DETERMINANT FACTORS OF THE DECISIONS ASSOCIATED TO RISK OF THE COLOMBIAN COFFEE GROWERS

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Abstract

The main idea of this paper is to identify the determinant factors of the decisions associated with the risk of Colombian small-scale coffee growers. Through a survey from a selected sample from Colombian coffee growers, classified by region and size,we identify the risk propensity and confidence in risk management instruments. With the data, we build two taxonomies: the first one, the risk taxonomy; and the second one, the risk management instruments taxonomy. With these results, we build six unobservable constructs through Confirmatory Factor Analysis CFA methodology. The constructs represented: i) the history of successes and failures resulting from decisions made in the past; ii) the influence of the idiosyncratic characteristics of the problem on coffee growers' perceptions of risk; iii) the tendency of coffee growers to take or avoid risks; iv) the alternatives that a decision maker confronts; v) the individual evaluation of the risks before a situation and the confidence in that evaluation; and iv) the effects of the risk management instruments offered to the coffee growers. The results of the six latent constructs were significant, which allows us to conclude that the latent constructs are measurement models defined as indicators that describe the decisions associated with the risk of small-scale coffee grower'strough the identified factors.

Key words: small-scale coffee grower, riskpropensity; risk management;risk perception; institutions; Confirmatory Factor Analysis.

INTRODUCTION

Coffee growing sector is vulnerable to exogenous events and due to its commodity nature; it is too sensitive to the volatility of international prices and climate change. Uncertainty about prices and production levels of raw materials increases the vulnerability of small-scale farmers in the world and makes decisions on the levels and varieties of production subject to greater risk (Antwi-Agyei, Peasey, Biran, Bruce, & Ensink, 2016). After the breakdown of the International Coffee Agreement in 1989 (Fonseca, 2003), coffee production in Colombia went into crisis, coffee growers experienced significant losses in productivity and a sharp decline in their income. The coffee sector experienced structural problems, in which populations with limited incomes see their purchasing power diminish and inequalities expand (Estrada, Gay, & Conde, 2012). In 2001, the lowest external real price of coffee was recorded in 180 years. However, unlike previous decades, the behaviour of the coffee business did not have a large-scale macroeconomic impact (Arango, Hernández, Ortiz, Perfetti del Corral and Velásquez, 2002).

Moreover, in 2010 climatic variability (girl phenomenon) increased vulnerability to diseases such as coffee rust (*Hemileia vastatrix*) and pests in coffee plantations. This stimulated the renewal of plantations towards resistant transitional varieties, which increased the renewal and technification of the cultivated area and led to a higher production until 2013 (Echavarría et al., 2014). In this year, in the context of a crisis in the agricultural sector, the coffee sector faced a third crisis; the dynamics of Colombian exports of agricultural products decreased.In addition, it

was found that in large areas of the national territory suitable for cultivation, thousands of hectares were used for livestock activities (Ocampo, 2015). Added to this, the persistent levels of volatility in prices during the first three decades of the 21st century are a source of growing concern about the effects on production and the profitability of growers.

In this sense, commodity producing countries should adopt instruments to manage the risk inherent to price volatility (Junguito and Pizano, 1993). As formulated by the Coffee Institutional Adjustment Committee, the latest crises in the world coffee industry are undoubtedly the most acute that have occurred in decades; what has harmed Colombian coffee growers and other emerging countries (Ramírez et al., 2002).That said, it is evident that coffee growers are exposed to multiple risks, which are considered extensive and common to coffee growers worldwide (Coble et al., 1999). Concerned about this, Samper and Topik (2012) identified that for most small-scale coffee growers, coffee is still a survival crop. Therefore, to address the efficiency and profitability problems of coffee, the present investigation aims to identify the factors that describe the decisions associated with the risk of small-scale coffee growers.

The following section presents the concepts associated with risk in the Colombian coffee sector, risk management and perception of coffee growers. The third part of the document explains in detail the methodological design, the application of the survey, the hypothesis statement, the specification of the latent constructs *Outcome History, Problem Framing, Risk Propensity, Risk Perception, Risk Management*, and *Institutions*; which represent respectively: i) the history of successes and failures resulting from decisions made in the past; ii) the influence of the idiosyncratic characteristics of the problem on coffee growers' perceptions of risk; iii) the tendency of coffee growers to take or avoid risks; iv) the alternatives that a decision maker confronts; v) the individual evaluation of the risks before a situation and the confidence in that evaluation; and iv) the effects of the risk management instruments offered to coffee growers, and the estimation of these through the multifactorial method Confirmatory Factor Analysis CFA. Finally, the descriptive results are discussed by the taxonomies developed and the confirmatory results through the measurement models of each CFA. Finally, the results are presented, which allows us to conclude that the estimated latent constructs are measurement models defined as indicators that capture the decisions of small-scale coffee growers.

RISK IN COFFEE SECTOR

The concept of risk in the coffee sector includes concepts such as climate change, natural disasters, food security and political ecology; where the concept of risk has several meanings and interpretations (Antwi-Agyei et al., 2016). Hence, social vulnerability takes into account that the state of human systems is influenced by political, economic and social factors that can put people at risk and reduce their ability to adapt to these risks. The literature has identified examples of such factors and includes access to service providers and institutional resources, poverty and food insecurity (Eakin, et al., 2014; Frank, Eakin, & López-Carr, 2011; Quiroga, Suárez, & Solís, 2015).

Therefore, the risks which coffee growers are exposed affect the economic sustainability of the coffee sector, given that unfavourable combinations of price and yield, volatility, level of household savings, climate change, diseases, pests and operational risks, among others, put coffee growers in a state of vulnerability (Giovannucci & Potts, 2008). The production risk of the Colombian coffee sector is divided into: (a) agroclimatic, (b) biological, which may be manifested as disease, pests or natural inhabitants; and (c) climatic (Cenicafé, 2013). Agroclimatic risk is defined as the probability that a climatic threat can reduce the productive capacity of a coffee production system (Cenicafé-FNC, 2013). This category includes: (a) water erosion, (b) wind erosion, (c) disasters and natural phenomena, (d) water excess, (e) water deficit, (f) reduction of water solar brightness, and (g) changes in temperature. Also, the biological risk is divided into three important groups: (a) diseases; (b) natural inhabitants, and (c) pests. Finally, the production risks that most worries the coffee growers, the FNC and the agricultural sector in

general, is the climatic risk. This category of risk causes serious damage to coffee production annually. Within this category of risks are: (a) climate change, (b) climate variability, (c) the greenhouse effect, and (d) global warming (Cenicafé-FNC, 2013).

On the other hand, economic risk is defined as vulnerability to possible harm to agents, individuals, organizations or entities, where, the greater the vulnerability, bigger is probability of being in danger (Korstanje, 2010). In the coffee sector, economic risk is an effect of the uncertainty caused by market fluctuations, which affects the price of grain in national and international markets (Katchova & Barry, 2005). In this regard, it can be classified into two categories, namely: (a) economic risks and (b) financial risks. With regard to economic risks, five subcategories can be identified that permeate the coffee sector, such as: (a) demographic risk, which describes changes in population density due to public order problems, little or no education high quality, the limitations for development imposed by the unsatisfied basic needs, and scarce offer of formal jobs; which reduces the supply of qualified labor (Bielza, 2004); (b) market risk, defined as volatility in international coffee prices, which causes economic losses for coffee growers (Bielza, 2004).

The third subgroup of economic risk is: (c) the risk of commercialization is defined as the probability of scarcity of buyers in the supply chain, caused by the lack of competition for the purchase of coffee or coffee oversupply, which causes the decrease in income received from the load of coffee sold and a possible economic loss; (d) the interest rate risk results from the variation in interest rates that makes loans to coffee growers more expensive and affects both supply and aggregate real demand, causing a variation in interest rates; and finally (e) the exchange rate risk, which is the probability of volatility scenarios in the value of currencies, which may be caused by external shocks and the dependence of commodities on the exchange rate (Heshusius, 2010; Tucker et al., 2010).

Finally, the category of hygienic risks refers to the possibility that a worker suffers damage, on occasion or as a consequence, of his work, in particular by environmental exposure, ie physical, chemical and biological agents, where a possible consequence of said exposures, are occupational diseases, or deterioration of workers' health (Carvajal, 2008). This type of risk, for the specific case of the coffee sector, is divided into two categories: (a) the health risk and (b) the toxicological risk. The first one divide in three subtypes of risk: (a) Ergonomic risk, which refers to injuries caused by incorrect movements and postures, due to ignorance of practices or carelessness of processes and increases the probability of suffering a work accident; (b) physical risk, which refers to the presence of glass, stones, pieces of wood or metal that affect the grains, caused by poor waste management, and poor postharvest and harvest practices, which increases the likelihood of suffering an accident at work; and (c) the risk of communicable diseases, which refers to communicable diseases in communities affected by a disaster and is proportional to the degree of endemicity in the region, caused by epidemics, lack of social security, lack of prevention, or failure to access to the health system, among others. These risks have as a consequence low productivity, an increase in mortality rates, and a labour deficit (Cenicafé-FNC, 2013).

Operational risk has a strong impact on the effectiveness of the sector, and is related to contracting, deficiency or rupture in internal controls or control processes, process control systems and quality. For the Colombian coffee sector, four operational risks were identified: (a) poor postharvest practices, which is related to poor handling of post-harvest procedures (Pulping, Washing, Drying, Storage and Transportation), and it occurs when there is ignorance or poor application of the processes and affects the quality and delivery times of the final product; (b) poor harvesting practices, which refers to the mishandling of the procedures corresponding to the harvest (use of tools, cultivation processes, etc.), which, like the previous one, is caused by ignorance or bad application of the processes and is causing a deterioration in the quality and delay in the delivery times of the final product; (c) the labour shortage is a phenomenon caused by the migration of rural inhabitants for reasons such as the armed conflict, the lack of

opportunities and the informality of the coffee sector (lack of social security), among others. which causes the increase in the cost of direct labour, the decrease in the volume of production and deterioration in the quality of the harvest; and (d) human errors, understood as human failures in the process of harvesting and post-harvesting coffee, caused by ignorance of the practices or neglect of the processes and causes a deterioration in the quality of the grain, and damages or delays in production (Cenicafé-FNC, 2013).

MANAGEMENT AND RISK PERCEPTION

Following Sitkin & Pablo (1992) who proposed a conceptual model focused on specific predictors of risk behaviour from the individual, organizational and problematic perspectives, and Sitkin & Weingart (1995) who examined the usefulness of situating the propensity to risk and the perception of risk in a central role; they have been references for the works that link management and risk perception. In this sense, van Winsen, de Mey, Lauwers, Pasel, Vancauteren and Wauters (2016) developed a theoretical model to understand risk behaviours in terms of risk attitude and perceived risks. The empirical evidence of this model is provided using an SEM model on data obtained from a survey on a large representative sample of farmers in the Flanders region of Belgium. They found that farmers who are more willing to take risks are managing risk with a proactive attitude, trying to reduce the impact and occurrence of risk: (a) by relying on external risk management tools, such as insurance and future markets; (b) Production and income sources on the farm or (c) optimize your business.

Tjemkes, Furrer, & Henseler, (2015) follow the same methodology of Sitkin & Weingart (1995) with the aim of showing that unravelling the relationships between risk propensity, risk perception and risk behaviour, provides knowledge that does not are available for decision making. They found that only when social dissatisfaction is low, risk-prone decision makers are less likely to act opportunistically and only when it is high, decision makers are more likely to participate in opportunism. When decision makers are risk averse, social dissatisfaction does not have a significant effect on their destructive behaviour.

RISK PERCEPTION IN COFFEE SECTOR

Tucker et al. (2010) examined the risk perception of small-scale coffee growers in Central America. They found that coffee growers feel more vulnerable to environmental risks and price changes; although in a consensus they perceive the risk in the sector associated with their Smallholder status and his family business scheme. According to Frank et al., (2011) risk perception has been recognized as a critical determinant of the human response to environmental impacts and change.

However, perception is a key variable that illustrates the influence of risk as an important determinant of adaptation, thus Antwi-Agyei et al., (2016); Eakin et al., (2014); Frank et al., (2016); and Tucker et al., (2010) explored the risk perception in the coffee sector and identified that is a determining factor in the life of coffee growers. Eakin et al., (2014) defined perception as one of the determinants of the adaptation of Central American coffee growers to risk situations. In the same way, Frank et al. (2011) stated that the perception of risk is presented as a cognitive variable and that it greatly influences the aversion to risk of Central American coffee growers.

METHODOLOGY

The methodology developed consists of two phases: a qualitative exploratory and other quantitative confirmatory one. In the first phase, a survey was conducted on a selected sample of 459 coffee growers from all over the country, classified by region and size. The sample was extracted from a population universe of 383,978 federated coffee growers in Colombia, of which 94.3% correspond to small-scale coffee growers, 4.2% are medium-sized coffee growers and 1.5%

can be considered as coffee growers on a large scale. Sample n was selected by simple random sampling, with N = 383.978, a margin of error α = 5% and probability of success p and error q of 50% each. Using the survey data, taxonomies about risks, institutions and risk management instruments were constructed. Taxonomies were validated through a panel of experts, 58 risks were identified to which Colombian coffee growers are vulnerable and were classified into four groups: (a) climate risk; (b) biological risk; (c) financial risk; and (d) operational risk. 161 risk management instruments were identified, which were grouped into 26 instruments and classified into four groups of instruments according to the type of risk they manage.

In the second stage, using the observations obtained in the survey and with the taxonomies constructed as input, a Confirmatory Factor Analysis CFA was estimated for each of the six latent constructs: *Outcome history, Problem Framing, Risk Propensity, Risk Perception, Risk Management*, and *Institutions*. The CFA is a type of Structural Equation model (SEM) that deals specifically with measurement models, that is, the relationships between observed measures or indicators and latent factors. A fundamental characteristic of the CFA is its hypothesis-driven nature, since it requires the researcher to previously specify all aspects of the model. Therefore, due to the emphasis on theory and hypothesis testing, the CFA provides many other analytical possibilities that are not available in other methodologies to address unobserved factors (Brown, 2014).

THE SAMPLE

The sample of 459 coffee growers was distributed in 16 departments of the 22 coffee growers, where the highest representation was Tolima, Cauca and Huila with 19%, 18%, and 14% respectively, 74% of the respondents are men and 26% women. With respect to the population universe proportion, 95% of the respondents are small-scale coffee growers, 4% are medium-scale and only 1% belongs to the large coffee growers.

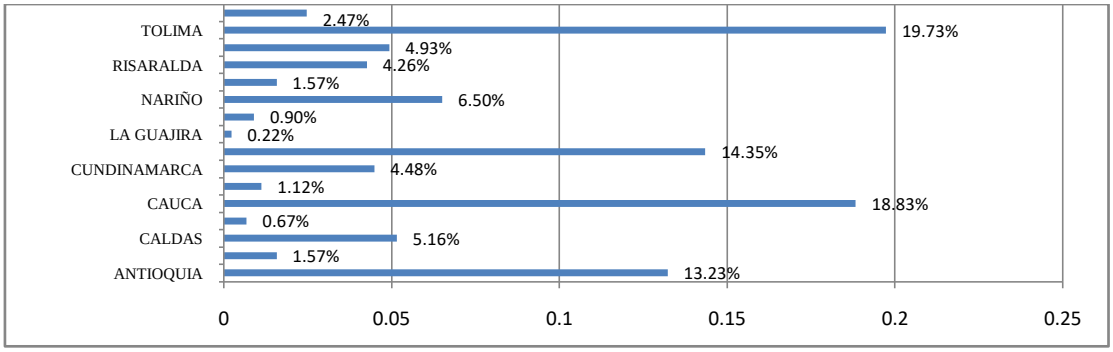

*Figure1*Departmental distribution of the sample

DECISIONS LINKED TO RISK

About the respondents, 86.9% have coffee cultivation as the main source of income while the remaining 13% have it as a second source of income and has to other sources of income as their main source of income. The extensive experience of the coffee growers surveyed can be evidenced by noting that 38% have experience in the production of coffee of 20 years or more; 30% between 10 and 20 years; 18% between 5 and 10 years and 14% less than 5 years. Therefore, when asked about the changes in the land cultivated during the last 10 years, it was found that 47% increased their cultivated area of coffee in the last 10 years; 38% did not change that area and 14% decreased the space dedicated to this crop.Regarding the most representative risk-related reasons, coffee growers decreased the coffee area due to climatic changes for 47% of the cases; for not having money for supplies for 45%; for the low price of coffee for 44% and for diseases in the plant for 39%.

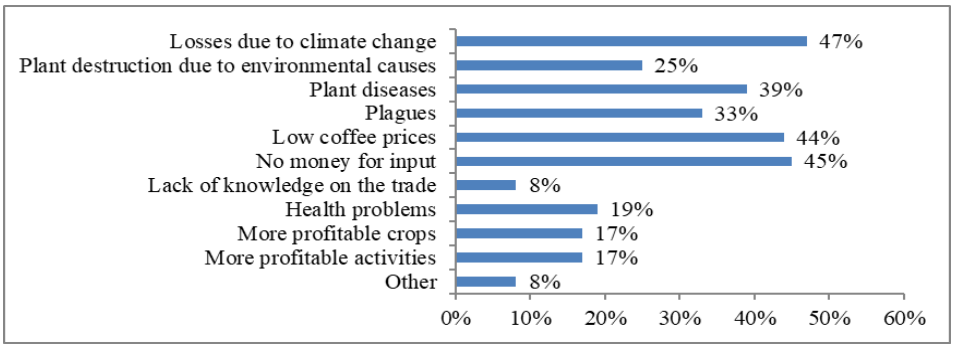

Figure 2 Causes related to risk, because of which coffee-cultivated area decreased.

In relation to the above, it was identified that 61% of the coffee growers had losses and the causes of the losses were mainly the "*El niño*" o "*La niña*" phenomena in 53% of the cases; followed by droughts for 40%.

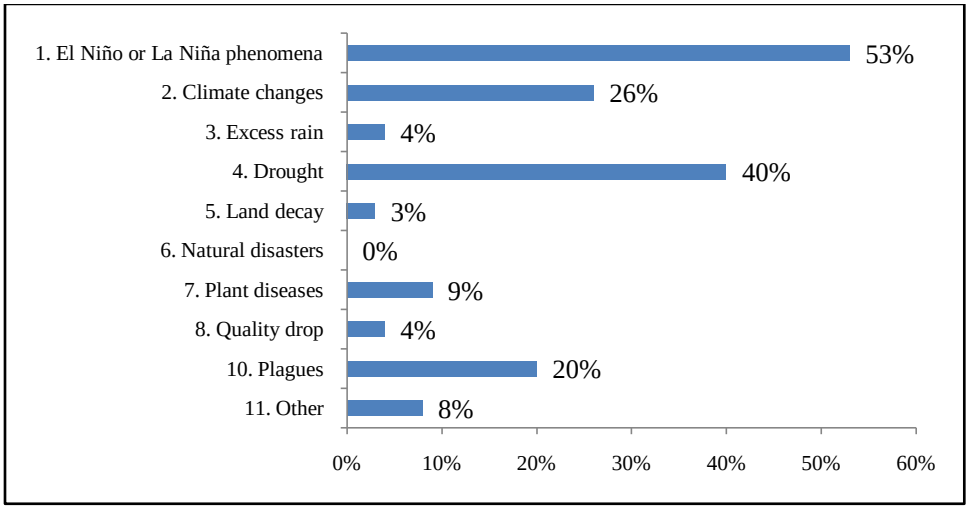

*Figure 3*Main drivers behind Colombian coffee growers' losses

COFFEE GROWERS PROBLEMS

According the coffee growers problems, we identified that, the average price per 125 Kg of coffee from the last harvests reached COP 675,591 for 74% of the respondents, where 61% was purchased by local distributors, 37% by coffee growers cooperatives and 2% by associative distributors and others. 22% had an average price per 125 Kg of coffee of COP 740,000 as dry parchment coffee; 39% received low prices due to quality problems, and 27% reported having difficulty selling their coffee. Among these difficulties, the most relevant corresponded to quality problems in 75% of cases, prices in 61% of cases, poor road infrastructure in 40% and other causes with 30%.

In crop management, 86% of respondents claimed to have changed their practices over the past 10 years, of which 75% implemented soil conservation, while 42% began using agrochemicals. Among other implemented practices, the adequate management of shade and fertilization stand out. Meanwhile, 52% of coffee growers made these changes due to the technical recommendations of the extension service and, as a result, 57% of them stated that the recommendations had positive results for the productivity of their crops.

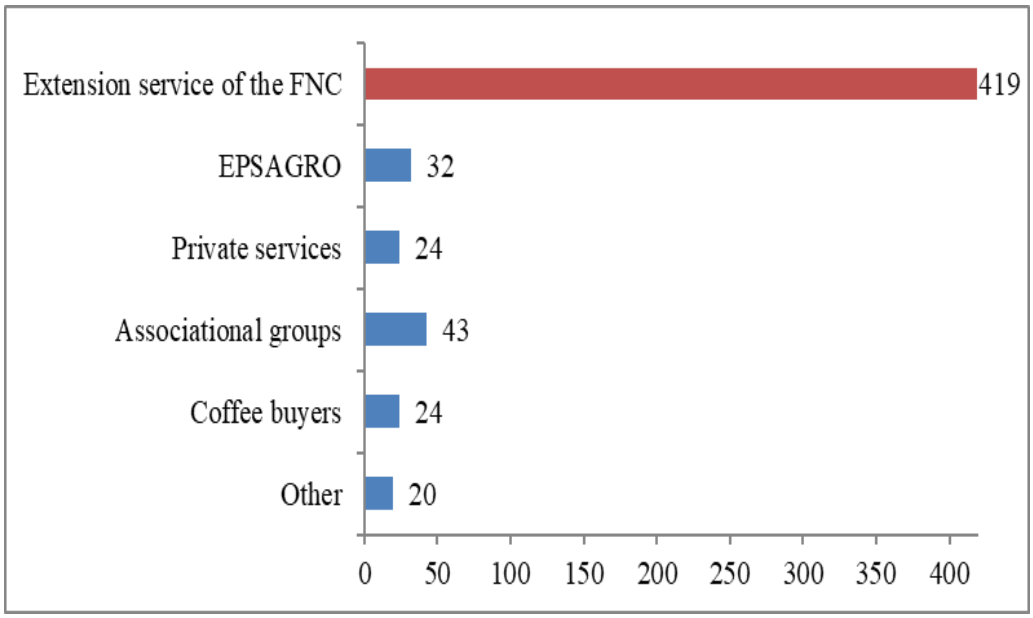

Figure 4 Institutions from which Colombian coffee growers receive technical assistance

Among the most representative risks in coffee plantations, most coffee growers (98%) were affected by pests and diseases at least once. Among these, 86% affected by the bit, and 33% by the leaf miner of coffee. In addition, as regards the natural inhabitants of the plants, 43% of the respondents suffered damage by the leaf cutting ants and 12% by the cochineals of the coffee branches.Just as technical assistance played an important role for coffee growers, access to financing also did so, since 68% of coffee growers received some kind of financial support for their agricultural operation, of which 86% received through the Agrarian Bank, while 53% obtained financing through FNC. Of this funding, 85% of the respondents had or have to pay interest on the loan obtained, while 14% did not have to pay them. It is important to highlight the success of this financing, since 91% of respondents were up to date on their loans and 77% received some type of incentive that ranged between 15% and 40% on the total credit used.

CONSTRUCTS SPECIFICATION

For the construction of each construct, its nature was taken into account, driven by hypotheses and the variables identified in the literature and captured by means of the survey (Brown, 2014). The manifest variables associated with each latent construct are described in Tables 1 to 6. Each CFA is estimated by maximum likelihood and evaluated both globally and in each of its coefficients. The standard errors of the standardized coefficients are calculated by bootstrapping with 5000 samples using the percentile-corrected percentile method (Bias-corrected percentile method), which offers the best results in the hypothesis tests according to the comparison of three approximations. Evaluated in MacKinnon, Lockwood, & Williams (2004),the bootstrap method does not depend on assumptions about the normality of the variables (Cheung & Lau, 2008), so it can offer better analysis possibilities for various types of variables that are not necessarily normal. All estimates of the CFA models were made in the STATA 14 program.

The first construct, *Outcome History*, represents the history of successes and failures resulting from decisions made in the past, and is determinant of the propensity to risk (Sitkin and Weingart, 1995, March and Shapira, 1987, Osborn and Jackson, 1988 Thaler and Johnson, 1990). This construct that is constructed from the variables presented in table 1 responds to hypothesis 1

Hypothesis 1: The more successful the results of the decisions made in the past by the coffee grower, the greater their propensity to risk.

Table1.

Observed Variables of the Latent Construct Outcome History

Index	Variable	Description
b32	*Agricultural practice*	This variable indicates that favorable results from agricultural practices lead to positive experiences that reinforce future positive
b39	*Plague control*	This variable indicates that positive results increase optimism on the future of the productive unit
e1	*Price information*	This variable indicates frequent access to information by coffee growers
e19	*Climate damage*	This variable indicates the efficiency of decisions on climate change. Low efficiency might be related to higher climate risk and

Note. Adapted from "Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity" by Sitkin and Weingart, 1995, Academy of management Journal, 38(6), 1573-1592.

The second construct, *Problem Farming*, represents the influence of the idiosyncratic characteristics of the problem on coffee growers' perceptions of risk. That is, if situations are positively conceived, they lead to risk aversion decisions and vice versa (Kahneman & Tversky, 1979). This construct responds to hypothesis 2

Hypothesis 2: The assessment as an opportunity or threat, by the coffee grower, of a risky situation determines their perception of risk.

Table2.

Observed Variables of the Latent Construct Problem Framing

Index	Variable	Description
b26	*Price-quality ratio*	This variable serves as a proxy for quality management issues, which have an impact on productive unit income
b28index	*Commercialization complexity*	This index averages commercialization difficulty causes, and measures commercialization system inefficiencies. A higher index value is associated to higher commercialization risks, which leads the most risk-averse coffee growers to negative
b14	*Harvest losses*	This variable indicates whether the coffee grower had losses during the latest harvest
b47	*Quality issues*	This variable indicates whether the coffee grower had quality issues originating from the productive process

Note. Adapted from "Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity" by Sitkin and Weingart, 1995, Academy of management Journal, 38(6), 1573-1592.

The third latent construct,*Risk Propensity*, represents the tendency of the coffee grower to take or avoid risks. It is an emergent property of the coffee grower that can change over time. This construct corresponds to hypothesis 3.

Hypothesis 3: The higher the risk propensity of a coffee grower, the lower the level of perception of the situation.

Table3.

Observed Variables of the Latent Construct Risk Propensity

Index	Variable	Description
c3	*Staff*	This variable measures the number of workers in the small-scale productive unit
b3	*Area scaling*	This variable measures the adjustments performed on the cultivated area. It is taken as the response to positive or negative shocks, depending on the coffee grower's risk propensity
e21	*Income changes*	This dummy variable displays whether income increased or decreased during the last 10 years. If an individual shows a higher risk propensity score, this means the individual has been exposed to loss situations, becoming more risk averse due to a negative assessment of the future if
c1	*Management time*	This variable determines coffee grower behavior regarding the number of hours dedicated to coffee farming

Note. Adapted from "Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity" by Sitkin and Weingart, 1995, Academy of management Journal, 38(6), 1573-1592.

The fourth latent construct,*Risk Perception*, represents the individual evaluation of the risks before a situation and the confidence in that evaluation. That is, risk prevention is greater when a high risk is perceived than when the coffee grower perceives little risk, because there is nothing to lose (Sitkin and Weingart, 1995). This construct responds to hypothesis 4.

Hypothesis 4: The perception of risk by the coffee grower determines its form of risk management.

Table4.

Observed Variables of the Latent Construct Risk Perception

Index	Variable	Description
e23risk_cl	*Climate risk impact*	These indexes were built using a combination of risk perception variables using Likert scales, measuring the degree of perception for each risk type. A higher index value indicates a greater perception for each risk type
e23risk_bio	*Biological risk impact*	
e23risk_fin	*Financial risk impact*	
e23risk_op	*Operational risk impact*	
e12index	*Context complexity*	This index averages coffee grower expectations and measures the problematic complexity degree the farmer has on the future, with higher index values indicating more negative expectations

Note. Adapted from "Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity" by Sitkin and Weingart, 1995, Academy of management Journal, 38(6), 1573-1592.

The construct *Risk Management*, characterizes the alternatives that a decision maker confronts. Following Sitkin & Pablo (1992) is, to a certain extent, the risk component of the strategies available to the coffee grower, and as such is a latent factor to the strategies. This construct responds to hypothesis 5.

Hypothesis 5: The level of risk propensity of the coffee grower determines its form of risk management.

Table5.

Observed Variables of the Latent Construct Risk Management

Index	Variable	Description
b44	*Fertilization*	This variable represents the response to production risks due to less soil nutrients
b45	*Soil analysis*	This variable represents the strategic long-term decision associated to coffee quality through soil care
c4	*Technical assistance*	This variable represents the short-term strategy that guarantees optimization, good practices in the productive process and quality of the final product
c6	*Assistance requirements*	This variable measures the assessment on technical assistance needs by coffee growers
d1	*Financial support*	Strategic short-term decision that allows coffee growers to operate under adverse conditions
Id7	*Coffee ID*	This variable represents the association level of coffee growers and their guild strategy

Note. Adapted from "Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity" by Sitkin and Weingart, 1995, Academy of management Journal, 38(6), 1573-1592.

In addition, we proposed to include the construct*Institutions*, which describes the effects of the risk management instruments offered to coffee growers. According to this construct, greater institutional trust is related to greater efficiency of institutions as a risk management instrument. This latent construct responds to hypothesis 6. And its construction is presented in table 6

Hypothesis 6: The assessment of the institutions that underlie the coffee sector is directly related to the perception of risk by the coffee grower.

Table6.

Observed Variables of the Latent Construct Institutions

Index	Variable	Description
e24index_bio	*Trust on biological risk instruments*	This variable represents trust on risk management instruments, offered by public and private institutions, employed to manage biological risks
e24index_oper	*Trust on operational risk instruments*	This variable represents trust on risk management instruments, offered by public and private institutions, employed to manage operational risks
e24index_cli	*Trust on climate risk instruments*	This variable represents trust on risk management instruments, offered by public and private institutions, employed to manage climate risks
e24index_fin	*Trust on financial risk instruments*	This variable represents trust on risk management instruments, offered by public and private institutions, employed to manage financial risks

Note. The combination of variables was performed following the taxonomies obtained during the qualitative stage (panel of experts), where risk instruments refer to the different institutions related to the Colombian coffee sector

Results

The results of this paper are presented in two parts; first the descriptive results, which are composed of the two taxonomies: the taxonomy of risks to which coffee growers are so exposed,

and the taxonomy of risk management instruments. Then the measurement models are presented with the confirmatory results and the validation of each one of the hypotheses proposed in the construction of each CFA.

DESCRIPTIVE RESULTS

RISK TAXONOMY

The taxonomy of risks to which Colombian coffee growers are vulnerable identified 58 risks, which were classified into four groups: (a) biological risk; (b) climate risk; (c) operational risk and (d) financial risk. The risk taxonomy is presented in tables 7 to 10.

Table7

Biological Risks

	Biological risks
Plant diseases	Coffee leaf scorch (Xylella fastidiosa) Black rot (Ceratocystis fimbriata) Root rot (Rosellinia bunodes and Rosellinia pepo) Thread blight (Corticium koleroga) Pink disease (Corticium salmonicolor) Iron spot disease (Cercospora coffeicola) Anthracnose (Colletotrichum) Phoma leaf spot (Phoma spp.) Nematodes South American leaf spot (Mycena citricolor) Coffee rust (Hemileia vastatrix) Black root rot (Rhizoctonia solani)
Natural inhabitants	Slug (Colosius pulcher) Brown twig beetlw (Xilosandrus morigerus) Steem and root boorer (Plagiohammus colombiensis) Mealybug (Planococcus citri) on coffee branches Termite (Comatermes perfectus) Monkey slug (Phobethron hipparachia) Tobacco budworm (Helicoverpa virescens) Gregarious foliage beetle (Ancistrosoma rufipes) Jelly worm (Paracraga argentea) Fall armyworm (Spodoptera frugiperda) Leafcutter ant (Atta cephalotes) Bean slug (Sarasinula plebeia) Snouth moth (Pococera hermasalis) White fly (Aleurothrixus floccosus)
Plagues	Coffee red mite (Oligonychus yothersi) Coffee borer beetle (Hypothenemus hampei) Coffee chamusquina bug (Monalonion velezangeli) Mealybug on coffee roots Coffee bean weevil (Araecerus Fasciculatu) Coffee leaf miner (Leucoptera coffeellum)

Note. Adapted from "Informe Anual Cenicafé 2013" by Cenicafé, 2013, Blanecolor S.A.S Colombia, "Assessing the adaptation strategies of farmers facing multiple stressors: Lessons from the Coffee and Global Changes project in Mesoamerica" by Castellanos et al., 2013, Environmental Science & Policy. 20:23-32. And "Adaptation in a multi-stressor environment: perceptions and responses to climatic and economic risks by coffee growers in Mesoamerica" by Eakin et al., 2014, Environment, development and sustainability, 16(1), 123-139.

*La taxonomía de los 58 tipos de riesgo dividida en cuatro categorías de riesgo fue obtenida a través de la literatura y validada a través del panel de expertos.

Table 8 shows the classification of climate risks into two groups; the first covers climatic risks associated with climate change, the greenhouse effect and climatic volatility. The second group includes those risks associated with agroclimatic risks such as water deficit, natural disasters, water erosion and excess water, among others.

Table 8.

Climate Risks

Climate risks	
Climate	Global warming
	Climate change
	Greenhouse effect
	Weather volatility
Agroclimatic	Hydric deficit
	Natural disaster/phenomena
	Wind erosion
	Water erosion
	Hydric excess
	Solar brightness reduction
	Temperature

The financial risks were divided into two groups, the first related to economic factors such as marketing, market prices, exchange rates, interest rates and demographics. On the other hand, the financial risks associated with credit and liquidity risks were grouped in the second group. The results are shown in Table 9.

Table9.

Financial Risks

Financial risks	
Economic	Commercialization
	Market prices
	Exchange rates
	Interest rates
	Demographics
Financial	Credit
	Liquidity

Finally, Table 10 shows the operational risks classified into three groups. The first group includes risks to public health, such as infectious diseases, ergonomics and physical risks; the second group is formed by toxicological risks related to agrochemical poisoning factors. The last group was labelled as operational, involving human errors, labour shortages, poor harvest practices and poor post-harvest practices.

Table10.

Operational Risks

Operational risks	
Public health	Infectious diseases
	Ergonomics
	Physical
Toxicological	Agrochemical poisoning
Operational	Human error
	Labor scarcity
	Bad harvesting practices
	Bad post-harvesting practices

Note. Adapted from "Informe Anual Cenicafé 2013" by Cenicafé, 2013, Blanecolor S.A.S Colombia, "Assessing the adaptation strategies of farmers facing multiple stressors: Lessons from the Coffee and Global Changes project in Mesoamerica" by Castellanos et al., 2013, Environmental Science & Policy. 20:23-32. And "Adaptation in a multi-stressor environment: perceptions and responses to climatic and economic risks by coffee growers in Mesoamerica" by Eakin et al., 2014, Environment, development and sustainability, 16(1), 123-139.

*The taxonomy on the 58 risk types in four risk categories obtained from literature and validated through a panel of experts.

Risk management instruments taxonomy

The risk management instruments refer to the inventory of institutional agreements that fulfil different functions in the risk management of the coffee grower. The coffee sector has 161 institutional risk management agreements, of which 99 are private and 82 are offered by FNC to coffee growers. Likewise, in 62 public risk management instruments 12 are part of the FoNC administered by FNC. That is, the FNC manages 97 institutional agreements. Finally, these were grouped into 26 risk management instruments, identified and distributed in four groups according to the risk classes that it manages.

Table11

Biological risk Management Instruments

Instrument	Institution	Nature
Rural extension	FNC extension service	Private
Research and transfer	CENICAFÉ	Private
	CRECE	Private
	FNC extension service	Private
Information systems	CENICAFÉ	Private
	CRECE	Private
	Coffee Information System SICA	Private
	ICA	Public
	Ministry of Agriculture and Rural Development	Public
	Bank of the Republic	Public
Technical assistance	EPSAGROS	Private
Technical assistance and financing	Rural development secretaries	Public
Research and diffusion	Ministry of Finance and Public Credit	Public

Note. The classification was created according to the risk managed by each of these instruments.

The first group relate the biological risk management instruments, such as rural extension, research and transfer, information systems, technical assistance and financing. The main objective of these instruments is to prevent biological risk in small-scale coffee production units.

Table12.

Climate Risk Management Instruments

Instrument	Institutional agreement	Nature
Rural extension	FNC extension service	Private
Research and transfer	CENICAFÉ	Private
	CRECE	Private
	FNC extension service	Private
Information systems	CENICAFÉ	Private
	CRECE	Private
	Coffee Information System SICA	Private
	ICA	Public
	Ministry of Agriculture and Rural Development	Public
	Bank of the Republic	Public

Note. The classification was created according to the risk managed by each of these instruments.

The second group responds to the management of climate risks through rural extension instruments, research and transfer, and information systems. These instruments manage the risks of coffee growers, with the aim of minimizing the effects of climate risks.

A third group responds to the management of operational risks such as labour shortages, bad practices, health problems and lack of training among others. These instruments such as marketing, export, educational processes, regulation and control, state representation, and union representation, among others; they are necessary to guarantee the development of the productive activity of the sector.

Table13

Operational Risk Management Instruments

Instrument	Institutional agreement	Nature
Commercialization	FNC	Private
	Procafecol (Juan Valdez stores)	Private
Commercialization and export	FNC	Private
	Private exporters	Private
Media	FNC	Private
	“Las Aventuras Del Profesor Yarumo” TV show	Private
	Extension service	Private
Operation and logistics	ALMACAFÉ	Private
Industrial services	ALMACAFE and coffee grower cooperatives	Private
Educational processes	CRECE	Private
	Manuel Mejía Foundation	Private
	"Profesor Yarumo" character	Private
	SENA	Public
Regulation and control	Coffee inspections	Private
	FoNC	Public
	ICA	Public
	INCODER	Public
	Ministry of Agriculture and Rural Development	Public
	Superintendence of Industry and Commerce	Public
	Ministry of Finance and Public Credit	Public
	Bank of the Republic	Public
State representation	Ministry of Finance and Public Credit	Public
	Ministry of Agriculture and Rural Development	Public
	Ministry of Trade, Industry and Tourism	Public

	Café de Colombia	Private
	Coffee ID	Private
Guild representation	FNC	Private
	"Juan Valdez" character	Private
	Procafecol (Juan Valdez stores)	Private
	Extension service	Private
Social security	Extension service	Private
	BUENCAFÉ	Private
Productive processes with value added	EXPOCAFÉ	Private
	FNC	Private
	Procafecol (Juan Valdez stores)	Private
	Ministry of Trade, Industry and Tourism	Public
	BUENCAFÉ	Private
Value added	EXPOCAFÉ	Private
	Extension service	Private
	FoNC	Public

Note. The classification was created according to the risk managed by each of these instruments.

The last set of instruments responds to those of financial risk management, within which financial and economic risks stand out. The management of these risks guarantees coffee growers the functioning of their commercial activities and minimizes the impact of risks such as price volatility and marketing difficulties. This group includes instruments such as: insurance, marketing, marketing and export, consulting, financing, promotion to the exporter, purchase guarantee, means of payment, public policies, and financial support.

Table14.

Financial Risk Management Instruments

Instrument	Institutional agreement	Nature
	Private banks	Private
	Coffee grower cooperatives	Private
	Extension service	Private
Financing	Banco Agrario	Public
	FINAGRO	Public
	PRAN CAFETERO	Public
	INCODER	Public
	Ministry of Finance and Public Credit	Public
Export promotion	PROCOLOMBIA	Public
Purchase guarantee	FoNC	Public
Insurance	Insurers	Private
Commercialization	Coffee grower cooperatives	Private
Commercialization and export	ASOEXPORT	Private
	EXPOCAFÉ	Private
	FNC	Private
Consulting	Banco Agrario	Public
Payment methods	Coffee ID	Private
	CAR	Public
	ICA	Public
	INCODER	Public
Public policies	Ministry of Agriculture and Rural Development	Public
	Ministry of Trade, Industry and Tourism	Public
	Ministry of Finance and Public Credit	Public
	Ministerio de Salud y Protección Social [Ministry of	Public
Financial backing	FOGACAFÉ	Public
	FAG	Public

Note. The classification was created according to the risk managed by each of these instruments.

MEASUREMENT MODELS

The estimates were made based on the surveys that had been fully completed. This reduced the sample size from 459 to 434 observations, which is a reduction of 5.45% of the observations and does not affect the estimates to a greater extent. Next, the results of the measurement models for each latent construct and the implications of these results are examined.

Outcome history.The four manifest variables associated with the *Outcome History* construct, and the respective loads or standardized regression coefficients are shown in Table 15. Although the absolute values of the loads are low for two of the manifest variables or indicators, they are all statistically significant and as a whole they satisfactorily define the latent construct. The individual significance of the coefficients is an appropriate criterion to statistically support the convergent validity of the construct and the acceptance of hypothesis 1 (Anderson & Gerbing, 1988).

Table15.

Measurement Model for the Latent Construct Outcome History

Item	Indicator	Standardized regression coefficient
Outcome of the change in agricultural practices compared to practices implementd ten years ago. (B32, Likert scale: 1: Very bad, 5: Excellent)	*Agricultural Practice*	0.519*** (0.165)
Efficacy of plague and disease control (B39, dichotomous: 0: No, 1: Yes)	*Plague Control*	0.202** (0.093)
Frequent access to coffee price information (E1, dichotomous: 0: No, 1: Yes)	*Price Information*	0.283*** (0.093)
Efficacy of actions to prevent climate damages (E19, dichotomous: 0: No, 1: Yes)	*Climate Damage*	0.400*** (0.112)

Note. Fit indicators: $\chi^2 = 1.582,\ df = 2,\ CMIN/df = 0.453,\ p = 0.453,\ RMR = 0.003,\ GFI = 0.998,\ AGFI = 0.991,\ RMSEA = 0.000.$
The value in parentheses corresponds to the standard error of the coefficient, obtained from bootstrapping with 5000 subsamples.
* indicates significance at 10% level.
** indicates significance at 5% level.
*** indicates significance at 1% level.

The coefficients of the *Agricultural Practices, Plague Control, InformationPrice* and*Climate Damages* indicators presented in Table 15 indicate that successful experiences in the change of agricultural practices, in the control of pests, in access to price information, and in the prevention of damages. Climatic events are positively and significantly associated with high values of the *Outcome History* construct. This allows affirming that the construct can be defined as an indicator of the success of the decisions and actions of the coffee growers in the past. Increasing values of the factor indicate better decisions and experiences of the growerr in relation to the context or environment, and lower values of the construct are associated with lower gratification or more frustrating experiences for the coffee grower.

Problem Framing. As in the previous construct, the four manifest variables associated with the Problem Framing construct, and their respective loads or standardized regression coefficients, are shown in Table 16.

The coefficients for the observed variables *Commercialization Complexity*, *Price-Quality Ratio*, *Harvest Losses* and *Quality Issues* are all statistically significant, while also defining the latent construct in a satisfactory way as a whole. The coefficients represent a proper criterion for supporting the convergent validity of the construct in a statistical manner (Anderson & Gerbing, 1988).

Table16

Measurement Model for the Latent Construct Problem Framing

Item	Indicator	Standardized regression coefficient
Causes originating difficulties in coffee commercialization. (B28index, continuous scale on interval [0,1] where 1 indicates all causes identified by the experts create difficulties simultaneously.)	*Commercialization Complexity*	0.510*** (0.045)
Quality issues at the time of sale that affected the price (B26, dichotomous: 0: No, 1: Yes)	*Price-Quality Ratio*	0.603*** (0.051)
Losses during the latest harvest (B14, dichotomous: 0: No, 1: Yes)	*Harvest Losses*	0.459** (0.050)
Quality issues originating from the productive process (B47, dichotomous: 0: No, 1: Yes)	*Quality Issues*	0.629** (0.045)

Note. Fit indicators: $\chi^2 = 1.528$, $\mathrm{df} = 2$, $\mathrm{CMIN/df} = 0.764$, $\mathrm{p} = 0.466$, $\mathrm{RMR} = 0.002$, $\mathrm{GFI} = 0.998$, $\mathrm{AGFI} = 0.992$, $\mathrm{RMSEA} = 0.000$.
The value in parentheses corresponds to the standard error of the coefficient, obtained from bootstrapping with 5000 subsamples.
* indicates significance at 10% level.
** indicates significance at 5% level.
*** indicates significance at 1% level.

These values indicate that the influence of the idiosyncratic characteristics of the problem on coffee growers' perceptions of risk leads the coffee grower to make risk-averse decisions if these are positively conceived situations, as proposed by Kahneman & Tversky (1979). This allows us to state that the *Problem Framing* construct can be defined as an indicator of risk aversion. Thus, higher values of the factor indicate greater aversion to risk.

Risk Propensity. The four manifest variables associated with the Risk Propensity construct, and their respective standardized regression loads or coefficients, are shown in Table 17. The coefficients are all significant and satisfactorily define the latent construct as a whole. The coefficients of the indicators *Staff*, *Area scaling*, *Income changes*, and *Management time*, represent an appropriate criterion to statistically support the convergent validity of the construct (Anderson & Gerbing, 1988), which represents the tendency of coffee growers to take or avoid risks, which validates the hypothesis 3.

Table17.

Measurement Model for the Latent Construct Risk Propensity

Item	Indicator	Standardized regression coefficient
Staff size. (C3, Ordinal scale: -1: decreased, 0: unchanged, 1: increased)	*Staff*	0.776*** (0.049)

Area dedicated to coffee growth (B3, Ordinal scale: -1: decreased, 0: unchanged, 1: increased)	*Area scaling*	0.546*** (0.052)
Changes in economic income (E21, Ordinal scale: -1: decreased, 0: unchanged, 1: increased)	*Income changes*	0.437*** (0.050)
Time dedicated to coffee plantation management (C1, Ordinal scale: -1: decreased, 0: unchanged, 1: increased)	*Management time*	0.589*** (0.051)

Note. Fit indicators: $\chi^2 = 5.242,\ df = 2,\ CMIN/df = 2.621,\ p = 0.073,\ RMR = 0.018,\ GFI = 0.995,\ AGFI = 0.973,\ RMSEA = 0.059.$

The value in parentheses corresponds to the standard error of the coefficient, obtained from bootstrapping with 5000 subsamples.

* indicates significance at 10% level.

** indicates significance at 5% level.

*** indicates significance at 1% level.

Risk Perception. The five manifest variables associated with the Risk Perception construct and their respective regression coefficients are shown in Table 18. The coefficients are all significant and satisfactorily define the latent construct as a whole. The coefficients of the indicators*Biological Risk Impact, Financial Risk Impact, Operational Risk Impact, Climate Risk Impact* and *Context Complexity*, support the convergent validity of the construct in a statistical manner and validate hypothesis 4. They represent the individual evaluation of the risks before a situation and the confidence in that evaluation (Sitkin and Weingart, nineteen ninety five).

Table18.

Measurement Model for the Latent Construct Risk Perception

Item	Indicator	Standardized regression coefficient
Average impact of biological risks on coffee production. (E23risk_bio, Likert scale: 1: minimum, 5: maximum)	*Biological risk impact*	0.557*** (0.065)
Average impact of financial risks on coffee production. (E23risk_fin, Likert scale: 1: minimum, 5: maximum)	*Financial risk impact*	0.459*** (0.067)
Average impact of operational risks on coffee production. (E23risk_op, Likert scale: 1: minimum, 5: maximum)	*Operational risk impact*	0.616*** (0.073)
Average impact of climate risks on coffee production. (E23risk_cl, Likert scale: 1: minimum, 5: maximum)	*Climate risk impact*	0.315*** (0.074)
Environment complexity perception (E12Index, continuous scale on an interval [0, 1] where 1 is the highest complexity perception due to the perceptions on all economic and environmental pressures.)	*Context complexity*	0.256*** (0.064)

Note. Fit indicators: $\chi^2 = 26.851,\ df = 5,\ CMIN/df = 5.37,\ p = 0.000,\ RMR = 0.038,\ GFI = 0.977,\ AGFI = 0.930,\ RMSEA = 0.098.$

The value in parentheses corresponds to the standard error of the coefficient, obtained from bootstrapping with 5000 subsamples.

* indicates significance at 10% level.

** indicates significance at 5% level.

*** indicates significance at 1% level.

Risk Management. With respect to the Risk Management construct, five manifest variables and their respective regression coefficients define the latent construct as a whole. Table 19 shows the loads of the manifest variables *Fertilization, Soil Analysis, Technical assistance, Financial Support* and *Coffee ID*,which are defined as a set of strategies that characterizes the alternatives confronted by a decision maker in situations of risk. Following Sitkin & Pablo (1992) is the risk

component of the strategies available to the coffee grower, and as such, the strategies are positively and significantly associated with high values of the Risk Management construct. This allows affirming that the construct can be defined then as an indicator of the decisions of the coffee grower in situations of risk. This validates hypothesis 5.

Table19

Measurement Model for the Latent Construct Risk Management

Item	Indicador	Coeficiente estandarizado de regression
Production improvement activities through fertilizers. (B44, dichotomous: 0: No, 1: Yes)	*Fertilization*	0.575*** (0.083)
Soil analysis before fertilization activities (B45, dichotomous: 0: No, 1: Yes)	*Soil Analysis*	0.295*** (0.045)
Receives technical assistance (C4, dichotomous: 0: No, 1: Yes)	*Technical assistance*	0.650*** (0.084)
Receives financial support for coffee production (D1, dichotomous: 0: No, 1: Yes)	*Financial Support*	0.408*** (0.054)
Owns a Coffee ID (ID7, dichotomous: 0: No, 1: Yes)	*Coffee ID*	0.211*** (0.087)

Note. Fit indicators: $\chi^2 = 9.344$, $df = 9$, $CMIN/df = 1.038$, $p = 0.406$, $RMR = 0.003$, $GFI = 0.993$, $AGFI = 0.984$, $RMSEA = 0.009$.
The value in parentheses corresponds to the standard error of the coefficient, obtained from bootstrapping with 5000 subsamples.
* indicates significance at 10% level.
** indicates significance at 5% level.
*** indicates significance at 1% level.

Institutions. Table 20 shows the loads or regression coefficients of the latent Institutions construct. The coefficients of the indicators *Trust on biological risk instruments, Trust on operational risk instruments, Trust on climate risk instruments* and *Trust on financial risk instruments*, statistically support the validity of the construct and represent confidence in the instruments that manage the different types of risk. The loads of the indicators of the latent Institutions construct are positively related to the construct and show that, at higher values of the indicators, the greater the value of the construct, which translates into greater confidence in the institutions that underlie the Colombian coffee sector to manage the risks of the coffee grower, which validates the hypothesis 6.

Table20

Measurement Model for the Latent Construct Institutions

Item	Indicator	Standardized regression coefficient
Average trust on institutions specialized on biological risk management. (E24index_bio, Likert scale: 1: minimum, 5: maximum)	*Trust on biological risk instruments*	0.973*** (0.005)
Average trust on institutions specialized on operational risk management. (E24index_oper, Likert scale: 1: minimum, 5: maximum)	*Trust on operational risk instruments*	0.913*** (0.009)
Average trust on institutions specialized on	*Trust on climate risk*	0.907***

climate risk management. (E24index_cli, Likert scale: 1: minimum, 5: maximum)	*instruments*	(0.009)
Average trust on institutions specialized on financial risk management. (E24index_fin, Likert scale: 1: minimum, 5: maximum)	*Trust on financial risk instruments*	0.967*** (0.005)

Note. Fit indicators: $\chi^2 = 0.42$, $df = 1$, $CMIN/df = 0.42$, $p = 0.517$, $RMR = 0.001$, $GFI = 0.999$, $AGFI = 0.995$, $RMSEA = 0.000$.
The value in parentheses corresponds to the standard error of the coefficient, obtained from bootstrapping with 5000 subsamples.
* indicates significance at 10% level.
** indicates significance at 5% level.
*** indicates significance at 1% level.

CONCLUSIONS

In order to identify the factors that describe the decisions associated with the risk of small-scale coffee growers, six latent constructs were constructed, which were validated in association with six hypotheses respectively. The results obtained for the first construct,*Outcome History,* validate hypothesis 1: The more successful the results of the decisions made in the past by the coffee grower, the greater their propensity to risk. Since the construct can be defined as an indicator of the success of the decisions and actions of the coffee grower in the past. Increasing values of the factor indicate better decisions and experiences of the coffee grower in relation to the context or environment, and lower values of the construct are associated with lower gratification or more frustrating experiences for the coffee grower.

On the other hand, the influence of the idiosyncratic characteristics of the problem on coffee grower' perceptions of risk, lead the grower to make risk-averse decisions if they are positively conceived situations, as Kahneman & Tversky (1979) put it. This allows affirming Hypothesis 2: The assessment as an opportunity or threat, on the part of the coffee grower, of a risky situation determines their perception of risk, and that the *Problem Framing* construct can be defined as an indicator of risk aversion. Thus, higher values of the factor indicate greater aversion to risk. Likewise, the four manifest variables associated with the *Risk Propensity* construct, and their respective loads, are all significant and satisfactorily define the latent construct, which represent an appropriate criterion to statistically support the convergent validity of the construct (Anderson & Gerbing, 1988), which represents the tendency of the coffee grower to take or avoid risks, which validates the hypothesis 3: The greater the risk propensity of a coffee grower, the lower the level of perception of the situation.

On account of the *Risk Perception* construct, the five associated manifest variables and their respective regression coefficients statistically support the convergent validity of the construct and of Hypothesis 4: The perception of risk by the coffee grower determines its form of risk management. Thus, they represent the individual evaluation of the risks before a situation and the confidence in that evaluation (Sitkin and Weingart, 1995). With respect to the *Risk Management* construct, five manifest variables and their respective significant coefficients define it as a set of strategies that characterize the alternatives confronted by a decision maker in situations of risk. Following Sitkin & Pablo (1992) is the risk component of the strategies available to the coffee grower, and this allows Validation of Hypothesis 5: The risk propensity level of the coffee grower determines its form of risk management.

Finally, the weight of the indicators of the latent construct*Institutions* are positively related to the construct and show that, at higher values of the indicators, the greater the value of the construct, which translates into greater confidence in the institutions that underlie the sector. Colombian coffee grower to manage the risks of the coffee grower, which validates the

hypothesis 6: The valuation of the institutions that underlie the coffee sector is directly related to the perception of risk by the coffee grower.

Another important result was the constructed risk taxonomy, since it revealed the inventory of risks to which the Colombian coffee grower is vulnerable, which will allow future studies to evaluate the sources of these risks in order to improve risk management instruments. Likewise, the taxonomy of risk management instruments will be useful for other sectors of agriculture with the same characteristics of the Colombian coffee sector to implement the institutional structure with which the coffee sector counts. Thus, synthesize these results in the six latent constructs: *Outcome History, Problem Farming, Risk Propensity, Risk Perception, Risk Management* and *Institutions*; it will make it possible to identify the existing relationships between the perceived risks, the perception of risk, and the effectiveness of the risk management instruments offered by coffee sector institutions.

REFERENCES

[1] Anderson, J. C., and Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*(3), 411-423. https://doi.org/10.1037/0033-2909.103.3.411

[2] Antwi-Agyei P, Peasey A, Biran A, Bruce J, Ensink J (2016) Risk Perceptions of Wastewater Use for Urban Agriculture in Accra, Ghana. *PLoS ONE*. 11(3): e0150603. doi:10.1371/journal.pone.0150603

[3] Bielza, M. (2004). Instrumentos de Gestión de Riesgo del Mercado. Aplicación al sector de la patata. (Tesis Doctoral. Universidad politécnica de Madrid, Escuela técnica superior de ingenieros agrónomos, Departamento de Economía y Ciencias Sociales Agrarias). Madrid, España.

[4] Brown, T. A. (2014). *Confirmatory factor analysis for applied research*. Guilford Publications.

[5] Carvajal Peláez, G. I. (2008). Modelo de cuantificación de riesgos laborales en la construcción: *ries-co*.

[6] Castellanos, E. J., Tucker, C., Eakin, H., Morales, H., Barrera, J. F., and Díaz, R. (2012). Assessing the adaptation strategies of farmers facing multiple stressors: Lessons from the Coffee and Global Changes project in Mesoamerica. *Environmental Science & Policy*. 20:23-32.

[7] Cenicafé-FNC (2013). *Informe Anual Cenicafé 2013*. Blanecolor S.A.S Colombia.

[8] Cheung, G. W., and Lau, R. S. (2008). Testing Mediation and Suppression Effects of Latent Variables: Bootstrapping With Structural Equation Models. *Organizational Research Methods, 11*(2), 296-325. https://doi.org/10.1177/1094428107300343

[9] Coble, K., Harwood, Y., Perry, J., and Somwaru, A. (1999). Managing Risk in Farming: Concepts, Research, and Analysis. Economic Research Service, U.S. *Department of Agriculture* 774: 14-79.

[10] Eakin, H., Tucker, C. M., Castellanos, E., Diaz-Porras, R., Barrera, J. F., and Morales, H. (2014). Adaptation in a multi-stressor environment: perceptions and responses to climatic and economic risks by coffee growers in Mesoamerica.*Environment, development and sustainability*, 16(1), 123-139.

[11] Echavarría, J. J., Esguerra, P., McAllister, D., & Robayo, C. F. (2014). Informe de la misión de estudios para la competitividad de la caficultura en Colombia. *Bogotá DC*.

[12] FNC de Colombia. (2013). *Sostenibilidad en Acción 2013*. Informe del Gerente General de la Federación de Cafeteros 2013.

[13] Frank, E., Eakin, H., and López-Carr, D. (2011). Social identity, perception and motivation in adaptation to climate risk in the coffee sector of Chiapas, Mexico.Global *Environmental Change*, 21(1), 66-76.

[14] Giovannucci, D., Pinard, F., Potts, J., Schuller, S., Soto, G., and Wunderlich, C. (2008). Seeking sustainability: COSA preliminary analysis of sustainability initiatives in the coffee sector.

[15] Heshusius, K. (2010). *Propuesta de Modelo de Sostenibilidad y Competitividad para la FNC de Colombia*. FNC de Colombia.
[16] Junguito, R., and Pizano, D. (1993). *Instituciones e instrumentos de política cafetera en*
[17] *Colombia 1927-1997*. Bogotá, Colombia: Fedesarrollo y Fondo Cultural Cafetero.
[18] Kahneman, D., and Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263-291.
[19] Katchova, A. and Barry, P. (2005). Credit Risk Models and Agricultural, *American Journal of Agricultural Economics*, 87(1): 194-205.
[20] Korstanje, M. (2011). Reconsiderando el concepto de Riesgo en Luhmann. Revista Mad, (22), 31-41.
[21] MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate behavioral research*, 39(1), 99-128.
[22] March, J. G., & Shapira, Z. (1987). Managerial perspectives on risk and risk taking. *Management science, 33*(11), 1404-1418.
[23] Ocampo, J. A. (2015). Misión para la transformación del campo. *Bogotá, DC: Departamento Nacional de Planeación, octubre*.
[24] Osborn, R. N., & Jackson, D. H. (1988). Leaders, riverboat gamblers, or purposeful unintended consequences in the management of complex, dangerous technologies. *Academy of Management Journal, 31*(4), 924-947.
[25] Quiroga, S., Suárez, C., and Solís, J. D. (2015). Exploring coffee farmers' awareness about climate change and water needs: Smallholders' perceptions of adaptive capacity. *Environmental Science & Policy*, 45, 53-66.
[26] Ramírez, L., Silva, G., Valenzuela, L., Villegas, A., and Villegas, L. (2002). *El Café capital social estratégico*: Informe final comisión de ajuste de la Institucionalidad cafetera. Bogotá, Colombia: FNC.
[27] Samper, M., and Topik, S. (2012). *Crisis y transformaciones el mundo del café*. Dinámicas locales y estrategias nacionales en un período de adversidad e incertidumbre. Bogotá, Colombia. Pontificia Universidad Javeriana.
[28] Sitkin, S. B., and Pablo, A. L. (1992). Reconceptualizing the determinants of risk behavior. *Academy of management review*, 17(1), 9–38.
[29] Sitkin, S. B., and Weingart, L. R. (1995). Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity. *Academy of management Journal*, 38(6), 1573-1592.
[30] Thaler, R. H., and Johnson, E. J. (1990). Gambling with the house money and trying to break even: The effects of prior outcomes on risky choice. *Management science, 36*(6), 643–660.
[31] Tjemkes, B., Henseler, J., & Furrer, O. (2015). Managers' Risk Propensity and Destructive Behavior in Buyer–Seller Relationships: An Application of PLS-analysis.
[32] Tucker C., Eakin, H., and Castellanos, E. (2010). Perceptions of risk and adaptation: Coffee producers, market shocks, and extreme weather in Central America and Mexico. *Global Environmental Change*, 20: 23-32.
[33] Van Winsen, F., de Mey, Y., Lauwers, L., Van Passel, S., Vancauteren, M., and Wauters, E. (2016). Determinants of risk behaviour: effects of perceived risks and risk attitude on farmer's adoption of risk management strategies. *Journal of Risk Research*, 19(1), 56-78.