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Restrictive supply chain: how to get in? A Transaction cost answer.

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1. Introduction

A new quality trend modified the coffee industry in Brazil. Consequently, new supply chains emerged. Some architectures provide a friendly environment for value creation in high-quality coffee production, as the strictly coordinated supply chain of illycaffè company. The Italian company rearranged the specific investment decisions of Brazilian coffee growers. The agents became to consider some aspects in their production processes, such as harvesting delay, investments in post-harvest equipment, monetary and social incentives, and so on. This setting emphasizes the underexplored alignment of quality production and governance mechanism behind the relationship between the both literatures of supply chain and transaction costs (Williamson, 2008). Thus, as an underexplored case, but as a worldwide relevant chain in coffee production, this paper investigates the following research question: *what are the determinants to participate in the Brazilian restrictive supply chain of high-quality coffee?*

The illycaffè supply chain is interpreted as a restrictive supply chain due to high-quality requirements to be a coffee supplier. The firm designed a complex network based on contracts to minimize hold-up problems. This scenario provides an opportunity to investigate the transaction costs economics' efficient alignment argument due to the rearranges in specific investment decision of Brazilian coffee growers in order to participate in this restrictive supply chain.

This institutional arrangement describes a strictly coordination mechanism. The high-quality issue involves a different connection between the transaction attributes and the transaction costs. It requires specific investments and open room to contractual breaches when weak coordinated mechanisms are adopted, which highlight the traditional hold-up problem (Klein, Crawford & Alchian, 1978). The attributes of asset specificity, uncertainty and incentives should be aligned with the governance structure to avoid these coordination inefficiencies.

Therefore, as a well-designed supply chain, illycaffè subsystem requires a high-level of quality of its suppliers. Additionally, the coffee growers reallocate their resources to specialize the coffee production. Different asset specificities are absorbed in the farming production to achieve the quality and, simultaneously, the Italian company provides incentives and reduces uncertainty in the relationship.

This setting offers an opportunity to explore the governance issue in terms of quality production, according to the Transaction Cost Economics perspective (Williamson, 1985). By doing so, this paper aims to present the determinants to participate in a restrictive supply chain based on quality and coordination aspects.

The theoretical contribution is to advance the underexplored connection between the strictly coordinated (i.e restrictive) supply chain and Transaction Cost Economics application (McNally & Griffin, 2004, Wever, Wognum, Trienekens & Omta, 2012), mainly the avenue started by Williamson (2008), whose works has been strongly acknowledged as the highest searched in the Journal of Supply Chain Management. The managerial contribution is the investigation of one of the most worldwide recognized and restrictive coffee supply chain in terms of high-quality coffee production, the illycaffè subsystem.

The innovative detail is the deep investigation of one of the most worldwide known coffee subsystem in quality terms, the illycaffè restrictive supply chain (Zylbersztajn & Neves, 1995, Lipparini, Cazzola & Pistarelli, 2000, Rauscher & Andriani, 2009).

This paper is structured as follows. Section 2 presents the theoretical background based on the interface of a restrictive supply chain and the Transaction Costs Economics application. Section 3 shows the methodology and model details. Section 4 explores the results of both techniques, the exploratory and confirmatory approach. Section 5 concludes.

2. Theoretical foundation

A new quality trend in coffee production modified the economic efficiency perspective of the coffee industry. The emerging of gourmet coffee resulted in new relationships besides the traditional spot market. Incentive and monitoring structures settled warranties when specific investments focused on coffee quality are made. This is the case of the coffee industry in Brazil, where the restrictive illycaffè supply chain provides an adequate arena to the vertical integration dilemma (Coase, 1937).

Ultimately, since Williamson (1975, 1985, 1996), the vertical integration issue has been strongly investigated through the Transaction Cost Economics literature. This theory brings the transaction attributes and the governance mechanism as the main driver in economic efficiency. The literature presents the asset specificity, uncertainty and incentives varying in the coordination limits (market and hierarchy), according to Williamson (1983, 1991).

TCE provides a theoretical framework where the efficient alignment argument is the focus. The concept explores the alignment between the specific investments, uncertainty and incentives and the transaction costs. Williamson (1985) argues that each transaction attributes is responsible for this governance alignment. He introduces the coordination limits where the superior level (vertical integration) is related to a high level of asset specificity and uncertainty and the inferior level (market) is the opposite. And, also, in the middle, there are the hybrids governance modes.

Asset specificity is the specific investments in a determined transaction which lost value in a secondary alternative. According to Williamson (1981) there are three asset specificity levels; k=0 when the assets have different and flexible uses; k=i when the assets are not completely specific but can harm the economic agent when opportunism situations are faced (intermediary level) ; k=∞ when the assets are idiosyncratic.

The focus in participation in illycaffè subsystem relies on its capability to deal with quasi-rents expropriation issues due to specific investments of coffee growers (Klein, Crawford & Alchian, 1978). The coffee supply transaction involves different asset specificities, such as physical machineries in farming production, post-harvesting equipment and delay worry in harvesting.

Specialization production may be investigated through the adoption of physical equipment that achieves higher values of quality in the final product (i.e. physical asset specificity) (Lyons, 1994, Joskow, 1987, Williamson, 1985, 1996). The technological framework increases the asset specific level considering any specific investment in all production stages in coffee crop.

In the coffee production case, value increasing depends on technical and biological characteristics. Post-harvest activities are essential to achieving this quality differentiation. The systems that increase the attribute of quality are; the presence of wash machines of coffee, coffee beans separators (green, mature and rotten), moisture meter, machine to remove the pulping and machine to remove the husks. These structures may emerge as an internal process inside the farm or also they can be outsourced. Based on Lyons (1994), Joskow (1987) and Williamson (1985, 1996), this vertical integration or outsourcing decision adds

value in coffee through specific investments in specialized equipment, by that, both are interpreted as physical specific assets in the coffee supply transaction.

The washing coffee bean activity removes impurities remaining after harvest. Other post-harvest equipment such as coffee beans separators (green, mature and rotten), moisture meter, machine to remove the pulping and machine to remove the husks contribute to the coffee quality due to its fermentation level, which brings benefits to the classification of the quality level related to the gourmet or commodity coffee.

Other asset specificity also emerges. According to Williamson (1985, 1996), time asset specificity relates to the harvesting delay and storage stage, since both processes influence the relationship between time and coffee bean value. The time aspect is usually considered in agricultural products because of the perishability and nature of these goods (Masten, 2000). In the coffee crop is not different, since time is an important variable in coffee storage and harvesting stage. Both situations illustrate the possibility of coffee quality loss due to its fermentation cycle (Silva, Salvador & Pádua, 2000, 2001).

The harvesting activity interconnects this setting to the level fermentation of coffee bean (green, mature and rotten). By doing so, the harvesting delay impacts direct the final coffee quality. Delay or anticipation in the harvest period may lead to loss of coffee quality, since the beans may be still immature or have already passed their maturity. Studies on coffee cultivation (Silva, Salvador & Pádua, 2000, 2001) expose that there is a specific percentage of green coffee still in the coffee tree to harvest at the ideal time. In other words, the time asset specificity coffee supply transaction is interpreted as: i) the number of storage days of the grains; and ii) the percentage of green beans in coffee tree to start the harvest.

In sum, the investment perspective above interferes the coffee supply transaction between the Brazilian coffee growers and the processing industry. The opportunistic value capture and hold-up problems highlight the quasi-rents in the presence of these asset specificities (Klein, Crawford & Alchian, 1978, Williamson, 1985, 1996). The presence of high asset specificity requires more coordinated governance structure to protect the quasi-rents, in other words, a strictly coordinated subsystem which is able to protect specific. In the Brazilian coffee this relationship is marked by the illycaffè supply chain which requires a high level of quality and, at the same time, provides a complex architecture that protects these quasi-rents and restricts opportunistic value appropriation. This setting shapes the first hypothesis as follows:

H_1: The higher the asset specificity in the coffee supply transaction, the higher the likelihood to participate in the restrictive supply chain.

The uncertainty attribute arises as the inability to predict events (Williamson, 1985, 1996, Farina, 1999). The predictability of these facts is external to the individual's ability to achieve total comprehension about a particular situation. This dimension involves the following behavioral assumptions: cognitive inability in information processing (bounded rationality) (Simon, 1955); and actions that seek self-interest and contradict the altruistic vision (opportunism) (Williamson, 1985, 1996). Both assumptions influence decision making according to the existence of contractual incompleteness, since any relationship is liable to opportunistic behavior. Thus, uncertainty influences the transaction coordination mechanisms.

The uncertainty concept is complex due to its interconnection with different environments. This attributes may assume three distinct natures: market uncertainty, technological and institutional (Carlton, 1979, Williamson, 1985, North, 1991, Lajili, Madunic, & Mahoney, 2007).

Uncertainty may reflect price volatility due to changes in supply and demand in the coffee production. And also, despite the existing technology, agricultural products are subject to climatic conditions (season, rain, temperature) and environmental accidents that are beyond

the control of the individual (Goldberg, 1968), as well as in the institutional impact through the change of legislation regarding the coffee production (e.g. agrochemicals, fertilizers, etc.). Therefore, the governance decision surrounds the quality-based remuneration stability according to an interference of an external shock on price decreasing, which will be, or even will not to be, transmitted to the coffee grower. Then, at least, the impact will be smaller to the coffee grower who participates in the strictly coordinated subsystem than to the others.

Keeping that in mind, the uncertainty in coffee supply transaction assumes the same role regarding the dilemma of vertical integration, since the illycaffè restrictive chain is able to minimize exogenous shocks and disturbances. This ability is observed in situations where a subsystem supply chain is able to minimize the shock, or else, the coordinator absorbs the all risks (i.e. costs) from these uncertainties (Zylbersztajn & Farina, 1999). In this case, ceteris paribus, the strictly coordinated subsystem becomes the lower transaction costs option when agents face uncertainty (Williamson, 1996). This argument bases the second hypothesis as follows:

H_2: The higher the uncertainty in the coffee supply transaction, the higher the likelihood to participate in the restrictive supply chain.

Another relevant attribute is the incentive (Williamson, 1985). This approach appears in high-quality coffee production in Brazil as monetary and reputation incentives. This environment denotes the relevance to the market volatility and price fluctuations in coffee production (Saes, 2008), since it is impossible to be an exclusive supplier in the illycaffè subsystem, because this supply chain restricts the participation based on a very high-quality level. By doing so, the coffee growers seek the simultaneous participation in multiple subsystems in order to try to capture different incentives provided by each chain (Nunes, Saes, Rossignolo, Souza & Souza, 2013), where the illycaffè subsystem is known for provide the highest incentives in the coffee market in Brazil.

As a restrictive supply chain that demands specific investments for high quality production, the coffee grower tends to participate in the illycaffè subsystem if, and only if, the incentives provided are satisfactory. In this case, the coffee grower participates in the strictly coordinated subsystem to protect his previous specific investments, to minimize the different uncertainties and to obtain the higher incentives in the market (Williamson, 1985, 1996). This setting presents the last hypothesis as follows:

H_3: The higher incentives in the coffee supply transaction, the higher the likelihood to participate in the restrictive supply chain.

3. Methodology

This paper adopts a quantitative approach. The investigation explores a primary data collected through a survey based on Transaction Costs Economics.

The questionnaire was validated by two coffee specialists during July and September in 2015. A pre-test was performed and resulted in 30 observations during in the International Coffee Week, which contains a diversity of Brazilian coffee growers. Other 39 observations were collected by telephone to analyze the coffee grower behavioral in this type of communication.

In sequence, 55 interviews during two well-known Brazilian coffee conferences (FEMAGRI 2016 e SimCafé 2016) and 50 telephone interviews built a final sample based a non-probabilistic nature. The telephone data collection adopted cooperatives and farmer association databases in the coffee industry in Brazil.

The coffee growers are from Minas Gerais and São Paulo States, because both places are the main relevant State producers in coffee production in Brazil. And, also, they include a

vast diversity of coffee farms and coffee growers that represent all different profiles along the Brazilian territory. The data collection focused on the arabica coffee production due to its high-quality level in comparison of others coffee species.

The empirical analysis assumes the alignment efficiency argument of Transaction Costs Economics as already exposed by the hypotheses (Williamson, 1985, 1996). A probit regression was performed based on its theoretical structure (Green, 2003). The probit regression estimates the likelihood P (y = 1 | x) = ϕ (xit 'β), where ϕ represents the cumulative normal distribution.

Equation 1. Probit regression and TCE variables

$$P(restrictive\_chain=1|x) = \phi\ (\beta_{0i} + \beta_1\ X\ \text{PostHarvEquip}_i\ + \beta_2\ X\ \text{PostHarvOutsour}_i + \beta_3 X\ \text{OutsourContracts}_i + \beta_4 X\ \text{GreenBeans}_i + \beta_5 X\ StorageDays_i + \beta_6 X Uncert\_Factor_i + \beta_7 X\ \text{Price\_Dif}_i + \beta_8 X\ \text{Qual\_Rec}_i + \beta_9\ X\ \text{BagsHec}_i + \beta_{10} X\ \text{CoffeeCropAge}_i + \beta_{11} X\ Workforce_i + \beta_{12}\ X\ \text{Perc\_Gourmet}_i + \beta_{13}\ X\ HighEducation_i + \beta_{14}\ X\ FrequencySales_i\ )$$

3.1 Variables

The probit regression assumes as dependent variable the participation in the *restrictive supply chain (1=yes and 0=otherwise)* and as independent variables the variables, which are detailed in sequence.

For "PostHarvEquip" construction we performed a tetrachoric correlation and factor analysis corresponding to the own (1), or not (0), of different post-harvest equipment. The tetrachoric correlation is related to a factor transformation of various binary variables. The factor analysis is more appropriated when applied in a tetrachoric correlation matrix due to unimodal continuous data. The factor is built based on the tetrachoric correlation coefficient (Uebersax 2000, Stata, 2013) between the answers to the following question: "Do you own [...] in your coffee farm?". Where […] represents any post-harvest equipment: presence of wash machines of coffee, coffee beans separators, moisture meter, own storage place, machine to remove the pulping and machine to remove the husks. Based on Hair et. al. (2006) and the Barlett's test, all variables were relevant to the construction of the factor, since they all correlated ($p<0.001$), at least in one pair. The final factor adopted in the regression analysis explains about 90.0% of the whole variance of those binary variables.

Based on Lyons (1994), Joskow (1987) and Williamson (1985, 1996) we expect that the higher the specific investment in specialized post-harvest equipment, the higher is the physical asset specificity in coffee supply transaction and, consequently, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved.

"PostHarvOutsour" is a binary variable associated with the following question: "Do you outsource any post-harvest service"?. According to Lyons (1994), Joskow (1987) and Williamson (1985, 1996) it is expected that The use of post-harvest equipment, even outsourced, increases the physical asset specificity in coffee supply transaction and, consequently, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved.

"OutsourContracts" is interpreted as the number of contracts in the service provision to the different coffee production stages, such as planting, harvesting, post-harvesting and so on. The reference question is: "How many contracts of service provision do you contract in the last coffee crop?". Based on Lyons (1994), Joskow (1987) and Williamson (1985, 1996) we expect that The use of specialized services in the different stages of coffee crop increases the physical asset specificity in coffee supply transaction and, consequently, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved.

"GreenBeans" captures the percentage of green coffee beans before the harvesting activity starts. The reference question is: "What is the percentage of green coffee beans before you start your harvesting activity"? . According to the expectations from Masten (2000), Silva, Salvador & Pádua (2000, 2001) and Williamson (1985, 1996) the coffee harvesting should be started in a specific time window because it is an arduous and long activity, that is, coffee beans should be harvested in an exact time when they are varying from a green fermentation to a mature fermentation, but, at the same time, they could not be all matures. By doing so, the lower the percentage of green coffee beans, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved.

Additionally, "StorageDays" presents the storage days since the harvesting activity finished related with the following question: "How many days you storage your coffee beans (consider the delivery time in sales operation". Based on the same authors, it is expected that the larger the storage period, the higher the likelihood to lose value due to fermentation beans decreasing quality, that is, the lower the likelihood to adopt a strictly coordinated governance structure.

For "Uncert_Factor" construction, we adopted a factor analysis based on the coffee grower's perception about the different uncertainties (market, technological and institutional). The question for this variable is: "Assign the respective grades (5) for Impossible to predict and (1) Easily predictable for the following phrases: i) guess, approximately, the price of coffee bag for the next crop (unc_pric); ii) the creation of new parameters of quality (i.e. bean size, bean color, bean taste, etc.) adopted by the processing firms (unc_buyer); iii) creation of new and impacting technologies in the coffee production in terms of quality (unc_tec); and iv) institutional changes in the sanitary regulation (unc_inst). Based on the Barlett's test, all variables were relevant to the construction of the factor, since they all correlated ($p<0.001$), at least in one pair. The final factor adopted in the regression analysis explains about 43% of the whole variance of all ordinal variables associated with uncertainties.

Based on Carlton (1979), Williamson (1985, 1996), North (1991) and Lajili, Madunic, & Mahoney (2007), the higher the coffee grower's perception about uncertainty in the coffee supply transaction, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved.

"Price_Dif" evaluates the difference between the higher price of the coffee grower's coffee bag and the mean of the market price. The question is: "What is the price of your most expensive coffee bag in the last crop"?. Using as references Williamson (1985, 1996), Saes (2008) and Nunes *et al.* (2013), we expect that the higher in the difference between the higher price of the coffee grower's coffee bag and the mean of the market price, the higher the likelihood to adopt strictly coordinated governance structure due to its incentives structure.

"Qual_Rec" is interpreted as the coffee grower's perception about the quality-level of his coffee supply. The reference question is: "Assign the respective grades (5) high and (1) low to: what is the relevance to be recognized as a high-quality coffee farmer?. Based on Williamson (1985, 1996), Saes (2008) and Nunes *et al.* (2013), it is expected that the higher the reputational incentive, the higher will be the externalities when the coffee grower will sale to another firms, that is, the higher will be the likelihood (i.e. interest) to participate in the strictly coordinated governance structure due to its reputational incentives structure.

"BagsHec" analyzes the logarithm of the productivity mean (i.e. coffee bags per hectare). The variable is based on the following question: "What is your productivity mean, in coffee bags per hectare?". We expect that the better the production efficiency, the higher the coffee grower's capability to manage the different coffee production stages, that is, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved in this specialized production.

"CoffeeCropAge" investigates the coffee crop age. The question about this setting is: "What is your coffee crop age, at mean (years)?". It is expected that the higher the coffee crop age, the higher the accumulated technical knowledge about coffee production, that is, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved in this specialized production.

"Workforce" evaluates the level of manual harvesting workforce in the coffee farming. The variable is captured through an ordinal scale assuming three different levels from mechanized to semi-mechanized to manual. The reference question is: "What is the level of the level of manual harvesting workforce in your coffee farming? Assign the respective grades (1) for mechanized; (2) for semi-mechanized and (3) for manual.". We expect that the higher the presence of machineries in harvesting activity, the lower the possibility to achieve quality due to the damages to the coffee trees, that is, the lower the likelihood to adopt a strictly coordinated governance structure.

"Perc_Gourmet" analyzes the percentage of gourmet coffee related to the whole coffee production. The reference question is: "What is the percentage of gourmet coffee related to the whole coffee production?". It is expected that The higher the percentage of gourmet coffees in the whole coffee production, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved.

"HighEducation" is a binary metric and evaluates if the coffee grower has an undergraduate education level. The reference question is: "What is your educational level: ( ) I did not do the primary school; ( ) primary school; ( ) High school ( ) Undergraduate. We expect that the higher the education level of coffee grower, the higher his managerial capabilities to achieve a high-quality of coffee production, that is, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved.

"SalesFrequency" is a discrete variable and investigates the sales frequency of the coffee supply transaction. This setting tries to capture the different incentives available in the coffee market. As a very restrictive case due to a high quality level, the farmers are only able to sell a share of his total production to the strictly coordinated supply chain. By doing so, the coffee growers should have a high frequency of sales operation as a way to expose the participation in different supply chains, more than the only the sale to the restrictive one. Thus, the recursitivity attribute presents this scenario illustrating that suppliers of the restrictive chain possible also sell to another supply chains with less restrictiveness. The reference question is: "At mean, how many sales operations do you make a long a year?".

4. Results

4.1 Exploratory data analysis

The primary data were collected based on a survey with 105 interviews with Brazilian coffee growers from São Paulo e Minas Gerais during December, 2015 to April, 2016. Firstly, we applied an exploratory approach to explore the data analysis.

The exploratory approach focuses on the three hypotheses where each one based on their interest variables adopting a correspondence analysis (quadratic euclidean distance).

H_1 analysis two different groups (suppliers of the restrictive supply chain and otherwise) about the owning of post-harvesting equipment (1), or not (0); wash machines of coffee, coffee dryer equipment, coffee beans separators, moisture meter, own storage place, machine to remove the pulping and machine to remove the husks.

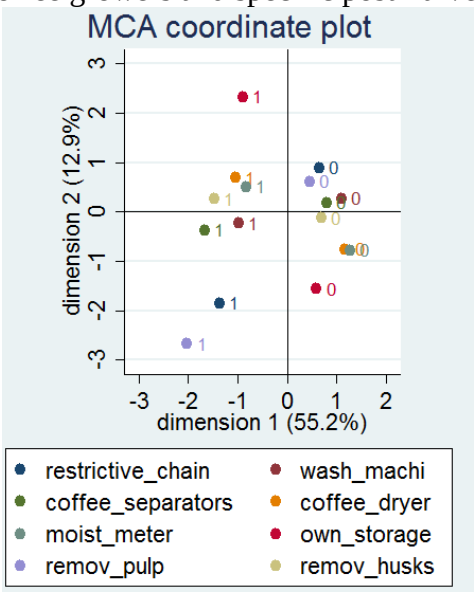
As an initial step, it was performed a chi-square analysis to verify if the variable pairs have correlation between themselves. The results show that all variables have a

significant correlation ($p<0.1$), at least, in a pair, which result in the using of all metrics in the correspondence analysis.

Eight dimensions explain the whole dependent variable variance. Although, we chose only two dimensions for visual purposes. The chosen two dimensions are responsible for 68.1% of the whole variance, whereas adding the third dimension the variance increases only for 75.6%.

Figure 1 presents the interaction between the variables.

Figure 1 – Coffee growers and specific post-harvest equipment.



Source: Authors.

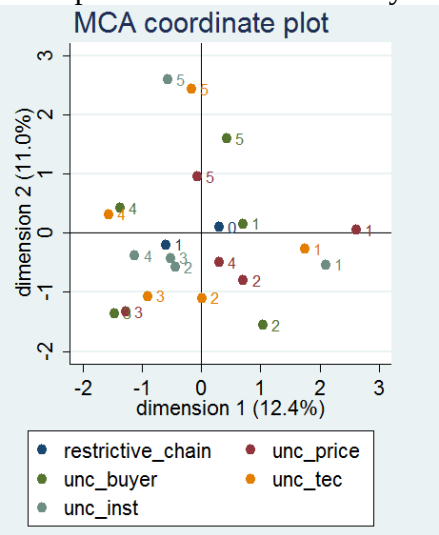
Based on H_1 and Figure 1, it is possible to argue that coffee growers who do not participate in the restrictive supply chain do not own the specific post-harvest equipment also. This illustration is on the superior and right quadrant above. At the same time, it does not suggest the opposite situation, which will be more explored in the confirmatory results.

Secondly, H_2 focus investigates the coffee grower's uncertainty perception about the market, technological, institutional uncertainty. Over again a chi-square verified the significant correlation between the variables inside, at least, a pair. The results brought up that all variables have a significant correlation ($p<0.1$), at least, in a pair, which result in the using of all metrics.

Seventeen dimensions explain the whole dependent variable variance. We adopted a visual graph of two dimensions to be pragmatic. The two dimensions analyzed are responsible for the explanation of 23.4% of the whole variance, while adding a third dimension this percentage only goes up for 32.4%.

Figure 2 illustrates the relationship between the uncertainty variables and the participation in the strictly coordinated supply chain.

Figure 2 – Relationship between the uncertainty and coffee growers



Source: Author.

According to H_2 and Figure 2, the results expose that restrictive supply chain participants have a medium uncertainty level, at least. This scenario emerges almost in the middle of the graph, in the left and inferior quadrant. Otherwise, it also suggests that coffee growers who do not are suppliers of this arrangement do not perceives a low uncertainty level. This argument brings that this specific farmers do not worry about the coordination problem as a consequence from their adoption of less strictly coordinated governance.

About H_3, the investigation takes account other variables related to the "Qual_Rec". This decision amplifies the incentives impact in the participation in the present supply chain issue. The other incentives variables analyzed are also ordinal scale based on the following question: "What is the relevance of [.....] for your coffee sale? Assign the respective grades (5) high and (1) low."

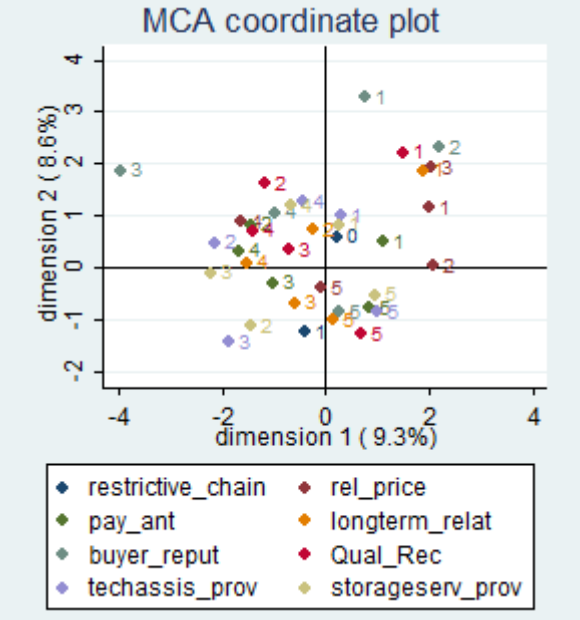
Where [.....] means: relevance of price (rel_price), payment anticipation (pay_ant), long-term relationship (logterm_relat), firm's reputation (buyer_reput), recognition as a high-quality coffee grower supplier (Qual_Rec), provision of technical assistance (techassis_prov), provision of storage services (storagserv_prov).

Similarly to the previous procedures, a chi-square demonstrated that all variables have significant correlation in a pair, at least. The results show that all are significant ($p<0.1$), leading to the use of all metrics.

This last correspondence analysis appeared based on twenty nine dimensions. We also illustrate this environment through a visual graph of two dimensions. The two dimensions analyzed are responsible for the explanation of 17.8% of the whole variance, while when a third dimension is added the percentage increases only to 25.2%.

Figure 3 presents the relationships between the incentives variables about the coffee sale and the participation in the interest supply chain.

Figure 3 – Relationship between incentives and coffee growers



Source: Author.

According to H_3 and Figure 3, the findings denote that coffee growers who participate in the restrictive supply chain highly concern about the different incentive types: payment anticipation, long-term relationship, firm's reputation, recognition as a high-quality coffee grower supplier, provision of technical assistance, provision of storage services.

The results illustrate the relevance in consider this variables for the research question as well as the mentioned variables above. As a consequence of this multicollinearity, we chose the variable "Qual_Rec" which sums with a distinct incentive than the monetary from "Price_Dif".

4.2 Confirmatory procedures

Firstly, we performed a non-parametric test, since the sample size is small (Siegel, 1956, Siegel, 1957). We adopted a Mann-Whitney test to verify the hypothesis if the two subsamples are independents, that is, to investigate whether participants or not of the restrictive supply chain have the same population distribution. The test assesses this setting through a Wilcoxon rank-sum test (Wilcoxon 1945, Mann & Whitney, 1947).

About the specificity assets construct, the Mann-Whitney test rejects the hypothesis that the investments in specific post-harvest equipment ($p<0.01$) and the percentage of green coffee beans before the harvesting begin ($p<0.05$) have the same distribution in the group of the suppliers of the restrictive supply chain and the other. Otherwise, the other variables, such as post-harvest contracting services, contract of other services and storage days have opposite results.

Focusing on uncertainty, the Mann-Whitney test does not reject the hypothesis that all uncertainties considered (market, technological and institutional) have the same distribution in the two different groups.

The incentives construct appear with a Mann-Whitney test rejecting the hypothesis that monetary ($p<0.05$) and reputational ($p<0.01$) have the same distribution in the group formed by the suppliers of restrictive supply chain and the other.

After this non-parametric analysis, a confirmatory approach based on the efficient alignment (Williamson, 1985, 1996) appears. This theoretical context considers that asset specificity, uncertainty and incentives are positively correlated to the adoption of a higher

coordinated governance mechanism, which, in this case, it is represented by the restrictive supply chain of illycaffè company.

A probit regression with robust errors supports the findings. Previously descriptive statistics are shown in Table 1.

Table 1 – Descriptive statistics of model's variables

Variable	Obs	Mean	Std-Dev.	Min	Max
restrictive_chain	105	0.3238095	0.4701726	0	1
PostHarvEquip	102	0.5668195	0.4438428	0	1.073
PostHarvOutsour	104	0.2692308	0.4457081	0	1
OutsourContracts	105	5.542	7.445	0	40
GreenBeans	104	0.1460577	0.1089884	0	.5
StorageDays	104	1.523	157.699	0	720
Uncert_Factor	103	4.16e-10	1	-2.101	1.991
Price_Dif	104	106.8	2.472808	-120	1990
Qual_Rec	104	3.846	1.384	1	5
BagsHec	105	4.008	1.255	1.791	9.210
CoffeeCropAge	105	11.89	5.969	3	40
Workforce	105	2	0.7337994	1	3
Perc_Gourmet	104	4.75625	13.99275	0	100
HighEducation	105	0.447619	0.4996336	0	1
FrequencySales	104	8.298	10.796	1	80

Source: Author.

Table 2 presents all regressions models using an incrementally procedure. Model A performs only control variables and the next models (B, C and D) include each theoretical construct, asset specificity, uncertainty and incentives.

Table 2 – Probit regression with robust errors.

Dependent variable "*restrictive_chain*"	**1 = supplier of the restrict supply chain 0 = otherwise**				
	Probit regression with robust errors				
	A	B	C	D	Marginal Effects – Model D
BagsHec	0.2660335** (0.1352232)	0.4027386*** (0.132399)	0.4540682*** (0.1421365)	0.6326929*** (0.184168)	0.0880123
CoffeeCropAge	0.0763492**** (0.0204649)	0.0916176*** (0.0264812)	0.0923776*** (0.0295991)	0.1351765**** (0.0351923)	0.0188041
Workforce	0.2354053^{NS} (0.1986302)	0.3726917 ^{NS} (0.2613963)	0.503993* (.2918875)	0.7185592** (0.3608958)	0.099957
Perc_Gourmet	0.0095312^{NS} (0.0094879)	0.0221621** (0.011062)	0.0166264 ^{NS} (0.0115774)	0.0294878*** (0.0106381)	0.004102
HighEducation	1.157529**** (0.3047106)	0.4694833 ^{NS} (0.4005905)	0.7072566* (0.3978439)	1.647586*** (0.5112736)	0.2291915
FrequencySales	0.0403393* (0.022456)	0.0813858*** (0.0282433)	0.0843839*** (0.0288279)	0.1376507**** (0.0371247)	0.0191482
PostHarvEquip		1.90513**** (0.5104284)	2.030456**** (0.563896)	1.763696*** (0.6479455)	0.2453433
PostHarvOutsour		0.2882373 ^{NS} (0.4650902)	0.0923661 ^{NS} (0.4672991)	0.193816 ^{NS} (0.5836314)	-

OutsourContracts		0.0184926 ^{NS} (0.0251652)	0.0314006 ^{NS} (0.0310723)	0.0517318* (0.0296193)	0.0071963
GreenBeans		0.4787221 ^{NS} (1.681727)	-0.4732649 ^{NS} (1.879401)	-0.4513817 ^{NS} (2.343387)	-
StorageDays		-0.0049192*** (0.0014833)	-0.0046272*** (0.0015969)	-0.0063585*** (0.0019443)	-0.0008845
Uncert_Factor			0.3763405** (0.1768222)	0.701323*** (0.3151006)	0.0975593
Price_Dif				0.0018821 ^{NS} (0.0013636)	-
Qual_Rec				0.8975425**** (0.2369244)	0.1248549
Constant	-3.935015 (0.7838958)	-5.893506 (1.088768)	-6.609512 (1.241755)	-13.29169 (2.778454)	
Observations	104	102	101	101	
Log-likehood	-46.47	-34.16	-32.21	-25.23	
Wald-chi^2	39.88	51.65	48.10	34.49	
Prob>chi^2	0.0000	0.0000	0.0000	0.0018	
Pseudo R^2	0.2929	0.4680	0.4951	0.6045	

NS not significant, *p<0.1, **p<0.05, ***p<0.01, ****p<0.001
Standard errors in brackets
Source: Authors.

The final model is the model D due to focus on all variables and hypotheses. The other model aimed to expose the interaction between the different theoretical constructs.

Model D presents a good estimation structure: i) *log-likehood* of -25.23; ii) *Likehood ratio* (LR) *chi-square* with 14 degrees of freedom equal 34.49; iii) chi-square likelihodd equal 0.0018, in other words, at least one of the predictors is different of zero at p<0.01. Also, other tests emphasize this argument: i) Hosmer-Lemeshow test that does not reject the hypothesis that the expected and observed value are equals; ii) a good global efficiency of the model (cut-off 0.5) with 87.13% of correctly classified data, 81.82% of sensitivity, 89.71% of specificity; and iii) a ROC curve with an area of 0.9541.

Considering the lowest level of significance, all hypotheses (H_1, H_2 e H_3) are supported at p<0.01, p<0.01 and p<0.001, respectively. Inside each hypothesis it is possible to observe different significance levels: p<0.01 in H_1, p<0.01 in H_2 and p<0.001 in H_3.

Variables at p<0.001 are: CoffeeCropAge, FrequencySales and Qual_Rec. At p<0.01: BagsHec, Perc_Gourmet, HighEducation, PostHarvEquip, StorageDays and Uncert_Factor. At p<0.05: only the variable Workforce. At p<0.1: OutsourContracts. The not significant variables are: PostHarvOutsour, GreenBeans and Price_Dif.

About H_1 it is possible to observe the variables PostHarvEquip (p<0.01) and OutsourContracts (p<0.1) are positively correlated with the participation in the restrictive supply chain. As expected, the variable StorageDays negatively affects this participation. In other words, the results show that asset specificity (i.e. physical and time) increase the likelihood to participate in a more coordinated governance mechanism, which it was already expected following the logics behind Lyons (1994), Joskow (1987) and Williamson (1985, 1996) and the efficient alignment argument from Transaction Costs Economics.

The variables that denote asset specificity in the supply coffee transaction are: physical (post-harvest equipment and outsourcing contracts in the different stages of coffee crop) and time (storage days of coffee beans). The expected difference in the likelihood to participate in the restrictive supply chain is associated with an increasing of 24.53 percentage points when PostHarvEquip increases in a unit as well as there is an increasing of 0.71%

when the number of contracts also increases in a unit (OutsourContracts). Otherwise, there is a decreasing of 0.08% in the likelihood of participating on the restrictive supply chain when there is a unit increasing in the storage days of coffee beans (StorageDays).

While the variables PostHarvOutsour and GreenBeans are not significant. The result of first it is possible due to the coffee grower's capability in produce quality in his coffee beans by other means, and not only by the outsourcing contracts of post-harvest services, which is highlighted when compared with the results of the variable PostHarvEquip that exposes this quality-increasing by the vertical integration of the post-harvest activities. And also, the findings from GreenBeans suggest that the concerning about the time to harvest might be smoothed due to the adoption of good post-harvesting processes that are able to deal with the coffee beans fermentation as another way to reach the expected quality.

About H_2 the results present that the variable Uncert_Factor ($p<0.01$) is positively correlated with the participation in the restrictive supply chain, that is, the higher the uncertainty level in the coffee supply transaction, the higher likelihood to participate in the restrictive supply chain. As expected, the empirical findings are associated with the logics behind Carlton (1979), Williamson (1985, 1996), North (1991) and Lajili, Madunic, & Mahoney (2007) and the efficient alignment argument from Transaction Costs Economics. The expected difference in the likelihood to participate in the restrictive supply chain is associated with an increasing of 9.75 percentage points when Uncert_Factor increases a unit.

About H_3 the results demonstrate that Qual_Rec ($p< 0.001$) is positively correlated with the participating on the restrictive supply chain, that is, the higher incentives in the coffee supply transaction, the higher the likelihood to participate in the restrictive supply chain. The findings highlight the reputational incentives expectation from Williamson (1985, 1996), Saes (2008) and Nunes et al. (2013) and from the efficient alignment argument from Transaction Costs Economics. The expected difference in the likelihood to participate in the restrictive supply chain is associated with an increasing of 12.48 percentage points when Qual_Rec increases in a unit in the perception scale about the recognition as being a high-quality coffee grower.

The variable Price_Dif appeared as expected, but not significant. The results suggest that the coffee-grower is just able to sale his high-quality coffee to the restrictive supply chain in a minimum share, and, as a consequence, the monetary incentives is proportional and, so, they are not much relevant. While the reputational incentive (Qual_Rec) may be result in other monetary incentives when the coffee grower sales for the other supplies chain, which means that the quasi-rents in this situation overlaps the financial aspect in the small high-quality share for the restrictive supply chain focus.

All control variables emerged as expected and significant: CoffeeCropAge ($p<0.001$), Perc_Gourmet ($p<0.01$), BagsHec ($p<0.01$), HighEducation ($p<0.01$), Workforce ($p<0.05$) and FrequencySales ($p<0.001$). All of them are positively correlated with the participating in the restrictive supply chain.

CoffeeCropAge shows that the higher the coffee crop age, the higher the accumulated technical knowledge about coffee production, that is, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved in this specialized production. The expected difference in the likelihood to participate in the restrictive supply chain is associated with an increasing of 1.8 percentage points when increases a year in the coffee crop age.

Perc_Gourmet illustrates that the higher the percentage of gourmet coffees in the whole coffee production, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved. There is an increasing of 0.41% in the likelihood of participating on the restrictive supply chain when there is an increasing of a unit of Perc_Gourmet.

BagsHec denotes that the higher the production efficiency, the higher the coffee grower's capability to manage the different coffee production stages, that is, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved in this specialized production. The expected difference in the likelihood to participate in the restrictive supply chain is associated with an increasing of 8.8 percentage points when BagsHec increases in a unit.

HighEducation exposes that the higher the education level of coffee grower, the higher are his managerial capabilities to achieve a high-quality in coffee production, that is, the higher the likelihood to adopt a strictly coordinated governance structure to protect the quasi-rents involved. There is an increasing of 22.91% in the likelihood of participating on the restrictive supply chain when the coffee grower has an undergraduate education level.

Workforce demonstrates that the higher the presence of machineries in harvesting activity, the lower the possibility to achieve quality due to the damages to the coffee trees, that is, the lower the likelihood to adopt a strictly coordinated governance structure. The expected difference in the likelihood to participate in the restrictive supply chain is associated with an increasing of 9.99 percentage points when Workforce increases in a unit.

FrequencySales shows that the higher the sales frequency in a year, the higher the likelihood to adopt a strictly coordinated governance structure due to the high-level of quality requirements, because it limits the possibility to sale a large share of the coffee production, which result in the sale to others firms. There is an increasing of 1.91% in the likelihood of participating on the restrictive supply chain when the sales operation in a year of the coffee grower increases in a unit.

5. Conclusions

The paper achieved the purpose of present the determinants to participate in a restrictive supply chain based on quality and coordination aspects. Theoretically, the results shed light on the empirical validation of the efficiency alignment argument of Transaction Costs Economics. The findings illustrated that asset specificity, uncertainty and incentives are positively correlated with a more coordinated governance mechanism.

The managerial contribution show that to reach high-quality, as a much high requirement level as one of the most worldwide and restrictive coffee supply requires, the coffee grower is oriented by the adoption of post-harvest equipment, outsourcing contracts in services in the different stages in the coffee crop, reputational incentive, manual workforce structure, high education level, coffee crop age, gourmet coffee production and sales operation along a year. Otherwise, the storage days of coffee beans has a negative impact in the participation on the restrictive supply chain, which underlines the losses of value due to quality degradation in the storage over time.

The results bring that the major impact factor in the likelihood of participating on the restrictive supply china is the adoption of post-harvest equipment, such as wash machines of coffee, coffee beans separators, moisture meter, own storage place, machine to remove the pulping and machine to remove the husks. And, also, the paper presents another situation where the financial incentive is overlapped by a reputational one. This illustration expose that the market reputational from being a supplier of a well-known firm in the coffee industry implies in other financial benefits when the coffee grower negotiate his other coffee production share with other firms. This argument emphasizes the relationship between the quasi-rents capture and generating in the Brazilian coffee industry from Saes (2010).

The investigation highlights that coffee quality is influenced by different perspective, and that the uniqueness of the manual workforce influence does not remains anymore. Different from some scholars (Vélez, Montoya & Oliveros, 2002, Cárdenas, Tascón, Mejia,

2015) that maintain this argument looking Colombia, this paper shows that the quality achievement is able to other farming production processes, such as in the post-harvest equipment and the storage activity. This scenario is even more emphatic due to the focus of the investigation, the analysis of one of the most worldwide recognized and restrictive coffee supply chain, the illycaffè subsystem.

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