TRANSACTION COSTS, CAPABILITIES AND VERTICAL INTEGRATION IN PHARMACEUTICAL INDUSTRY

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Abstract

The objective in this study is to analyze the influence of transaction costs and capabilities on the choice between internal or external supplier for the manufacturing stage of drugs in the pharmaceutical industry in Brazil. The population is the set of 1566 drugs in the public database "Bulário Eletrônico" from the National Agency of Sanitary Surveillance (ANVISA). We developed a structural model with hypotheses on constructs of experience, diversification, asset specificity, bargaining power and vertical integration. We collected the data for each drug, including pharmaceutical form, therapeutic class, regulatory category and vertical integration of the manufacturing transaction. To test the hypotheses we conducted a confirmatory factor analysis of the measurement model through a structural equation model solved by Partial Least Squares. With respect to transaction costs, we found two main theoretical implications. The first is that there is a negative relationship between asset specificity and vertical integration. The rejection of the hypothesis seems to indicate a low strategic value of the transaction of drug manufacturing in the value chain of the pharmaceutical industry. In this sample, firms tend to outsource manufacturing transaction precisely for products with specific attributes. The second is the lack of influence of bargaining power on vertical integration. This result may be due to two aspects: the very market structure portrayed by population and the low importance of manufacturing transaction to generate value. We also found two main conclusions with regard to capabilities. The first is that the higher experience, the lower vertical integration. It seems that the positive correlation between capabilities and vertical integration does not appear to be valid in any situation. The opposite case is more appropriate to the history of outsourcing in various industries, as verified for electronics and automotive. The second is the positive relationship between diversification and vertical integration, supporting the view that the limits of the firm reflect a bundle of capabilities. The result could be subject to criticism that the vertical integration adoption may be resultant of cost considerations and delimitation of the scope based on the stages of greatest value to the company.

Key words: *governance structures, structural equations modeling, drugs manufacturing*

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1. Introduction

This article deals with the influence of transaction costs and capabilities on the adoption of governance structures for the manufacturing stage in a productive system, following previous studies on the relationships between the approaches of organizational economics and capabilities (Williamson, 1999; Hoetker, 2005; Nakamura, & Odagiri, 2005). The research context is pharmaceutical industry, which is highly dynamic in technological innovation and acquisitions. In Brazil, we observe institutional changes, government incentives and growth of the local laboratories (Silva, & Ruiz, 2011).

The Transaction Cost Theory (TCT) argues the firm is a nexus of contracts (Coase, 1937) and agents present bounded rationality and opportunism. The unit of analysis is the transaction between productive stages, with the dimensions of frequency, uncertainty and asset specificity. The last one is prevalent in empirical studies and indicates the potential for loss of previous specific investments in the absence of the transaction. Thus, the choice of governance structure is a rational choice to minimize transaction costs, due to the hazard of opportunistic behavior by the counterpart in the transaction (Williamson, 1991, 1999). This framework is useful to study contractual arrangements in productive systems, such as the franchising in retail markets or strategic partnerships in R&D activities (Ménard, 2006).

The capabilities approach has sought to understand the processes of adaptation and change of organizations in changing environments (Teece, Pisano, & Shuen, 1997; Dosi, Nelson, & Winter, 2000). The concept of routine was useful in this approach as a basic unit of variation, selection and replication, which allows the adaptation of firms to environmental changes. This process would explain the functioning and change of economic systems in the evolutionary theory proposed by Nelson and Winter (1982). The concept of routine has ambiguities for measurement in empirical studies (Becker, 2004).

In order to advance in a potential integration between the two approaches (Jacobides & Winter, 2005), we propose the following research question: what is the influence of transaction costs and capabilities in the vertical integration of manufacturing in the pharmaceutical industry? The general objective is to analyze the influence of transaction costs and capabilities on the choice between internal or external supplier for drug manufacturing in the pharmaceutical industry in Brazil. The specific objectives are: (1) develop a theoretical model with relations between the constructs experience, diversification, asset specificity, bargaining power and vertical integration, (2) measure the constructs with secondary data on products of the pharmaceutical sector, (3) test the construct validity of the proposed model and (4) test the hypotheses of the model concerning the relationships between the constructs.

The constructs related to transaction costs in this study are asset specificity and bargaining power. We measured asset specificity with two dimensions: the presence of differential aspects in the product (Bigelow, & Argyres, 2008) and the share of products with certain attributes in the firm´s portfolio. The construct bargaining power was associated with transaction costs by opportunism the phenomenon of "small numbers" (Pisano, 1996; Walker, & Weber, 1984). In order to examine capabilities we adopted the constructs of experience and diversification. The first one was measured by operation time of the firm or group in the industry (Dosi et al., 2000; Bataglia, & Meirelles, 2009; Bataglia, Silva, & Klement, 2011).

The adoption of the construct diversification was based on the assumption of the firm as a bundle of capabilities (Kogut, & Zander, 1992), and it was measured by the product attributes within the market. This concept is a narrower than the deployment of the knowledge base of the firm in different markets (Klein, & Lien, 2009).

The pharmaceutical industry has grown with the adoption of hierarchy as the prevailing governance structure in the various stages of the value chain, generating large and vertically integrated corporations. From the 1980s, adoption of strategic alliances increased, first abroad and later in Brazil (Powell, White, Koput, & Owen-Smith, 2005, Estrella, & Bataglia, 2013; Macedo, & Bataglia, 2012). At the manufacturing stage, the motivation for outsourcing by firms with traditional products would be the competition with companies that offer similar products (me too). When adopting outsourcing in this stage, firms may rely on multiple vendors for common industrial requirements. Thus, companies focused on innovative products can reduce production costs and increase margins in the period between the launch of the product and the entry of similar or generic (Polastro, 1999).

To obtain registration as a drug producer in Brazil, companies must operate according to the "good manufacturing practices" defined by National Agency of Sanitary Surveillance (ANVISA, 2010). This can lead to the predominance of vertical integration, due to the need of firms to achieve tight control of processes. In case of outsourcing of some stages, the regulator must also approve the contractor. This option requires a close relationship with the contractor in order to carry on tasks from the design of processes until the quality management of the final products. We assumed the "make or buy" strategic decision (Bataglia, & Yu, 2008) in manufacturing corresponds to the vertical integration or strategic alliance for outsourcing. We can measure that by the presence of vertical integration at each stage of manufacturing or by an index measuring participation of vertical integration in all the stages, following Hoetker (2005) and Nakamura and Odagiri (2005).

The study has five sections. The second presents the theoretical framework and the third explains the methods used in this research, including the data and procedures. We present and discuss the results in the fourth section and final considerations in the last section.

2. Theoretical Framework and Hypotheses

This section presents a conceptual model for explanation of governance structures in the manufacturing stage based on transaction cost and capabilities approaches. Williamson (1999) suggests the attributes of the transaction could explain the choice of generic governance structure, while aspects of organizational learning could influence some attributes of the chosen governance structure. The theme of governance structures involves an extensive research field, specifically for hybrid structures (Ménard, 2004). However, we delimitated the analysis of this governance structure with a variable often used in empirical studies of TCT: the choice between internal (make) and external (buy) supplier (Hoetker, 2005).

The second delimitating choice is the focus on transactions of manufacturing stage, considering its relevance in infant industries like the pharmaceutical in Brazil. Nogueira (2011) observed this process with the Brazilian laboratory Aché, which initially grew supported by partnerships with multinational companies for plant acquisitions and drugs licensing. The company has accumulated manufacturing expertise and resources to increase market share and generate resources to conduct product innovation activities in recent years.

We developed the conceptual model upon Jacobides and Winter (2005). They argue the distribution of productive capabilities between firms in an industry defines the vertical scope with moderation of transaction costs. The approach to the present model is similar, but

considers only the capabilities on operations of the firm owning the product. This choice is justified by the adoption of the product as the unit of analysis and by making easier to evaluating the influence of the firm´s capabilities on a specific transaction. The model of Jacobides and Winter (2005) refers to the analysis of a population of firms in an industry in order to measure the distribution of capabilities. Nogueira and Bataglia (2012) proposed a conceptual model to explain the choice of supplier for manufacturing with transaction costs and organizational competences of the firm owing the product.

Drawing upon Dosi et al. (2000), Kogut and Zander (1992), and Jacobides and Winter (2005), we expect the organizational knowledge stored and expressed in routines define the limits of the firm, particularly in the manufacturing stage. In this approach, the firm offers an environment for exchanging experiences and organizational learning by the employees in formal or informal groups, and it establishes the conditions for an appropriate level of specialization in the different stages of the value chain.

Henderson and Cockburn (1994) found two types of relevant capabilities for R&D activities in the pharmaceutical industry: component and architectural capabilities. The component capabilities refer to the skills on disease categories and the specific issues that support the development of medicines. The architectural capabilities refer to the ability to combine the disciplines and areas of therapeutic classes within the firm. For these authors the experience could be useful to measure these capabilities.

Since the focus of this work is the manufacturing stage, we assume the experience might be relevant and could be measured by how long the firm operates in the sector. Bigelow and Argyres (2008) consider the influence of the firm´s experience in the industry on the choice of governance structure, which support the analysis of capabilities of the firm owing the product. Along these lines, we propose the following hypothesis:

Hypothesis 1 (H1). The experience of the firm in the industry has a positive relationship to vertical integration in the manufacturing stage of the product.

Diversification reflects the range of different types of products offered by the company. In the pharmaceutical industry, the product can be described by the pharmaceutical form, by therapeutic class and by regulatory category. We expect that successful pharmaceutical companies have a minimum size efficient and offer a diverse portfolio of products in order to achieve economies of scope in production systems and risk management in R&D to deliver new products to market (Bogner, 1996). A diversified portfolio can influence the capabilities on operations by exposure of this functional area to a broad range of pharmaceutical forms. In this sense, this characteristic of capabilities might encourage the company to internalize the manufacturing. Following this reasoning, we derive the hypotheses below:

Hypothesis 2 (H2). The diversification of the firm in attributes of products in the industry has a positive relationship to vertical integration in the manufacturing stage of the product.

Hypothesis 3 (H3). The experience in the industry has a positive relationship to the diversification of the firm in attributes of products in the industry.

The asset specificity is an attribute often discussed in the literature of TCE as a relevant factor in the choice of governance structure. The rationale is that the greater investment in transaction-specific assets, the greater the tendency to adopt the hierarchy to coordinate this transaction, in relation to the contracting of external suppliers. The basic argument is that the existence of transaction-specific asset resulting from investments of one partner leaves this agent in a disadvantageous position and subject to opportunistic behavior

by the other partner (Williamson, 1991). Under these conditions there is a tendency to internalize the transaction for the firm. The hypothesis is as follows:

Hypothesis 4 (H4). The asset specificity in the manufacturing stage of the product has a positive relationship to vertical integration in that stage.

The relationship between transaction costs and capabilities in operations are less explored in the literature and present some difficulties to be depicted by researchers because each one is associated to distinct objects, respectively the transaction and the firm. However, it can be assumed that the transactions carried out by the firm can influence its productive capabilities. According to Jacobides and Winter (2005), the productive capabilities rest on the firm´s general and specific knowledge to do things and also involve specific investments in equipment, training and retention of key personnel required to put that knowledge to work.

The moderation function of transaction costs on the relationship between distribution of productive capabilities of firms in an industry and the vertical scope is argued by Jacobides and Winter (2005). They offer two hypotheses: (1) if capabilities are dissimilar along the value chain, then latent gains from trade across firm´s boundaries exist, then a reduction in transaction costs will lead to substantial disintegration, and (2) if capabilities are similar along the value chain, then there are no latent gains from trade across firm boundaries, then a reduction in transaction costs will not lead to substantial disintegration.

A critical vision on this approach is presented by Argyres and Zenger (2011). They recognize that empirical research in the literature corroborate this straightforward application of comparative capabilities logic to boundary choices. However, they argue transaction costs and capabilities are intertwined in a dynamic way as determinants of firm boundaries. In the phase of forming capabilities originally, transaction cost considerations have relevance to firms in deciding whether to retain, develop or sell them off. They focus on how organizations develop their capabilities in their early and later boundary decisions, and consider that, besides simple serendipity, the distribution of capabilities across firms and their suppliers reflects transaction costs operating in the past.

In the present model it is argued that transaction costs, besides their direct influence on the choice on governance structure with internal supplier, could be a driver for the development of capabilities on operations. Considering that asset specificity increases transaction costs, it is expected it would have a negative effect on diversification, reducing the range of therapeutic classes and pharmaceutical forms. We propose the following hypothesis:

Hypothesis 5 (H5). The asset specificity in the manufacturing stage of the product has a negative relationship to diversification of the firm in attributes of products in the industry.

With respect to the variable bargaining power, it refers to the possibility of opportunistic behavior by the partner in the transaction by the phenomenon of "small numbers". This phenomenon occurs when a potential partner has a position of market power for that transaction, because he has few competitors, which can lead to hold-up behavior to take advantage of this situation. When this is present, the other partner tends to avoid the transaction at market conditions, preferring vertical integration. This phenomenon was treated by Pisano (1991), who analyzed the choice of governance structure for R&D activities in biotechnology industry. Thus, the proposed hypothesis is as follows:

Hypothesis 6 (H6). The bargaining power of the firm for the manufacturing stage of the product has a negative relationship to vertical integration in that stage.

The bargaining power of a firm in a transaction in the value chain of a product depends on at least two factors: (1) the dissemination of the technology involved in the

transaction, (2) the number of suppliers operating with the technology in that transaction. The dissemination of the transaction´s technology is the percentile participation of its presence in the total products in the industry. This level of adoption is associated to the technological evolution and emergence of standards in the industry for this transaction. The dissemination of the transaction favors the number of suppliers and increases bargain power of the firm that owns the product, since it reduces the risk of opportunistic behavior by potential suppliers. In this sense, the adoption of a product with widely spread attributes in the market reduces the need for the development of the required capabilities to carry out the activity, since an external supplier could be contracted under favorable conditions.

Given the dissemination level of the technology, it is necessary to evaluate the number of suppliers for the transaction. The more the number of suppliers greater the bargain power of the firm owning the product. If the firm possesses this bargaining power due to the large number of suppliers, this could be a negative incentive for the investments in specific assets involved in the transaction and the subsequent choice of a more coordinated governance structure, such as the hierarchy. This expected effect on capabilities development resulting from asset specificity investments could be in support of the direct influence of bargaining power on the choice of outsourcing. The hypothesis is as follows.

Hypothesis 7 (H7). The bargaining power of the firm owning the product for the manufacturing stage has a negative relationship to asset specificity in that stage.

The model and hypotheses presented are an effort to deepen the comprehension for the role of capabilities and transaction costs for the choice of the limits of the firm in the manufacturing stage of a product. In order to test these hypotheses, we developed a structural equations model (Williams, Edwards; & Vandenberg, 2003).

3. Methods

This section presents the methodological procedures of the study. The research was planned and carried out with the use of data from public records of drugs in Brazil. Based on this approach, the text contains the description of procedures involving the definition of the unit of analysis, the measurement of the constructs and strategy of data analysis.

Considering the objectives of the study, we made some decisions regarding the data to be collected. The first issue is for the research universe as the set of drugs registered and approved for marketing in Brazil by the National Agency for Sanitary Surveillance (ANVISA). Within this universe, the object of analysis is the transaction of drug manufacturing. As the definition of ANVISA (2010), manufacturing involves the stages of production, potting, packaging and distribution. For this object, we considered the constructs Asset Specificity, Bargaining Power, Experience, Diversification, and Vertical Integration. We will present the indicators of the constructs in the next section.

With these constructs, the unit of analysis is the drug registration in ANVISA and we opted for the collection and analysis of the total population of records in the public database called Bulário Eletrônico (<http://www.anvisa.gov.br/fila_bula/>), which is a portion of the total drugs registered with ANVISA, predominantly new products and proprietary formulae. In the new database created for the research, we defined the product as the combination of the active principle with the pharmaceutical form, since a drug may be presented in two or more forms, and different levels of vertical integration in each one. For example, the drug Acheflan, (Aché Laboratories) is one case in ANVISA, but generates two products in the new database: Acheflan cream and Acheflan aerosol. We followed these steps: (1) data extraction of the drug registration from ANVISA, (2) generating records of products, (3) search and collection

of operation time of firms that owns the product and their groups, and (4) calculation of the indicators of the latent variables and constructs as presented in the next section.

3.1 Measurement of Latent Variables

We created indicators for the latent variables with data of drug registration in ANVISA. Starting with the product, we searched in many sources and collected the name of firm and its controller holding or corporation, defined as "group", and the experience, measured by operation time of the firm and of the group, respectively. Thus, this study provides a methodological contribution to the measurement of capabilities and transaction costs based on secondary data of products in the pharmaceutical industry.

We measured Vertical Integration by an endogenous variable with the same name and eight indicators. The drug label identifies the firm responsible for each stage of manufacturing: production, potting and packaging. We used the choice between vertical integration versus outsourcing contract, a strategic alliance contract by definition (Ménard, 2004, 2006). The dichotomous indicators for the firm are "Make Prod in Firm" (internal supplier for production in firm), "Make Pott in Firm" (internal supplier for potting in firm) and "Make Pack in Firm" (internal supplier for packaging in firm). Similarly, the indicators for the group are "Make Prod in Group", "Make Pott in Group" and "Make Pack in Group". The scalar indicators were the percentile participation of the number of stages with internal supplier in the total of stages ("Vertical Integ in Firm" and "Vertical Integ in Group").

We measured Asset Specificity by two latent variables: "Form Specificity", with three dichotomous indicators, and "Class Specificity", with two scalar indicators. We transformed the list of 62 pharmaceutical forms from ANVISA (2011) in dichotomous indicators assigned to the product. Then we created new indicators called "aggregate forms" by grouping the original forms with common attributes related to asset specificity: "Release Attribute in Agg Form" (the aggregate form composed by original forms with specific attributes to release the drug in the human body), "Pack Attribute in Agg Form" (the aggregate form composed by original forms with specific attributes in potting or packaging), and "Any Attribute in Form" (an indicator for the original form with any specific attribute).

The therapeutic class is the attribute of the drug´s function, which was measured by 72 dichotomous indicator called Class, relative to different diseases or effects generated by the drug, and 13 anatomic classes, resulting from aggregation of similar therapeutic classes (dichotomous indicator called Agg Class), relative to organs and systems of the human body. This method of classification is the Anatomic Therapeutic Chemical (ATC), from the World Health Organization (WHO, 2010), and is an internationally standard for drug classification. The scalar indicators for Class Specificity are "Agg Class in Firm" (percentile participation of the number of products with the aggregate class in the total products of the firm) and "Agg Class in Group", the analogue for the group.

For Bargaining Power we used the latent variables "Form Bargaining" and "Class Bargaining", both with three indicators. The indicators for Form Bargaining are "Products with Form" (share of products with the form in total products), "Firms with Form" (share of firms with the form in total firms), and "Groups with Form", the analogue for the group. The indicators for Class Bargaining are "Products with Class" (share of products with the class in total products), "Firms with Class" (share of firms with the class in total firms), and "Groups with Class", the analogue for the group.

The indicators for Experience and the latent variable of the same name are "Firm Time" (operation time of the firm in Brazil in years) and "Group Time" (operation time of the

oldest firm of the group, in years). The indicators in the level of firm for the construct Diversification and the latent variable of the same name are "Firm in Forms" (share of the number of distinct forms of firm in total forms), "Firm in Classes", (share of the number of distinct classes of firm in total classes), and "Firm in Categories" (share of the number of distinct categories of firm in total categories). The analogue indicators for the level of groups are: "Group in Forms", "Group in Classes" and "Group in Categories). All indicators were entered in the database described in the results section. The regulatory category of the drug is defined by ANVISA and is related to intellectual property (new, similar or generic drugs) and technological aspects (drugs derived from plants or biotechnological processes).

3.2 Strategy of Data Analysis

The data analysis involved three steps: analysis of descriptive statistics, correlation analysis and analysis of structural equation model. The analysis of descriptive statistics showed the characteristics of central tendency and dispersion in the population. The correlation analysis was based on partial correlation coefficients between the indicators. The analysis of the structural equation model involved the measurement model and the structural relationships, which test the hypotheses using the method Partial Least Squares (PLS) (Wold, 1985). The PLS is a technique of structural equation modeling used to analyze causal relations between constructs (Shea, & Rowell, 2000). This technique do not requires the multivariate normality in variables distribution.

The variables Vertical Integration and Form Specificity were modeled in a formative mode (Edwards, & Bagozzi, 2000). The others were modeled reflectively. The coefficients of the structural model represent standardized regression coefficients and the loads of latent variables associated to constructs are factor loadings. The significance was determined by bootstrap with 1000 repetitions. A $p < 0,05$ ($t > = 1.96$) was used for significance tests.

4. Results and Discussion

This section presents and discusses the results of the data analysis. First, we present the general characteristics of the data with the structure of indicators. The following sections are analysis of descriptive statistics and correlations. Finally we present the analysis of the proposed structural model. In a preliminary data analysis there were no missing values. Outliers were tested via the Mahalanobis distance. We identified and hold 40 cases, given the lack of requirement of multivariate normality of the PLS method.

4.1 Descriptive Statistics and Correlations

The database presents 1566 cases of products associated with 111 firms consolidated into 88 groups. For Vertical Integration we found the averages for production and potting are the same in 61%, lower than the averages for groups (83%). The same occurs between the average packing in firm (73%) and the average packing in group (90%). For scalar aggregate indicators, the average in firms (64.75%) is lower than in groups (85.55%).

The data of Experience reveal the average operation time of firms in Brazil (50 years) is lower than the groups' average operation time (148 years), reflecting the relatively recent history of manufacturing in Brazil compared with foreign pharmaceutical groups. The results for Diversification showed the average shares of 25% of total forms for the firm and 53.23% for the group. The difference in favor of the group reflects its function to increase the diversification. The average shares in total classes are 25% for the firm and 32.7% for the group, revealing a relatively minor effect on the diversification of the group, perhaps by

higher costs involved in the development of different capabilities in therapeutic classes. The average shares in total regulatory categories are 30.7% for firms and 35% for groups, revealing more profound differences between categories. For Asset Specificity, the average frequencies for aggregate forms are 10% for packing attribute and 30% for release attribute. The average shares of aggregate class are 30.75% in firms and 25.12% in groups. With regard to Bargaining Power, we found the following results: for Form Bargaining, the average shares are 6.78% for products with the form in total products, 26% for firms with the form in total firms, and 27% for groups with the form in total groups. For Class Bargaining, the average shares are 3.52% for products with the class, 15% for firms with the class, and 15.61% for groups with the class. We analyzed the partial correlations between the indicators and found values around 0.30 and 0.60, with some cases greater than 0.80, which allows the application of multivariate analysis, such as factorial analysis by means of structural equations.

4.2 Construct Validity

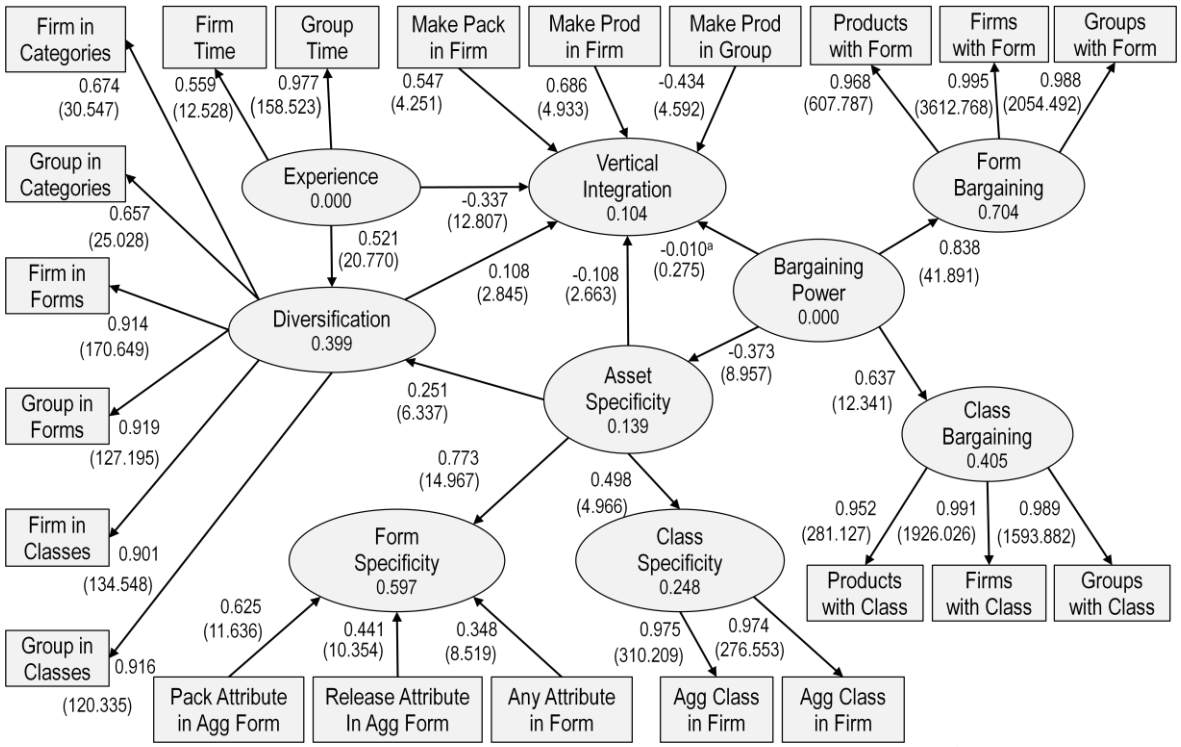
In this section we discuss the validity of the scale used to measure the constructs. We used tests of reliability, convergent and discriminant validity with the software SmartPLS 2.0 M3. Figure 1 shows the measurement model estimated by PLS after the validation stage. The ovals include the construct or variable and percentage of variance explained by relationships with other variables. We present the loads and t values in the arrows for constructs, latent variables and indicators. The criteria for acceptance of an indicator was the statistical significance ($p < 0.05$, $t > = 1.96$) and the value superior to 0.45 of the load. Most of the loads are above 0.60 and exhibit $p < 0.01$ ($t > = 2.576$), indicating its adaptation.

In the process of re-specification of the model we eliminated the indicators Make Pott in Firm and Vertical Integ in Firm due to multicollinearity indicated by offensive loads. The second round of model calculation excluded the indicators Make Pott in Group (load = -0.174, t = 0.073), Make Pack in Group (load = 0.111, t = 0.058) and Vertical Integ in Group (load = 0.220, t = 0.037) due to the lack of significance of the loads.

With respect to Experience, both indicators showed significance. Noteworthy is the higher load of Group Time than Firm Time. This result may reflect the predominant share of foreign products in the population (70%), since all are linked to firms with average operating time higher than the domestic firms. For Diversification, all indicators showed loads higher than 0,600 and appropriate significance. The Asset Specificity had loads suitable for the first-order variables used in its measurement. The Form Specificity showed a load about twice larger than the variable Class Specificity. The Bargaining Power presented appropriate and significant factor loadings for the variables used in the first-order model. The variable Form Bargaining showed a higher load than Class Bargaining, as expected for the manufacturing.

The reliability of the constructs was based on three criteria: reliability of lower-level variables; composite reliability (the construct) (acceptable values> 0.70), and average variance extracted (AVE) (acceptable values> 0.50) (Chin, 1998). It is noteworthy that the composite reliability and AVE have meaning only for the latent variables modeled reflectively (Fornell, & Larcker, 1981). The reliability of the variables related to the constructs was assessed by the magnitude of the factor loads in relation to the corresponding constructs. Most of loads must be at least 0.60 and ideally at or above 0.70 (Chin, 1998; Falk, & Miller, 1992). Figure 1 present the factor loads. Four loads items displayed near but less than 0.60 and fourteen exhibited loads greater than 0.80. Table 1 shows the composite reliability and average variance extracted (AVE). Both meet the suitability criteria established.

Figure 1 – Mensuration model reespecified with coefficients*



* All coefficients with p < 0,000 (t > 2.576), except the case marked with [a]: (ns, *t*= 0.275). Figures in parenthesis indicate the t-values.

The analysis presented in Table 2 supports the convergent validity for the constructs of the model as it indicates larger loads in absolute value for the indicators related to the latent variables as predicted by the model, with smaller loads for the other variables (Chin, 1998). The test of discriminant validity was based on Fornell and Larcker (1998).

Table 1 – Measurement of construct reliability.

Variable	AVE	Composite Reliability
Experience	0.6338	0.7632
Diversification	0.7032	0.9331
Bargaining Power	0.5547	0.8806
Class Bargaining	0.9678	0.9890
Form Bargaining	0.9551	0.9846
Class Specificity	0.9491	0.9739

Source: The authors.

All constructs in the model showed discriminant validity as the square root of the AVE for the latent variables, displayed in bold on the diagonal of the correlation matrix, is higher than the correlations with other latent variables (Table 3) for the first level latent variables.

Table 2 – Cross loads for evaluation of convergent validity

Indicator	Experience	Diversification	Class Specificity	Form Bargaining	Class Bargaining
Firm Time	**0.559**	0.132	0.072	0.049	0.068
Group Time	**0.977**	0.620	0.315	0.041	0.044
Firm in Forms	0.624	**0.914**	0.414	0.059	0.047
Group in Forms	0.509	**0.919**	0.476	-0.004	0.012
Firm in Classes	0.609	**0.901**	0.329	0.130	0.055
Group in Classes	0.520	**0.916**	0.445	0.056	0.026
Firm in Categories	0.220	**0.674**	0.184	0.049	0.024
Group in Categories	0.203	**0.657**	0.199	0.049	0.031
Agg Class in Firm	0.288	0.400	**0.975**	-0.077	0.129
Agg Class in Group	0.292	0.441	**0.974**	-0.099	0.117
Products with Form	0.043	0.065	-0.065	**0.968**	0.101
Firms with Form	0.050	0.070	-0.096	**0.995**	0.123
Groups with Form	0.049	0.067	-0.104	**0.988**	0.133
Products with Class	0.030	0.049	0.211	0.075	**0.952**
Firms with Class	0.064	0.034	0.091	0.132	**0.991**
Groups with Class	0.063	0.034	0.083	0.142	**0.989**

Source: The authors

Table 3 – Cross correlation of first level latent variables.

	Class Bargaining	Form Bargaining	Diversification	Class Specificity	Experience
Class Bargaining	**0.9838**				
Form Bargaining	0.1210	**0.7446**			
Diversification	0.0396	0.0684	**0.8386**		
Class Specificity	0.1267	-0.0901	0.4312	**0.7412**	
Experience	0.0546	0.0481	0.5833	0.2974	**0.7961**

Source: The authors

4.3 Analysis of Structural Model

As shown in Figure 1 the explained variance for the dependent variables of the model (R2) is greater than 10%, showing a satisfactory and substantive predictive power of the PLS model (Falk, & Miller, 1992). In Table 4, we present the hypotheses and test results, showing that the structural loads were significant except for the hypothesis H6. The hypothesis H1 establishes a positive relationship between Experience and Vertical Integration. We found a negative and significant coefficient, which does not support the hypothesis. The pioneer firms were created integrated due to regulation and low initial dissemination of capabilities among agents. As time passed and capabilities were spread in the industry, these firms tended to outsourcing for stages not considered fundamental. The hypothesis H2 establishes a positive relationship between Diversification and Vertical Integration. The model showed a positive and significant coefficient, which supports the proposed hypothesis, and the view of the firm or the group as a bundle of capabilities.

Table 4 – Test of hypotheses of the model

Hypothesis	Proposed Effect	Regression Coefficient	Observed *t* Value	Hypothesis Support
Effect on Vertical Integration (R^2 = 0.104)				
H1: Experience ➔ Vertical Integration	+	-0.337	12.807	No
H2: Diversification ➔ Vertical Integration	+	0.108	2.845	Yes
H4: Asset Specificity ➔ Vertical Integration	+	-0.108	2.663	No
H6: Bargaining Power ➔ Vertical Integration	-	-0.010	0.275[a]	No
Effect on Diversification (R^2 = 0.399)				
H3: Experience ➔ Diversification	+	0.521	20.770	Yes
H5: Asset Specificity ➔ Diversification	-	0.251	6.337	No
Effect on Asset Specificity (R^2 = 0.139)				
H7: Bargaining Power ➔ Asset Specificity	-	-0.373	8.957	Yes

[a] Non significant
Source: The authors.

The hypothesis H3 establishes a positive relationship between Experience and Diversification. In this respect the model had a positive and significant coefficient, which supports the hypothesis. That is, as firms gain experience, tend to broaden the knowledge base through diversification, which is also associated with its growth conform Bogner (1996). The hypothesis H4 establishes a positive relationship between Asset Specificity and Vertical integration. The model presented a negative and significant coefficient, which contradicts the proposed hypothesis. Apparently, the manufacturing does not involve the strategic relevance to justify vertical integration when asset specificity increases. The hypothesis H5 establishes a negative relationship between Asset Specificity and Diversification. The model had a positive and significant coefficient contrary to the hypothesis. Considering the earlier discussion of diversification, the search for an optimal size of the group seems to reveal that the competitive pressure for diversification outweighs considerations relating to investment in specific assets.

The hypothesis H6 establishes a negative relationship between Bargaining Power and Vertical integration. In this respect the model showed a negative coefficient, but not significant, which does not support the hypothesis. It is possible to raise the conjecture that the bargaining power is not a source of transaction costs arising from possible opportunistic behavior. This may be a result of low relevance of the manufacturing for the creation of value. The hypothesis H7 establishes a negative relationship between the Bargaining power and Asset specificity. The model presented a negative and significant coefficient, which supports the hypothesis proposed. Thus, the spread of products and firms with the attributes of the product, seems to indicate less need for investment in specific assets for the manufacturing.

Final Considerations

The study aimed to analyze the influence of transaction costs and capabilities on vertical integration for the manufacturing step of the pharmaceutical sector in Brazil. This objective resulted from the possibility to contribute to the research agenda in the literature on the relationship between the approaches of transaction costs and capabilities, particularly with regard to the governance structure adoption in a production system. While the TCT has been successful in confirming its hypotheses in empirical studies, the capabilities approach still

faces some difficulties in measurement of constructs, but has shown a growing application of some aspects of their studies in the area of strategy. In this section we present the main implications from the results of the hypothesis testing.

The results confirm the basic assumption of the model proposed by Jacobides and Winter (2005), that there are interdependencies between transaction costs and the distribution of capabilities in a population of firms in a production system with effects on vertical scope adopted by companies. Although the confirmed hypothesis H2 showed a positive relation between diversification and vertical integration, the result of the test of the hypothesis H1 indicated that the higher the experience, the lower the vertical integration in the pharmaceutical industry. Since diversification and experience are capabilities proxies, we could raise some qualifications for these results. First we can highlight the difference in the kind of capabilities measured in each proxy, since diversification measures the number of different capabilities of the firm in form, class and category, while the experience reveals the learning curve associated to productivity gains with the main capabilities of the firm.

Another qualification is the positive correlation hypothesis between capabilities acquired and vertical integration argued by Bigelow and Argyres (2010) is not valid in any situation. It seems that at the current stage of the pharmaceutical sector in Brazil, the adoption of vertical integration may be due to cost considerations, delimiting the integration scope to stages of greater value to companies. This means that the existence of the capability to manufacture a product does not imply in the internalization of this transaction. It seems that the stage of the production system of the industry moderates the relation between capabilities acquired and vertical integration.

A finding of this study refers to the positive relationship between experience and diversification (hypothesis H3). The result indicates a general trend in the pharmaceutical sector for the growth pattern of the companies associated with the diversification of the product portfolio in order to achieve economies of scope in R & D, to reduce risks and maintain a regular flow of new product launches as complaint Bogner (1996). This research result is most relevant to the group level, since operating time for the group had a higher load on the construct experience. Thus, given the predominance of products from foreign groups (70%) in the database, the coefficient captures the evolution of foreign groups, which are older than domestic groups in average, thus had more time to diversify the operation.

We found a negative relationship between asset specificity and vertical integration (hypothesis H4). The rejection of the hypothesis, rather than suggesting the invalidity of TCT, seems to be related to aspects of the industry and of the transaction in question. The result seems to indicate a low strategic value of the transaction of drug manufacturing in the value chain of the pharmaceutical industry. It seems that companies tend to outsource manufacturing of products with specific attributes, preferring in some cases to use the capabilities of a partner instead of using an internal supplier, which would be expected according to the TCT. The result indicates that these specific attributes apparently do not represent sources of transaction costs due the risk of opportunistic behavior of partners. The result indicates the strategic alliance for manufacturing stage for products with specific attributes presents a low risk of hold up by the service provider.

Other finding is a positive relationship between diversification and asset specificity. The assumption behind the rejected hypothesis H5 was that the existence of specific assets reveals exclusive investment for the transaction, which in theory reduces the ability of the firm to diversify its product portfolio in the dimensions of form, class and category. We found that the presence of specific attributes of the form does not produce an inhibitory effect on

diversification. This can be explained by the negative effect of asset specificity on vertical integration, which invalidates the assumption of the commitment of firm resources with a portfolio of products with specific attributes and manufactured with vertical integration. The diversification seems to be more subject to the scale rather than the asset specificity of the product portfolio.

The bargaining power does not influence the structure of governance in the pharmaceutical sector (hypothesis H6). The absence of effects of the bargaining power seems to be due to two aspects, the first is the market structure and the second is the low importance of manufacturing to the transaction's value generation. The market structure of the manufacturing stage showed in the database presents a positive correlation of frequencies of product attributes (form and class) and firms and groups operating with each attribute. In this sense the more the adoption the attribute, the more the number potential suppliers for the manufacturing stage. For the products with the more widespread attributes, there is not a concentration in few suppliers for the manufacturing stage, which could be expected in order to explore economies of scale. By the other hand, for the products with less adopted and specific attributes, we found a tendency to the use of strategic alliances, as shown in the hypothesis H4, which reflects the low strategic relevance of the manufacturing stage.

Another finding of this study is that the bargaining power of the firm or group that owns the product, as measured by the spread of products, firms and groups with the form or class of product, indicates smaller incentives for investments in specific assets of the manufacturing stage of the product, which supports the hypothesis H7. The result confirms the effect predicted by the theory, but do not offer a contribution to a deeper understanding of the effects of bargaining power because of the structure of the database with the correlation between the spread of products, firms, and groups for each form and class. Future studies could find the causes for this uniform dissemination of capabilities and this correlation.

One limitation of the study relates to its exploratory nature. Attempts to establish relationships between the approaches of transaction costs and capabilities are still in nascent stage, though already accumulating empirical evidence about the possibilities of complementary application of theories. However, the literature has not yet reached a consensus of the feasibility of a more general and integrative theory. The results and the implications derived taken should be interpreted with caution in view of the characteristics of the indicators and the structural model used. Our attempting to use secondary data of products as a starting point to generate firms and groups data may contain biases related to the capabilities. We cannot evaluate if the product was developed internally or came to the portfolio by means of mergers or acquisitions. The second limitation of this study relates to the distribution of cases between domestic and foreign firms and groups. The population tested reflects a market segment with a predominance of new drugs produced mostly by foreign companies. Although the offered picture has relevance, the population studied does not reflect the current situation and trends in the pharmaceutical sector in Brazil, with greater dynamism and growth of generics segment.

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