## Increasing Vertical Integration in Brazilian Orange Juice Sector after 1990: Power and Transaction Costs

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### Abstract

The presence of juice processors within citrus growing activity is a characteristic in Brazilian orange juice sector since its beginning but, during 1990s, this presence became increasingly large. No dramatic changes in transaction costs were observed, but accusations of market power exertion of juice processors and antitrust actions marked the period. More importantly, backward vertical integration of juice processors was free and citrus growers faced barriers to forward vertical integration during the period. The research question is: how power affects vertical integration choice in orange juice sector after 1990? The main hypothesis posits that power has an important role in the economic organization of orange juice sector, but it is simultaneously found with economizing drivers. Using panel data analysis, a sample of the five largest juice-processing firms contemplated a 15-years period, from 1993 to 2007. Results indicate asset specificity and power as the determinants of economic organization of orange juice sector. The study contributes to the investigations of the special cases in which power is relevant, indicating that the simultaneous consideration of power and efficiency should be the starting point of organizational analysis.

Keywords: Transaction Costs; Power; Vertical Integration; Orange Juice

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## 1. Introduction

The presence of juice processors within citrus growing activity is a characteristic in Brazilian orange juice sector since its beginning but, during 1990s, this presence became increasingly large. No dramatic changes in transaction costs were observed in the beginning of 1990s. Nevertheless, accusations of market power exertion of juice processors and antitrust actions are persistent in the sector during 1990s and 2000s. The research question is: how power affects vertical integration choice in orange juice sector after 1990?

Distinguish power exertion from efficiency arguments in vertical integration decision is an ambiguous matter in economic theory (Lafontaine and Slade, 2008). Transaction Costs Economics (TCE) literature points to economizing in transaction costs as the main case and applied to all situations, while power explanations are applied to small number of situations (Williamson, 1991a, 1991b). Recognition of power as determinant of vertical integration decision is limited and no efforts were made to investigate which are the special case situations in which power is relevant. According to Joskow (2002: 105),

> essentially no effort has been made to harmonize the large body of theoretical and empirical work in the TCE tradition that is relevant to understanding why specific governance arrangements emerge, and for performing any trade-offs may arise between increases in market power and reduction in the costs of transacting à la Williamson (Joskow, 2002: 105).

The paper aims to analyze vertical integration choice of juice processors in orange juice chain, in order to highlight the determinants of the increasing in vertical integration after 1990. The main hypothesis posits that power has an important role in the economic organization of orange juice sector. In the beginning of 1990, citrus growers made complaints in the antitrust agency against juice processors about the transactions of oranges, claiming that juice processors were using the contract to orchestrate actions in order to raise their profits. Furthermore, a juice processing plant controlled by citrus growers co-operative shut down in 1993, which was the last effort of farmers in forward vertical integration. Backward vertical integration after 1993. High relationship specific investments were involved and, as result of this state of affairs, juice processors made increasing investments in new trees and orange production.

The paper is organized in five sections. Second section presents the transaction costs arguments to vertical integration decision and role of power under this theoretical lens. Third section analyzes the history of orange juice sector in São Paulo state, located in Brazil, emphasizing the previous events that led to vertical integration path after 1990. Fourth section presents data and methods and, in the fifth section, results are discussed. Finally, in sixth section, concluding remarks follow.

## 2. Vertical Integration Choice

It is possible to split the production process in many technologically separable activities and the firm is a technological combination of these activities to transform inputs in outputs. Thus, the firm combines economic activities that are technologically similar or complementary, in order to minimize production costs. Vertical integration occurs when the firm internalizes technologically separable activity that was originally carried on through market (Joskow, 2005). In neoclassical economic theory, when the internalized activity is not technologically similar or complementary to the current firm activities, there is no cost minimizing reasons to vertically integrate. In effect, on the one hand, power exertion is usually pointed as the reason for non-standard vertical integration. On the other hand, in Transaction Costs Economics' lens (Williamson, 1985), vertical integration is not a technological problem and efficiency reasons take place.

In TCE framework, vertical integration decision depends upon the transaction costs involved on the comparative analysis of governance costs under market transactions, contracts, and bureaucracy within firms. Governance is an adaptation problem, in which relational features results in costs of transacting. Three critical transactions attributes affect the governance costs: uncertainty (disturbances in quantity, quality, or prices, for example), asset specificity (relationship-specific investments that lose value in alternative uses), and frequency (in relation to transactions recurrence). Given bounded rationality and the presence of opportunism (Williamson, 1975, 1985), contracts are incomplete and there is a risk in transactions completion. Governance costs are those incurred to mitigate those risks.

Among transactions attributes, asset specificity received more attention in both theoretical models (Williamson, 1985, 1991a) and empirical analyses (Masten and Saussier, 2000). The main hypothesis states that as relationship-specific investments deepen, risks of renegotiation and quasi-rent appropriation become higher (Klein, Crawford, and Alchian, 1978) and safeguard are required, i.e. in presence of asset specificity, long length contracts and vertical integration are more likely to be adopted (Williamson, 1991a). TCE hypothesis finds incontrovertible empirical support (Masten 1993, Shelanski e Klein, 1995, Masten, 1996, Masten and Saussier, 2000).

TCE's empirical tests use measures of asset specificity and correlate to governance structure. Shifter parameters in TCE's empirical inquiries were disregarded. Shifter parameters are factors that affect governance costs, such as property rights, contract law, uncertainty, and reputation (Williamson, 1991a). Property rights are related to value expropriation by the lack of capacity of firms to protect property rights against Govern, rivals, suppliers, or buyers. Changes in contract law can affect governance costs, because it alters contract enforcement. Uncertainty is disturbances in factors that affect the transaction. Finally, reputation represents a behavioral standard that guarantee or not contracts. Furthermore, empirical research in TCE tradition does not test power explanations for economic organization along with transaction costs variables.

Nevertheless, power is not disregarded in transaction costs lens. Williamson (1995) compare transactions using efficiency and power purposes. When contracting is voluntary, knowledgeable, and farsighted, there is no room for power. Actually, power is present in the opposite situation, when contracting is involuntary, uninformed, and myopic. Williamson (1995) claims that contracting processes are frequently voluntary, knowledgeable, and farsighted, especially in intermediate product markets, and economizing lens is a useful place to start the analysis. In addition, Williamson (1991b) argues that solve maladaptation problems have more significant effects than possible deadweight losses. Thus, economizing in transaction cost has potentially greater effects over welfare and it is more widely present in the economy than power exertion.

Using game theory, Azevedo (1996, 1997) analyzed the partial vertical integration in Brazilian orange juice sector during 1990s. Taking into account the presence of specific investments and barriers to forward vertical integration of citrus growers, vertical integration can serve as bargaining instrument over surpluses. Azevedo (1996) showed that optimal degree of vertical integration is chose when marginal benefit is equal to marginal cost of organizing this activity under contracts. Azevedo (1996, 1997) also showed how juice processors could extrapolate the optimal degree of vertical integration in order to appropriate part of the surplus generated from cooperation. In fact, when higher than optimal vertical integration degree is found, welfare losses will take place. Thus, vertical integration can be used as strategic means to redistribute wealth through market (bargaining) power, with implications to welfare.

Transaction costs arguments highlight non-technological determinants to vertical integration, represented by transactions attributes. This is a significant contribution, as in neoclassical theory combination of economic activities under non-technological features were solely viewed as market power exertion. Nevertheless, investigations in TCE tradition did not debated possible trade-off between economizing in transaction costs and power explanations. Indeed, debates between power and efficiency arguments to vertical integration are ambiguous. Vertical integration is efficient when avoid the double marginalization in a sequence of two monopolists (Tirole, 1988) or when mitigate risks from opportunistic renegotiation in contracts (Klein, Crawford, and Alchian, 1978). However, under power perspective, vertical integration creates barriers to entry, raises rivals costs, affects prices (Riordan, 1998, Joskow, 2005), or serves as bargaining instrument (Azevedo, 1996). Despite TCE provides additional information about efficiency reasons to vertical integration, it fails to recognize and give sufficient attention to special case situations in which power is relevant (Dorward, 2001). There is a risk in conclusions for efficiencies purpose in every non-standard - different from minimize production cost - vertical integration, inasmuch as power is also potentially present.

## 3. Orange Juice Sector: Transaction Costs and Power<sup>i</sup>

Citrus sector in São Paulo state is dedicated to production and exportation of high quality orange juice. The genesis of orange juice sector in Brazil is related to weather conditions in Florida and excess of orange controlled by large groups of fruit exporters. After an intense freeze in Florida in crop season of 1962/1963, the first orange juice processor plant was installed in São Paulo state in 1963, named as Suconasa<sup>ii</sup>. Two other juice processor plants was created in 1964, Citrosuco Paulista (henceforth Citrosuco) and Citrobrasil. Sucocítrico Cutrale (henceforth Cutrale) acquired Suconasa in 1967. Three large Brazilian orange exporters, Cutrale, Citrosuco (Fischer Group) and Citrobrasil, constituted the major juice processors in 1960s, taking advantage of excess of fruit production.

Initially complementary, juice production in Brazil presented rapid growth during 1970s and 1980s. Exportation of orange juice increases from 531 tons in 1963 to more than 33 thousands tons in 1970 and, then, to more than 401 thousands tons in 1980. The sector becomes more specialized, as 2% of orange production in São Paulo was used to produce juice in 1970, while this figure changed up to 81% in 1980. New entries occurred in orange juice production market in 1970s and Cargill was one of them. Cargill is an important firm for innovation of juice distribution system and one of the largest companies operating in that market until 2003.

Another important factor of the sector is the technological features of production processes. As juice production requires large operation and economies of scale, while citrus growers could easily face diseconomies of scale, the industrial structure in juice processing is naturally more concentrated than agricultural production. It is also worthwhile to note the important participation of Cutrale and Citrosuco, who are the leaders of juice processors. These two firms were marked by intense rivalry between them. In this context, the presence of specific investments and power asymmetries derived from industrial structures led to the creation of citrus growers association in the beginning of 1970s, called *Associação Paulista de Citricultores* (Associtrus). At the same time, juice processors followed grower's initiatives,

creating their association, named Associação Brasileira das Indústrias de Sucos Cítricos (Abrassucos).

Under TCE's lens, when specific investments deepen, denoted by specialization in juice production, transactions governed by markets face increasing governance costs. Industrial structure was also not favorable to citrus growers, given the concentration of orange buyers. In response to these characteristics, collective negotiations started between the associations, Associtrus and Abrassucos, in order to deal with several conflicts among the parties. The adoption of hybrid forms economized transaction costs and mitigated power asymmetries among farmers and processors, which led to the creation of Committees Citrus in Federal and State level Governments, in the beginning of 1970s. Thus, after a period with predominantly market transactions during 1960s, the sector evolved to hybrid forms under Government coordination during 1970s and half of 1980s. During 1970s and 1980s, the presence of Government in economic activity was frequent in agro-industrial relations; for instance, sugarcane, coffee and milk were regulated sectors in Brazilian economy.

Committee Citrus worked well until the beginning of 1980s. Nevertheless, freezes in Florida increased juice prices and Brazilian juice processors could achieve higher profits. Citrus growers, however, were not able to take any advantage from international markets conditions. Committee Citrus failed in provide accordance about this new market condition and, in crop season 1986/87, a standard contract was created as a private solution, excluding Government participation. Creation of the standard contract was intermediated by Abrassucos and Associtrus. The new contract design linked juice prices in New York Board of Trade (NYBOT) to orange prices in Brazilian domestic market and its adoption was voluntary. Citrus growers massively adopted this contract and their initial results were beneficial. Beyond change in prices, Brazilian institutional environment was in transformation due to the end of Military Governments in 1980s and economic openness and stabilization in 1990s. Government regulation in economic activity decreased in 1990s and private solutions to transactions coordination emerged as Government moved away. These events occurred in several agricultural sectors and standard contracts were the solution adopted by citrus sector at that time.

Initially, standard contract was beneficial to citrus growers and solved conflicts in the relationship. New investments were made in juice processing and Citrovita, new big juice processing firm, started its operation in the end of 1980s. Beneficial results from adoption of standard contract were only transitory for citrus growers. Juice prices in NYBOT were an important determinant of orange prices in Brazil and these prices became highly volatile. When citrus growers accepted standard contract, they were both accepting benefits from increases in juice prices and accepting risk sharing from decreases in those prices. Then, in the beginning of 1990s, citrus growers faced deficits because orange prices were below production costs. Citrus growers were also dissatisfied with some terms of standard contract, which were not modified in private negotiations. First, citrus growers claimed that juice processors were deliberately delaying orange harvest, causing dehydration of the fruit implying in lower weight and lower prices. Second, citrus growers requested the change of payment method from weight to solid content, since the amount of juice inside the orange are correlated to its solid content rather than its weight. There was no agreement about these topics.

Disagreements about contract motivated Associtrus and other representative associations to initiate a litigation process in Administrative Council of Economic Defense (CADE), Brazilian antitrust office. Citrus growers accused juice processors of concerted action using contract terms in order to deliberately raise profits. CADE accepted the accusations and initiated the legal process, but citrus growers and juice processors decided to sign an agreement, called commitment term to conduct cessation. This agreement does not

imply that juice processors recognize their anticompetitive conduct, but it solves the contentious. In this agreement, CADE suspended the use of standard contract and collective negotiations were forbidden. In practice, CADE extinguished the standard contract and the sector starts to pursuit new forms of organization.

The end of standard contract had an immediate and positive effect for citrus growers, recovering better price levels for orange. Nevertheless, CADE intervention had transitory effects (Marino and Azevedo, 2003), partly because power asymmetries between citrus growers and juice processor were reestablished by the prohibition of collective negotiations. Associtrus and other representative associations of citrus growers were not successful in CADE litigation and lose space in further negotiations. Another event occurred in 1980s with impacts on economic organization of 1990s. Cargill introduced a new technology for the logistics of processed juice, substituting steel drums for a "bulk system". Investments on trucks, port terminals in Brazil and Europe, and specialized ships were made to implement this new distribution system, reducing costs. All relevant players in juice production quickly adopted forward vertical integration of distribution created by Cargill. Given overcapacity in port terminals in Brazil, forward vertical integration of juice distribution is an important barrier to entry in this sector.

In 1993, Louis Dreyfus Commodities (henceforth Dreyfus) acquired Frutesp, a juiceprocessing firm controlled by a farmer's co-operative. Frutesp was the last effort of citrus growers on forward vertical integration. The acquisition of Frutesp along with concentrated industrial structure in juice processing, barriers to entry given by distribution system, and increasing in orange prices are special conditions faced by citrus growers in 1990s. There are highly specific investments of both sides, citrus growers and juice processors, but farmers were no longer able to protect their specific investments through forward vertical integration or collective contracts. In response to this context, juice processors started to increase its partial backward vertical integration into orange production, while maintaining part of supply under contracts. In fact, it was observed a continuous and increasing path in this effort for the next fifteen years rather than an immediate adaptation to new market conditions. Table 1 presents the evolution of economic organization in orange juice sector.

Date	Period	Description	Governance Structure	
1963-1970	Embryonic stage	Transactions are not coordinated	Market	
1970-1986	Growth and specialization	Transactions are negotiated by representative associations under Government coordination	Hybrid	
1986-1995	Collective and private negotiations	Transactions are negotiated by representative associations through private mechanisms	Hybrid	
After 1995	Post-Antitrust intervention and accusations of power exertion	Increasing in partial backward vertical integration of juice processors and contracts without collective negotiations	Hierarchy/Hybrid	

Source: elaborated by the authors.

Partial vertical integration is present in the organization of the orange juice sector since 1963. However, this study analyzes the growth path in the quantity of orange produced by juice processing firms after 1990, which is significantly higher than previous periods. The juice processing firms are large, but there is no technical reason that links size of juice processing plants to orange internal production by processing firms. In other words,

economies of scales in juice processing do not generate economies of scale in agricultural process for orange production. Increases in firm size of juice processors do not justify new investments in orange production regarding technical efficiency in production costs. Graph 1 presents the evolution of investments in orange production made by the two largest juice processors from 1963 to 2007.



## **Graph 1 – Juice Processing Firm's Investment in Orange Production**

Graph 1.2 – Orange Production by Juice Processing Firms (number of boxes)



Source: elaborated by the authors from Associtrus data.

Graph 1 shows that investments in orange production have an increasing path after 1990. The traditional TCE analysis would look for efficiency explanations in terms of transaction costs. Relationship-specific investments are the most important dimension to be analyzed under transaction costs arguments and there are several specific investments juice production chain. Regarding citrus production, first, it is a perennial crop and new trees remains unproductive for long periods; second, it is an immobile investment in terms of

geographic location; and third, types of oranges destined to juice production are not appreciated by fresh fruit consumer. In juice processing, investments in plants are also specific, since plants cannot be used for anything else without additional costs and plants are geographic immobile as well.

Analyzing the relationship between citrus growers and juice processors, the distance between farms and processor plants are called site specificity. According to Williamson (1985), "cheek-by-jowl" relationships are more specific, due to redeployment and set up costs. Distances between farms and plants reduce transportation and coordination costs and also reduce transportation time. There is also a temporal specificity, because orange is perishable and it must be processed quickly after harvest. According to Masten, Meehan and Snyder (1991), temporal specificity occurs when threats of delays are conditions to extract prices concessions, which is the case in orange juice production chain. Thus, as distances between plants and farms decreases, more specific are the investments and more vertical integration is expected.

Relationship between citrus growers and juice processors also presents physical specificity. According to Williamson (1985), physical specificity is related to investments in equipment, machines, and other physical assets with characteristics that are designed to a specific transaction. In citrus growers activity, trees are physically specific because orange type destined to juice production lose value in alternative use, i.e. for fresh fruit consumer. The investment in trees require time – around 4 years – to be fully productive and its redeployment is quite restricted. Thus, as physical asset specificity increases, greater will be transaction costs associated and more vertical integration will be expected. Thus, as relative quantity of oranges delivered in juice-processing plant grows, more specific are investments in orange production. Joskow (1987) used a similar relative quantity of supply as asset specificity measurement in coal mining sector.

Finally, in juice processing side, juice-processing plants have no alternative use rather than produce orange juice. It is possible to note that investments on juice distribution such as ports terminals, trucks, and ships would follow investments in processing plants. Thus, as the number of plants increase, more specific are those investiments. Hypothesis 1 is then a hypothesis of economizing in transaction costs.

# Hypothesis 1 ( $H_1$ ): increases in (a) site specificity, (b) physical specificity in orange crop, and (c) physical specificity in processing-plants are positively related to increases in vertical integration.

Relationship-specific investments create situation of small number bargaining, i.e. bilateral monopoly between citrus growers and juice processors. This is, however, a structural view of transaction that does not include the process perspective (Zajac and Olsen, 1993). The barriers to entry in juice processing industry and absence of citrus growers efforts in forward vertical integration, marked by the end of Frutesp, are transformations in the evolution process of the relationship. Before 1990s, citrus growers could protect their specific investments through vertical integration and they did it, as well as juice processors maintained low levels of investments in orange production.

Nevertheless, changes in the relationship and market context led to a situation in which just juice processors can protect their specific investments through vertical integration. Citrus growers are vulnerable to opportunistic price renegotiations. The contracting is no longer voluntary, knowledgeable, and farsighted, because non-predictable changes occurred after specific investments were made. Juice processors can choose high degrees of vertical integration in order to achieve bargaining power over citrus growers (Azevedo, 1996, 1997). As juice processors achieve more market power, controlling more market share, more vertical

integration will be expected in order to exert bargaining power. The hypothesis 2 is then a hypothesis of power explanations for vertical integration.

Hypothesis 2 ( $H_2$ ): increases in market share of juice-processing firms are positively related to increases in vertical integration.

Two different and not mutually exclusive explanations are presented. Using TCE's lens, backward vertical integration could be the solution to coordinate orange transactions in order to economize in transaction costs. The second explanation is consistent with power explanations to vertical integration, as conditions of voluntary, knowledgeable, and farsighted contracting are not satisfied. Thus, backward partial vertical integration increased bargaining power over citrus growers (Azevedo, 1996, 1997).

## 3. Data and Methods

The following functional form represents the basic model:

## *VI* = *f*(*K*, *SHIFTPAR*, *POWER*, *LAND*, *SUGCANE*)

where,

- $VI_{it}$  = Investments in orange production made by juice processing firms, given by:
  - $VI\_BOX_{it}$  = quantity of orange boxes produced by *i*th firm in the *t*th period (million boxes; source: Associtrus); or

 $VI\_TREE_{it}$  = number of new trees acquired/expanded divided by *i*th firm in the *t*th period (million trees; source: Associtrus).

K = Asset Specificity:

 $K\_CROP_t$  = physical specificity<sup>iii</sup> of orange crop, sum of the quantity of orange boxes processed by all firms in the *t*th period divided by total boxes produced in São Paulo state in the *t*th period. This measure is not firm specific (source: CitrusBR e IEA).

 $K\_PLANT_{it}$  = physical specificity of processing plants, dummy variable where 0 denotes period before installation of new processing plant by *i*th firm and 1 denotes the period after installation of new processing plant by *i*th firm.(source: according to references in endnote 1).

 $K\_SITE_{it}$  = site specificity<sup>iv</sup>, given by modified Herfindhal-Hirschmann index (HHI), measuring the concentration of orange production around processing plants for *i*th firm in the *t*th period weighted by distance. The index is the sum of squares of orange production share in *j*th city weighted by the squared distance between *j*th city and plant's city (source: calculated from IEA data)

- SHIFTPAR = Shifter parameters:  $UNCERT_{i}: uncertainty, standard deviation of orange boxes annual prices in the last five years for$ *t* $th period (source: FNP e CEPEA).
  <math display="block">PROP_{R_{i}}: \text{ overall score of economic freedom index for$ *t*th period, which measures elements such as property rights, business freedom, labor freedom, among others. (source: Heritage Foundation).
  - *POWER*<sub>*it*</sub> = power, given by market share of *i*th firm in the *t*th period (source: IEA, FNP, and Sabes,  $2010^{v}$ ).
    - $LAND_{it}$  = Land value, average price of land in the region of the *i*th firm in the *t*th period. Prices deflated using IGP-DI index (source: IEA).
    - SUGC = Influence of sugarcane sector in orange juice sector:  $SUGC_{P_{it}} =$  average value of tenancy for sugarcane production in the region of *i*th firm in the *t*th period. Prices deflated using IGP-DI index (source: IEA)  $SUGC_{A_{it}} =$  production area of sugarcane in the region o *i*th firm in the *t*th period.

#### (source: IEA)

Initially, some commentaries about dependent variable are needed, which is a measure for vertical integration. Backward vertical integration is the production of orange by juiceprocessing firms. One can say that some kind of degree of vertical integration is better than the dependent variable used in this study. Nevertheless, if juice-processing firms expand their juice production and, consequently, buy more oranges, the expansion of degree of vertical integration does not necessarily follow juice production expansion. There is no direct relationship between agricultural production of oranges and industrial production of juice, i.e. there are no economies of scale in agricultural production generated by industrial juice processing. Thus, only changes in transaction costs, through specific investments, justify new investments in new trees or increase in orange internal production. In this sense, degree of vertical integration can decrease in one period, but expansion of new trees or orange production can actually increase. The focus is the rationality in the decision of doing more oranges internally rather than decide a percentage of orange ownership. It is not the relative quantity of inside production versus outside procurement, but the simple fact that juiceprocessing firms are increasing the quantity of inside production. In simple words, increase in inside production must be correlated to specific investments under TCE's lens, which is not necessarily true when the degree of vertical integration is employed.

Interest variables are asset specificity  $(H_1)$  and power  $(H_2)$ . In addition, consistent with transaction costs propositions, parameter shifters can influence the choice for governance structures. Whereas TCE's theoretical propositions do not specify expected effects for shifter parameters, it is expected that uncertainty is positively associated to vertical integration because more hierarchical coordination is better to deal with uncertainty. Regarding property rights, it is expected that increases in the quality of property rights index are negatively associated to vertical integration, because it is less costly to avoid value expropriation through markets or contracts. Parameter shifters variables are not firm specific.

Control variables include: land value and sugarcane influence over orange sector. It is expected that land value is negatively associated to vertical integration, since increases in land prices can inhibit expansion of vertical integration. Sugarcane crop is located in the same region of orange crop and these two products compete for land. Thus, price of land tenancy to sugarcane production can attract citrus growers to change their crop from orange to sugarcane. It is expected that increases in prices of land tenancy to sugarcane is positively associated to vertical integration, because juice processors will seek to guarantee their supply of fruits. Furthermore, increases in the production area of sugarcane can threat orange supply and it is expected that these increases are positively associated to backward vertical integration.

This is an exploratory study. This study advances in empirical inquiry under TCE lens using longitudinal data of just one transaction. Inclusion of parameter shifters effects is not frequent in empirics of TCE, which is made in this study. The model tested power explanation along with TCE's traditional measures of asset specificity, which is also not frequent in this kind of investigations. Sample contemplated a 15-years period, from 1993 to 2007, for five largest juice-processing firms. This is an unbalanced panel data, since there was a juice processor that closed operations during this period and there is no available information about market share in 1994 for one of juice processors. Hence, a total of 70 observations are available for major part of variables. Property rights index, land prices and tenancy prices for sugarcane are available between 1995 and 2007. Dependent variable measured by number of new trees is available between 1993 and 2004. Table 2 shows descriptive statistics.

Econometric model is specified as follow:

$$VI_{it} = \beta_0 + \beta_1 K\_CROP_t + \beta_2 K\_SITE_t + \beta_3 K\_PLANT_{it} + \beta_4 UNCERT_t + \beta_5 PROP\_R_t + \beta_6 POWER + \beta_7 LAND_{it} + \beta_7 SUGC\_P_{it} + \beta_8 SUGC\_A_{it} + \beta_7 UGC\_P_{it} + \beta_8 SUGC\_A_{it} + \beta_7 UGC\_P_{it} + \beta_8 SUGC\_A_{it} + \beta_8 SUGC\_A_{it}$$

where,  $VI_{it}$  can assume values of  $VI\_BOX_{it}$  and  $VI\_TREE_{it}$ . Variables were defined in section 3 and expected effects are in parentheses right below each variable. First, the equation was estimated by using ordinary least squares (OLS). Transformations of the data were made to deal with differences in units of measurement and assumption of homoscedastic disturbance terms was assessed. Table 2 also shows the correlation matrix after variables transformation.

Table 2 Correlation Matrix													
Variable	Average	Std. Dev.	1.	2.	3.	4.	5.	6.	7.	8.	9.	<i>10</i> .	11.
1. VI_BOX	11,26	9,92	1										
2. VI_TREE	0,43	0,51	0,60*	1									
3. K_ CROP	0,775	0,083	0,35*	0,29*	1								
4. K_SITE	0,0004	0,0002	-0,01	0,03	-0,19	1							
5. K_PLANT	NA**	NA**	0,12	-0,11	0,27*	-0,30*	1						
6. UNCERT	1,037	0,262	0,04	0,11	-0,10	0,19	-0,08	1					
7. PROP_R	57,89	5,11	0,36*	0,30	0,17	0,16	0,23	0,65*	1				
8. POWER	0,166	0,092	0,84*	0,57*	0,16*	-0,003	-0,09	0,11	0,39*	1			
9. LAND	10427,23	3603,57	0,32*	0,02	0,19	0,009	-0,01	-0,24	-0,19	0,25	1		
10. SUGC_P	603,33	100,15	0,07	-0,13	-0,07	-0,12	0,17	-0,31*	-0,13	-0,05	-0,02	1	
11. SUGC_A	$1,31 \times 10^{5}$	$2,40 \times 10^4$	0,15	0,18	0,18	0,14	0,08	0,06	0,26*	0,20	-0,22	-0,03	1

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\*at 0.05 \*\* dummy variable

Source: elaborated by the authors.

The main part is the panel data analysis. This is a long panel, since it has relatively many time periods and few firms. As the five largest juice-processing firms constitute the sample, it is reasonable to assume that fixed effects estimates are suitable to data characteristics. Nevertheless, estimations using fixed effects and random effects were compared by Hausman test, indicating the use of fixed effects. During Hausman test, models estimated using new trees as dependent variable ( $VI\_TREE_{it}$ ) were not significant, according to F statistics. The small number of observations available – between 1993 and 2004 – potentially caused the problem in estimations using new trees as dependent variable. Thus, panel data analysis was estimated only using number of orange box produced by the firm ( $VI\_BOX_{it}$ ) as dependent variable. After estimations the independence of residuals were assessed.

### 5. Results

Table 3 presents the results. In general, both economizing in transaction costs and power exertion find empirical support for the explanation of backward vertical integration ( $H_1$ and  $H_2$ , respectively). Physical specificity in agricultural production ( $H_{1b}$ ) presents positive and significant effect on five models estimated, while physical specificity in juice-processing plants ( $H_{1c}$ ) presents positive and significant effect in four models estimated. Although asset specificity is important to vertical integration trend in orange juice sector, site specificity ( $H_{1a}$ ) is significant only in one model estimated. Also related to TCE's arguments, uncertainty presents significant and positive effects in three models, as expected, and property rights are not significant in orange juice sector.

Land prices are significant and positively associated to vertical integration in model 4, contradicting the expected effect. Sugarcane sector, in turn, presents minor impacts on orange

juice activity. The effects of tenancy prices for sugarcane are significant and positive in models 1 and 6, as expected. The area occupied by sugarcane presents negative and significant effect in just one model, contradicting the expected direction. There is no potential explanation for the opposite sign in the case of sugarcane area. Uncertainty, property rights, land value, and sugarcane area present changing directions of the effects among models, which indicate problems in model specification. Nevertheless, effect directions were consistent among estimations using panel data methods.

	1	2	3	1	5	6
	1995-2007	1993-2007	1995-2007	1993-2007	1993-2007	1995-2007
	OLS	OLS	Panel	Panel	Panel <sup>(1)</sup>	Panel <sup>(1)</sup>
	VI BOX	VI TREE	VI BOX	VI_BOX	VI_BOX	VI_BOX
K_CROP	4.42	1.52*	19.34***	9.83*	19.34**	9.83**
	(0.60)	(1.75)	(2.72)	(1.69)	(3.66)	(4.25)
K SITE	1714.35	119.73	8912.90**	5541.61	8912.90	5541.61
_	(0.48)	(0.30)	(2.18)	(1.26)	(1.07)	(0.93)
K PLANT	3.17**	0.10	7.10***	5.76***	7.10**	5.76
_	(2.40)	(0.57)	(4.45)	(4.04)	(2.90)	(2.00)
UNCERT	6.46*	-1.22	0.76	5.72**	0.76	5.73*
	(1.97)	(-1.35)	(2.12)	(2.18)	(0.69)	(2.67)
PROP R	-0.14	0.05		0.17		0.17
—	(-0.86)	(1.15)		(1.16)		(0.71)
POWER	100.50***	3.44***	31.66**	29.84**	31.66**	29.84
	(12.96)	(3.28)	(2.36)	(2.32)	(3.02)	(1.60)
LAND	0.0002	-6. 5x10 <sup>-6</sup>		0.003*		0.0003
	(1.49)	(-0.29)		(1.79)		(2.04)
SUGC P	0.01**	0.0002		0.008		0.008*
-	(2.16)	(0.33)		(1.63)		(2.45)
SUGC A	-0.00005*	$2.5 \times 10^{-6}$	0.00002	$1.62 \times 10^{-6}$	0.00002	$1.62 \times 10^{-6}$
—	(-1.85)	(0.79)	(0.84)	(0.06)	(0.31)	(0.02)
	$R^2 = 0.82$	$R^2 = 0.26$	$R^2 = 0.45$	$R^2 = 0.53$	$R^2 = 0.45$	$R^2 = 0.53$
	N = 61	<i>N</i> = 49	N = 70	N = 61	N = 70	N = 61

## Table 3 – Results

\*\*\*at 0.01; \*\*at 0.05; \*at 0.10 and t-statistic in parentheses

<sup>(1)</sup> Using cluster robust

Source: elaborated by the authors.

It is important to emphasize that positive relationship between power and vertical integration as found in the econometric test is not technological. If increase in market share means increase in quantities, which is not always truth, there is no technological link between processing activity of juice production and agricultural procedures in orange production. In other words, it is not economies of scale effects. Another issue related to the variable power is the direction of the effect. One can say that more vertical integration enable more bargaining power and, then, more market share. In this case, vertical integration explains market power and not the other way around. However, one can say that more vertical integration in orange production are the causes of more specialized chain, which elevate the relative quantity of oranges dedicated to juice production. In this sense, the ambiguity in effect direction occurs in both cases, economizing in transaction costs and power.

## 6. Concluding Remarks

The aim of the paper is to analyze vertical integration choice of juice processors in orange juice chain, in order to investigate the role of power in the increasing in vertical integration in 1990s and 2000s. Transaction costs arguments posit that economizing in transaction cost is the main case and power is applicable only under special conditions. The empirics of transaction costs commonly do not consider the process involved in the economic organization. In orange juice sector, changes in the environment caused by antitrust interventions, technological change in juice distribution, and restrictions to forward vertical integration for citrus growers are non-predictable events when specific investments were made in the earlier periods. Thus, investments made when transactions were knowledgeable, voluntary, and farsighted can be vulnerable to power exertion in the future. In this case, power can influence vertical integration trend, as econometric evidence demonstrate in orange juice case.

Results indicate simultaneous effect of power and asset specificity in the economic organization of orange juice sector. It is not possible to evaluate which is the most important determinant of vertical integration, power or transaction costs, or even to evaluate the trade off between them. Moreover, results show that transaction cost minimizing is not necessarily the starting point to the economic analysis, since power is also present when the organization process is under scrutiny. The starting point should be efficiency and power perspective in organizations. It is also worthwhile to note the use of shifter parameters in the econometric model, because it is not usual in empirics of transaction costs.

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<sup>&</sup>lt;sup>i</sup> The historical description was extracted from Hasse (1987), Moreira and Moreira (1991), Amaro (1991), Azevedo (1996, chap. 4), Maia (1996), Vegro, Veiga Filho, and Amaro (2003), Marino and Azevedo (2003), and Neves and Lopes (2005, chap. 2). Furthermore, we consult publications about the sector, reports, articles from <sup>ii</sup> In fact, before 1963 there was an incipient production of orange juice with two leading firms, Seiva and Companhia Mineira de Conservas. One can say that the orange juice was not the main activity of these firms. Suconasa was the first company whose main activity was the production of orange juice.

<sup>&</sup>lt;sup>iii</sup> This variable also captures temporal specificity effects.

<sup>&</sup>lt;sup>iv</sup> Concentration ratio indicates the extent in which orange production is geographically concentrated around cities where processing plants are installed in each firm and each year.

<sup>&</sup>lt;sup>v</sup> Paper presented in conference (Encontro Nacional de Engenharia de Produção). Author: SABES, J. J. S. Title: Medidas de Concentração no Processamento de Laranja no Estado de São Paulo, no Período de 2000/01 a 2007/08.