.*, 2010).

Besides, the literature on innovation in food companies suggests that: first, larger firms are more R&D intensive and place greater emphasis on new product (Trail and Meulenbergh, 2002); second, when size is considered, larger firms are more likely to introduce product and process innovation (Triguero *et al.*, 2013); third, food companies are mainly process-innovation oriented, and use new technologies developed by upstream industries (Capitanio *et al.*, 2010).

2.5 Research gap

Prior research has indicated that supplier and customer integration enhances innovation and contributes to better firm performance in many manufacturing sectors (e.g. Soosay *et al.*, 2008; Lau *et al.*, 2010; Cao and Zhang, 2011). However, as we stated earlier, the literature indicate that there are several differences in innovation between food and other types of manufacturing companies. Overall, studies show that in food companies external integration with suppliers and customers is positively linked to innovation (e.g. Trail and Meulenbergh, 2002; Bhuyan, 2005; Capitanio *et al.*, 2010), however, these studies indicate that this research field is not clearly verified in the literature, and those that are verified in many cases contain conflicting arguments. For instance, Herath *et al.* (2008) indicate that the impacts of firm size on a firm's innovative capability have been intensely contested in the literature. Based on this context, the following research gaps can be address.

First, analyses involving external integration and innovation outcomes carried out for the food sector are scarce. To the best of our knowledge there are no authors that focus the link among external integration and innovation outcomes (surveying food companies) in a developing country. This relationship is unexplored. Therefore, here we will contribute to the discussion of an important question to food companies.

Second, we examine the link among external integration and innovation outcomes analyzing both types of innovation: incremental and radical innovation. To the best of our knowledge, these two types of innovation have usually not been together considered by other studies, and in the case of the Brazilian food sector, there is not any study that examines it.

Last, given that most of the previous research on innovation outcomes in the food companies has been made based on case studies or on very small samples of firms (Trail and Meulenbergh, 2002; Triguero *et al.*, 2013), here we will examine this issue using a large and representative sample of a national sector.

3. Research methodology and data analysis

3.1 Sample and data collection

To understanding if integration activities with suppliers and customers impact innovation outcomes in food companies, we conducted a nationwide survey with 500 companies of this sector (including industries of farming support such as fertilizers, pesticides, and agricultural machines) in Brazil. Questionnaires were sent out to supply management professionals of the 50 largest companies (based on sales for the year 2011) of Brazilian agribusiness. The list of firms was derived the ranking *Melhores e Maiores* from *Exame*, year 2011. This business periodical is an annual publication that presents the largest companies in Brazil, including agribusiness companies.

Given that our main interest is the innovation outcomes in large and non-large companies from links of external integration, the units were selected to provide a mixture of large and non-large companies. For each of the 50 largest companies, we selected an average of ten business units to receive the questionnaires. The justification for this procedure stems from the fact that each firm of our initial sample (50 largest companies) has between ten and 20 units of different types of food products, from basic food to highly processed food. Given the variation in the number of units (and due the impossibility of sending questionnaires to all units) we choose the participating units by intentional sampling. In addition, all firms in our total sample (84 food companies) are units autonomous. We decided to direct the survey to directors or managers of the supply chain, purchasing, logistics or other leaders in the firm who have clarity and visibility of supply chains and operations.

For data collection, we used a two-stage process. After a literature review seven individuals (three professors in operations and SCM, two industry experts, and two PhD candidates in operations management) were selected as participants in a pretest to indicate if the questionnaire was adapted in accordance to food companies perspective. Besides, the respondents were asked to provide feedback about question clarity and consistency with literature review. By incorporating their feedback, measurement items were modified, discarded or added to strengthen the questions and content validity.

The data collection was realized between June and July 2012. We sent a letter in which the respondents were directed to respond to the survey in three ways: by selecting the link that would take them to the online questionnaire, by e-mail in PDF format, or by mail giving back a physical copy of questionnaire. The survey instrument consists of three parts. In the first part, we asked for information about the function of respondent and their company. In the second part, these respondents were asked about the degree of integration with suppliers and customers of their company. Next, they were asked to indicate the levels of process and product innovation (incremental and radical).

The total sample is 84 business units, i.e. of 500 surveys sent out, 84 surveys were returned. The response rate was 16.8 percent (84/500). This response rate compares closely to that reported in recent supply management and operations management papers (e.g. Schmoltzi and Whu, 2012; Koufteros *et al.*, 2012). We attempted to minimize non-response bias through the use of introductory letters and an assurance of confidentiality (Schmoltzi and Whu, 2012). All respondents were offered a report of the main results as an incentive to complete and return the questionnaire. We tested for non-response bias by first comparing company demographics of the responding firms to those of the non-responding companies. Then, we compared responses for the early and late respondents (Armstrong and Overton, 1977). The tests suggest that non-response bias is not present. Table II summarizes characteristics of respondents and companies.

Characteristics	Respondents	Characteristics	Companies
<i>Job title</i>		<i>Industry</i>	
Director	9	Sugar	18
Manager	64	Beef	12
Supervisor	5	Poultry and pork	8
Others	6	Milk and dairy products	8
		Oils and canned	15
<i>Job functions</i>		Fertilizers and pesticides	13
SC management	48	Agricultural machines	10
Purchasing	2		
Logistics	15	<i>Number of employees</i>	
Marketing and sales	4	<100	1
Operations Management	11	101-250	7
Others	4	251-500	27
		501-1,000	36
<i>Years worked at organization</i>		>1,000	13
<2	11		
2-5 years	56	<i>Annual sales</i>	
6-10 years	10	US\$ 1-5 million	59
> 10 years	7	>US\$ 5 million	25

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Table II.
Characteristics of the
respondents and
companies

3.2 Measurement item development and model of analysis

As we highlight earlier, the existing scales were adapted during the two-stage in data collection process. Supplier and customer integration was assessed using items adapted from Droge *et al.* (2004), Devaraj *et al.* (2007), Flynn *et al.* (2010), and Shoenherr and Swink (2012). Variables for incremental and radical innovation (processes and products) were measured by using measurement items from the works of Jansen *et al.* (2006), Herrmann *et al.* (2007), Valle and Vázquez-Bustelo (2009), and Kim *et al.* (2012).

The model of analysis consisted of to calculate means and standard deviations of each issue. To examine the relationship between external integration and innovation outcomes we have used linear regression in SPSS 20.0. Next, we used the Wilcoxon-Mann-Whitney Test to compare the two sets of companies, i.e, large companies (annual sales >US\$5 million), and non-large companies (annual sales US\$1-5 million). The Wilcoxon-Mann-Whitney Test is a non-parametric test that compares two independent groups. The test has two important assumptions. First the two samples under consideration are random, and are independent of each other, as are the observations within each sample. Second the observations are numeric or ordinal, i.e. arranged in ranks. This test uses the relative position of the data in a rank ordering, unlike the *t*-test which uses the actual values (Marôco, 2011). The means and standard deviations for measurement items from large and non-large companies are shown in Table III.

4. Results and discussion

4.1 External integration impacts positively innovation outcomes in food companies

The results (as shown in Tables IV and V) indicate that the purpose of this research was supported broadly.

Consistent our literature review, the findings of this study show that external integration is related to incremental and radical innovation in food companies. Using linear regression, we found that the *R*-value is 0.924, which is statistically

Table III.
Measurement Items and
Descriptive Statistics

Variables and scale items	Large		Non-large	
	Mean	SD ^a	Mean	SD ^a
<i>Supplier and customer integration^b</i>				
<i>SI – supplier integration^c</i>				
1. My company provides suppliers with information forecasting demand	5.779	0.865	5.222	1.553
2. My company shares important information with our suppliers	5.604	0.719	5.003	1.140
3. Our suppliers participate in the design phase of our products	3.969	1.110	3.021	2.330
4. There is connection between the computers of our company and our suppliers	4.760	1.010	3.060	1.665
5. Our company shares the cost information with our main suppliers	5.385	0.826	4.985	1.229
6. Our company share information on production schedule in real-time suppliers	5.271	0.988	5.025	1.345
<i>CJ – customer integration^c</i>				
7. My company shares resources with the clients, such as deposits and facilities	5.938	0.665	4.556	1.150
8. Our clients and my company do jointly development of new products	5.344	1.002	4.705	1.758
9. Our customers and my company jointly identify opportunities for new markets	5.948	0.554	5.002	1.040
10. Our company carries out integrated management of demand with our customers	5.938	0.365	3.101	1.892
11. Our company carries out management of customer relationships	6.229	0.810	3.111	1.900
12. Our customers have access in real time about the availability of products	5.458	1.005	3.258	1.123
<i>RPI – incremental product innovation^{b, d}</i>				
13. My company introduced new products that minor differ from existing products	5.469	1.046	5.336	1.112
14. We introduce incremental product innovations into the market frequently	6.031	1.357	5.556	1.428
15. My company is well known by customers for incremental product innovations	6.010	1.349	5.725	2.011
16. Our incremental product innovations in the product range is significantly high	5.021	1.345	5.043	1.378
<i>RPI – radical product innovation^{b, d}</i>				
17. Our new products differ substantially from our existing products	5.677	0.979	1.562	0.745
18. We introduce frequently radical product innovations into the market	5.656	0.982	1.035	0.501
19. Our percentage of radical product innovation in the product range is high	6.016	0.957	1.008	0.652
20. The percentage of total sales from radical product innovations is up substantially	5.406	0.936	1.406	0.831
<i>RPI – incremental process innovation^{b, d}</i>				
21. We introduced minor improved machinery and equipment for our products	4.996	0.668	5.652	0.968
22. We introduced minor modified productive processes for producing products	5.417	0.541	5.634	0.981
23. We introduced minor improved information technologies for our products	5.404	0.332	6.104	0.994
<i>RPI – radical process innovation^{b, d}</i>				
24. We introduced new machinery and equipment for producing products	4.996	0.968	2.396	1.566
25. We introduced new productive processes for producing products	5.417	0.981	3.017	2.001
26. We introduced new information technologies for producing products	5.404	0.994	2.995	1.654

Notes: ^aStandard deviation; ^bitems were measured using a seven-point Likert-type scale, where 1 = strongly disagree and 7 = strongly agree

Sources: ^cAdapted from Droge *et al.* (2004), Devaraj *et al.* (2007), Flynn *et al.* (2010); ^dadapted from Jansen *et al.* (2006), Herrmann *et al.* (2007) and Kim *et al.* (2012)

significant. It indicates a high degree of correlation. The R^2 value indicates how much of the dependent variable (innovation outcomes) can be explained by the independent variable (external integration). In this case, 85.4 percent can be explained, which is very large. In addition, p -values < 0.01 and < 0.001 (which is < 0.05) indicate that, overall, the model applied is statistically significantly (Hu and Bentler, 1999).

In today's competitive environment companies need to cooperate closely with their suppliers and customers to meet various challenges, and respond to an environment full of uncertainties (Zhao *et al.*, 2011). From our findings, we understand that external integration practices can individually speed up the innovation process and it may contribute directly to performance of companies. Thus, our research provides significant implications for agribusiness industries in Brazil, as well as for different industries, by indirectly linking external integration to business performance through improved incremental innovation.

4.2 Comparing large and non-large food companies

According to the response profile in Table VI, this study finds that non-large companies are engaged with incremental innovation. Meanwhile, our findings allow stating that large food companies are engaged with radical innovation rather than

Model	Dependent variable	R value	R^2	Adjusted R^2	SE of the Estimate	Method
1	Innovation outcomes	0.924	0.854	0.51	0.37796	Enter

Table IV.
SPSS output for linear regression

Model		Sum of Square	df	Adjusted R^2	Mean Square	F	Sig.
1	Regression	67,849	2	0.854	33.925	237,473	0.002
	Residual	11,571	81		0.143		
	Total	79,421	83				

Table V.
SPSS output for regression model predicts

Issue	Variables	Companies	Mean Rank	Sum Rank	χ^2/df^a	p -value	Relationship
1-6	Supplier integration	Large (L)	7.83	49.0	0.917	***	L > NL
		Non-large (NL)	5.17	29.0			
7-12	Customer integration	Large (L)	9.5	57.0	0.956	**	L > NL
		Non-large (NL)	3.5	21.0			
13-16	Incremental innovation	Large (L)	6.57	46.0	0.690	**	NL > L
		Non-large (NL)	8.43	59.0			
17-20	Radical innovation	Large (L)	11.0	67.5	1.682	***	L > NL
		Non-large (NL)	4.0	37.5			

Notes: ^aValues ≤ 5.0 . ** $p < 0.01$; *** $p < 0.001$
Source: According Hair *et al.* (2010), Hu and Bentler (1999)

Table VI.
Path results

non-large food companies (11.0 and 4.0, respectively). This is an important finding and it adds to the literature, however, the present study is not unique in finding evidence in this way as other studies with similar results have already been reported, e.g. Fortuin and Omta (2009).

Besides, our findings show that large food companies are engaged with customers integration rather than non-large food companies. To the best of our knowledge, this is pioneering information. Previous research has related that the interaction between companies and their customers one of the main drivers of innovation success. However, in terms of benefits of customer integration on innovation, none have addressed the link between customer integration and radical innovation, specifically, in the Brazilian food companies. Nevertheless, future longitudinal studies could be conducted to better investigate this issue.

5. Conclusions and limitations

In the last decades of the twentieth century, the industrialized and developed world have conducted significant advances in many areas of scientific and technological knowledge, especially the USA, Japan and the major economies of continental Europe. However, at the end of the first decade of this century the world witnessed a shift in the center of gravity of economic growth for countries that until recently were considered peripheral, such as Brazil, Russia, India, and China – the BRIC.

In this context, Brazil – for their natural resource potential, by the advancement in scientific and technological capacity, by the dynamics of its domestic consumer market and by the degree of development achieved – lived in recent years, especially from 2003, a process of turning in their pattern of industrial development, overcoming an important part of the historical constraints on your process of economic growth.

In the past decade (2001-2010), the Brazilian agribusiness accounted for 25 percent of gross domestic product (GDP) of Brazil. Besides, Brazilian agribusiness is currently employing approximately 38 percent of the labor force in Brazil. In 2010, the GDP of the sector reached US\$421.1 billion, which represented 22.3 percent of GDP total. Food industry, focus of this study, is one of the major sectors of the Brazilian economy and of key importance in the development process of the country. From an economic standpoint, this sector is distinguished from the others due to the high number of companies formally established, the production capacity and the potential to generate trade surpluses from exports and generation new jobs.

Given that innovation is important to the growth of all firms, and ultimately for sustainable development of the economies in which they are inserted, the goal of this study was to explore the relationship among external integration, and innovation outcomes in the Brazilian food companies. Using a nationwide survey we show that: external integration with suppliers and customers is positively related to innovation outcomes in food companies, and; radical innovation is directly related to large companies rather than non-large food companies; overall, external integration and innovations outcomes are perceived in large companies rather than non-large companies.

This research makes several contributions to the existing literature. First, it adds to the literature by to demonstrate that incremental innovation was directly related to non-large rather than large food companies. Second, this research shows that customer integration and radical innovation are perceived in large food companies rather than non-large food industries. The third contribution lies with the embedding of these concepts in a research from the perspective of a developing economy. Seen in this light

it is noteworthy that such findings may contribute to the understanding of innovation outcomes in food sector of other developing countries.

While this study extends the external integration and innovation literature, there are also some limitations along with more opportunities for future research. First, our findings are based on single respondent data. Even though the respondents were prequalified and had direct experience with SCM, the same individual provided information on all measures of constructs, which could potentially bias the results. Second, because the data were only collected from food companies, future studies can broaden their scope by collecting data from several supply chains, including suppliers, manufacturers, and customers. Third, although this research provided some interesting findings about this complex relationship in Brazil, it is not clear whether these relationships will be the same in other countries. Future research should examine differences in this relationship in others countries, in particular, in developed versus developing economies.

Finally, because integration in supply chain perspective is developed over time, it will be fruitful for future research to examine the influence of integration on innovation outcomes in a longitudinal fashion or in deep study, including the different types of innovations that exist in Brazilian food companies. As SCI is an increasingly important area of research due to the fact that supply chains are becoming more widely dispersed across the globe, this research addresses only one fundamental issue in this context. In terms of Brazil, further research is needed in this area.

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